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GLOBAL ENERGY CENTER

ISSUE BRIEF

Asian Energy Transition

Moving the Oil Market One Step Closer to Peak Demand?

JANUARY 2018 ROBERT J. JOHNSTON AND LILY GHEBRAI

The Asian economy is a "region of regions" with distinctive economies, patterns of industrial development, infrastructure, and resource security. While Japan and South Korea look hopefully to US crude and liquefied natural gas exports to mitigate decades-long dependence on Persian Gulf energy, the impact of US energy "dominance" will take time to be fully realized. Meanwhile, China's energy security is perhaps the strongest it has been since the country began importing crude oil in 1996. The prospect of deeper energy infrastructure connections and rail/maritime trade routes through the Belt and Road Initiative, alongside existing regional pipeline initiatives, bodes well for China's energy future. However, for all the improvements in energy security from the supply side, the region will still depend on hydrocarbon resources from the rest of the world to satisfy energy demand.

Greater disruption and transformation will likely come on the demand side, with the transportation sector being the main focal point of change. The transformation will be a spurred by a shift from rapid energy-intensive growth to improved efficiency, and focus on electrification. Slowing regional consumption will have significant market and geopolitical implications, particularly given the tepid prospects for energy-demand growth outside of Asia. Indeed, if a clean transportation revolution takes place in Asia, it would be a major signpost that the world is moving closer to a peak demand scenario for oil. While industry forecasts on a demand peak are wildly divergent, 56 percent of global oil demand is in the transportation sector—and Asia is predicted to be far and away the fastest-growing region for fuels in the road, maritime, and aviation sectors.[1]

The **Global Energy Center** promotes energy security by working alongside government, industry, civil society, and public stakeholders to devise pragmatic solutions to the geopolitical, sustainability, and economic challenges of the changing global energy landscape.

1 There are many data points on this, but one good example is the Organization of the Petroleum Exporting Countries' 2017 *World Oil Outlook 2040*. See https://woo.opec.org/index.php/woo-2017-figures. For an overview of diverging forecasts around peak demand, see Lynn Cook and Elena Cherney, "Get Ready for Peak Oil Demand," *Wall Street Journal*, May 26, 2017, https://www.wsj.com/articles/get-ready-for-peak-oil-demand-1495419061.

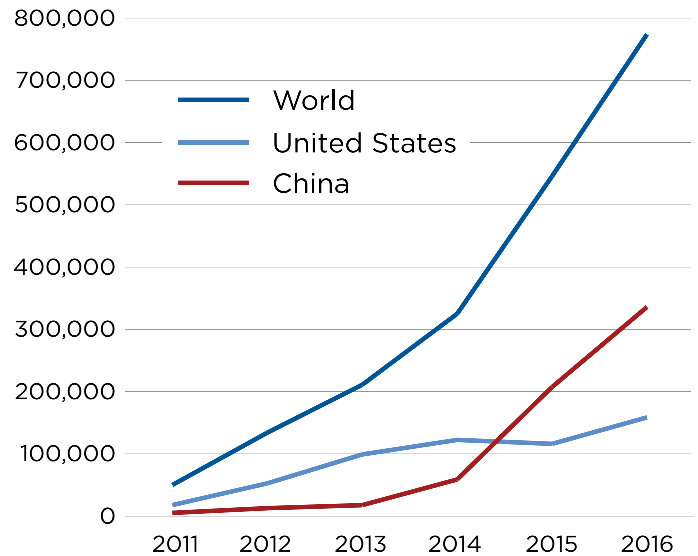
In contemplating the future trajectory of Asian demand, an important question to consider is the plausibility of electrification and deep decarbonization of the transportation sector in Asia. This issue brief argues that the Asian energy market has three critical factors that enable an acceleration away from fossil fuel–intensive energy dependence in the Asian energy market: energy insecurity, climate/environmental policy, and industrial policy.

To be sure, these factors are distributed unevenly across regional economies and, as such, the timing and pace of an energy transition will be mixed. Moreover, the Asian economy as a whole will likely remain the fastest-growing market for oil, gas, and coal, even as an energy transition takes hold. Nonetheless, a proactive and integrated approach to policy around climate, energy, and the economy is likely to result in Asia outpacing the rest of the world as the leader in the adoption of a portfolio of clean and disruptive technologies in the transportation sector.

A good starting point is to consider the transition that has already taken place in major Asian economies, specifically in the electric power sector. Renewable energy has gained significant ground in that sector, alongside nuclear power, more efficient combined-cycle gas-fired power plants, and ultra-supercritical coal power plants. In fact, China alone is responsible for more than 40 percent of global renewable capacity growth and has already surpassed its 2020 solar photovoltaic target. In the rest of developing Asia, off-grid generation capacity will nearly triple, surpassing three thousand megawatts in 2020, from industrial applications, mini-grids facilitated by government electrification programs, and private sector investment.[2] China has leveraged its manufacturing base and low-cost capital to become the global industrial leader in clean electricity technology and is the largest generator of solar-powered electricity.

Japan has also seen significant momentum toward renewable power generation and aspires to build around hydrogen to reestablish itself as a leader in both the clean energy and automotive spaces. Similarly, in South Korea, the development of information and communication technology (ICT)–based eco-

Figure 1. Electric Vehicle Sales



Source: China Association of Automobile Manufacturers.

technologies will not only keep South Korea on track to reduce greenhouse gas (GHG) emissions by 30 percent by 2020, but will also be vital to ensuring the success of several smart-city projects.[3]

The same model that has facilitated this power sector transition is likely to accelerate energy transition within the transportation sector, as the same combination of energy insecurity, climate/environmental policy, and industrial policy is setting the stage for a clean transportation breakthrough. Government agencies like China's National Development and Reform Commission; Japan's Ministry of Economy, Trade and Industry (METI); and South Korea's Ministry of Knowledge Economy help coordinate industry investment goals and quotas, facilitating system-wide transition encompassing both the energy and transportation sectors. Asian manufacturing, finance, energy, and transportation firms are comfortable with government-led industrial policy, in contrast to Western countries, where combinations of voluntary industry commitments and government incentives complement mostly market-led energy transformation.

2 "Renewables 2017: Key Findings," International Energy Agency, Organisation for Economic Co-operation and Development/International Energy Agency, October 4, 2017, www.iea.org/renewables/#section-2-4.

3 "Korea Emissions Trading Scheme," International Carbon Action Partnership, last updated October 10, 2017, icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=47.

The China Railways CRH380 is a high-speed electric train model in use throughout China. The 380, which emerged out of the national technology support program in China's 2009 "Eleventh Five-Year Plan," can accelerate up to 236 mph in 7 minutes and its regenerative braking system can feed up to 800 kWh back into the electric grid with each stop. *Photo credit*: Jucember/Wikimedia.

China's Electric Future

In China, the government's ability to effectively leverage climate, energy, and industrial policy to address energy insecurity needs has facilitated a monumental shift away from fossil fuel dependence toward clean electricity technology. China is already dominant in solar power through a combination of industrial policy might and a strong energy/environment agenda, but policy makers in Beijing now see electric vehicles (EVs) as the next crucial element of China's "new energy economy."[4]

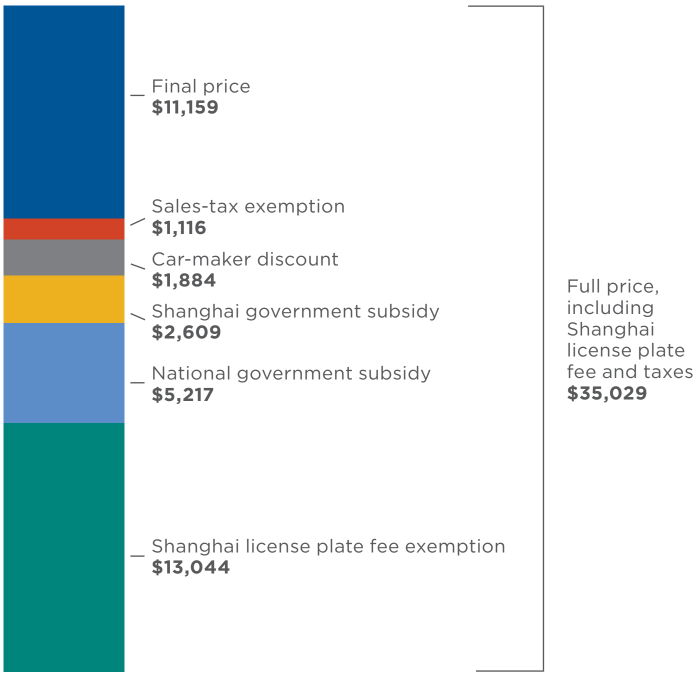
Made in China 2025: Restructuring Chinese Industry

"Made in China 2025" is a strategic set of policies that Beijing developed with the aim of comprehensively upgrading Chinese industry, including information technology, automated machine tools and robotics, aerospace and aeronautical equipment, maritime equipment and high-tech shipping, modern rail transport equipment, new energy vehicles and equipment, and power equipment.[5] The government has increased investment in these areas as they support the country's vision to develop new green technologies, enhance existing electrification capabilities, and strengthen domestic manufacturing. In fact, these priority sectors have been identified as vital to ensuring China's long-term energy security and manufacturing dominance, and thus, have enjoyed staunch policy support in the form of government subsidies and relaxed regulations.

4 "China and the New Energy Economy," S&P Global Platts, last updated October 31, 2017, https://www.platts.com/latest-news/electric-power/london/feature-china-and-the-new-energy-economy-26831057.

5 Scott Kennedy, "Made in China 2025," Center for Strategic & International Studies, June 1, 2015, www.csis.org/analysis/made-china-2025.

Figure 2. Shanghai EV Subsidies



Source: Beijing Automotive Industry Corp.

Electric Vehicles—China's New Competitive Edge in Manufacturing?

China's efforts to enhance its electrification capabilities can be best demonstrated by the government's unwavering support of its booming EV market. Indeed, the government has forcefully carved out and cultivated this market by funding its own manufacturers, attracting domestic buyers with subsidies, and providing preferential license-plate processes for EVs in crowded cities like Beijing and Shanghai. The Made in China 2025 program also illustrates the intersection between more innovation-driven manufacturing and the growing EV market. The Ministry of Industry is launching an extensive certification process requiring EV production facilities to master any technologies they are manufacturing. As a result, Chinese-made models are dominating the domestic market, with sales of plug-in passenger vehicles surpassing 350,000 in 2016. In addition, new rules will require 8 percent of car sales in China to be electric as early as next year, and 12 percent by 2020.[6]

The electrification of transport has been identified as an essential tool to combat China's fossil fuel dependence. In 2016 alone, transportation in China required 2.5 million barrels of gasoline a day, which is projected to rise to 3.6 million by 2024.[7] As such, the Chinese government continues to heavily subsidize EVs through payments to the abovementioned manufacturers, which are in turn able to sell EVs more cheaply. Official targets currently call for 40 percent of cars bought in China in 2030 to be pure EVs or plug-in hybrids, with the goal of as many as thirty-two million so-called "new energy vehicles" in China by 2025.[3]

The Chinese government's generous EV incentives have proved to be very effective in driving sales. The government has provided $8 billion in subsidies since it began promoting EVs in 2009.[8] These measures aim to support China's plan to put five million EVs on highways by 2020.[9] China's promotion of EVs also drives demand for batteries and the materials that compose them. When subsidies amounted to nearly 60 percent of an EV's full price, sales quadrupled and facilitated heavy trading of lithium and cobalt—crucial battery components. While roughly 55 percent of global lithium-ion battery production is already based in China (compared with 10 percent in the United States), China's share is forecast to grow to 65 percent by 2021. Indeed, the Chinese government sees lithium-ion batteries as a major industry in the Made in China 2025 plan. As policy support for EVs continues, global battery-making capacity is expected to more than double by 2021 to 273 gigawatt hours, up from 103 gigawatt hours today.

While EVs are receiving most of the media and market attention, China's clean transportation agenda has several other vital components, including the electrification of mass transport. State-owned operator China Railway had a $115.1 billion budget for 2017, which supported the construction of 2,100 kilometers (km) of a new mainline railway, including the electrification of 4,000 km of railway during the year. In addition to these efforts, electric locomotives will

6 Emily Feng and Charles Clover, "China Puts a Stop to Electric-Car Gold Rush," *Financial Times*, June 27, 2017, www.ft.com/content/891d8264-5016-11e7-bfb8-997009366969?mhq5j=e5.

7 Trefor Moss and Brian Spegele, "Gas Guzzlers Rule in China," *Wall Street Journal,* May 21, 2017, www.wsj.com/articles/gas-guzzlers-rule-in-china-1495418821?mg=id-wsj.

8 Trefor Moss, "China, with Methodical Discipline, Conjures a Market for Electric Cars," *Wall Street Journal*, October 2, 2017, www.wsj.com/articles/china-with-methodical-discipline-takes-global-lead-in-electric-cars-1506954248.

9 Joe Ryan, "China Is about to Bury Elon Musk in Batteries," *Bloomberg*, June 28, 2017, www.bloomberg.com/news/articles/2017-06-28/china-is-about-to-bury-elon-musk-in-batteries.

be manufactured locally by 2020.[10] Other significant policies include rapid growth in ride sharing and bicycle sharing,[11] support for advanced biofuels, smart cities, and mass transit projects, and a proposed ban on internal combustion engine (ICE) vehicles. Echoing many policies in China, the ICE ban would be the "stick" complementing the "carrot" of generous subsidies for EV production.[12]

Japan's Hydrogen Revolution

The Pursuit of a Hydrogen Society

There is also a strong alignment between climate, energy, and industrial policy in Japan. Among its flagship initiatives is hydrogen, as the government intensifies its focus on the pursuit of a hydrogen society. For resource-poor Japan, hydrogen is a particularly attractive energy alternative because it can be produced from a wide variety of sources, including natural gas, coal, biomass, solar or wind power, and nuclear power. Hydrogen, which offers a potential solution to Japan's decades-long dependence on foreign oil, also presents several new opportunities in the clean energy and automotive spaces.

Central to Japanese plans are hydrogen fuel cell vehicles.[13] There are many fuel cell technologies, but the core models for passenger vehicles use water and hydrogen to power a fuel cell, which in turn powers an electric motor.[14] The upsides of hydrogen fuel cell

"For resource-poor Japan, hydrogen is a particularly attractive energy alternative because it can be produced from a wide variety of sources. . ."

versus electric battery vehicles are the subject of much debate, but are generally said to include longer ranges, less need for strategic minerals and lengthy recharge times, and linkages to broader industrial and household applications.[15] As most hydrogen is made from natural gas or coal, without carbon capture and storage technology, hydrogen production remains an emissions-intensive process, even though tailpipe GHG emissions are zero.

However, Japanese automakers' ultimate goal would be to produce hydrogen from clean energy sources. This would involve either using nuclear power or renewable electricity to power hydrogen production from the steam reforming of natural gas, or through an electrolysis process that can produce liquid hydrogen from water. These processes are controversial, as some critics argue that renewable electricity would be more efficiently directed to powering plug-in EVs rather than hydrogen production.[16]

Hydrogen represents just one of Japan's low-carbon solutions for the transportation sector, as there are still several barriers to realizing a hydrogen society, including scale, cost, infrastructure, and underdeveloped technology. Nonetheless, hydrogen continues to play a major role in the country's national climate strategy, industrial policy, and energy security, as the government anticipates it will replace imported

10 Kevin Smith, "China Railway Sets Out 2017 Targets," *International Railway Journal*, January 4, 2017, www.railjournal.com/index.php/financial/china-railway-sets-out-2017-targets.html.

11 Ride sharing and bicycle sharing are beyond the scope of this issue brief, but will be examined further in an upcoming study from the Atlantic Council Global Energy Center. For an overview of key Asian players in ride sharing, see Mayumi Negishi and Phred Dvorak, "A Multibillion-Dollar Bet on One Question: Who Owns the Future of the Automobile?" *Wall Street Journal*, updated November 13, 2017, https://www.wsj.com/article_email/softbank-calls-uber-to-get-to-ride-hailing-network-goal-1510575441-lMyQjAxMTA3OTEzMzQxNDMyWj/.

12 "China Moves towards Banning the Internal Combustion Engine," the *Economist* (Print Edition), September 14, 2017, https://www.economist.com/news/business/21728980-its-government-developing-plan-phase-out-vehicles-powered-fossil-fuels-china-moves.

13 Umair Irfan, "Japan Bets on a Hydrogen-Fueled Future," *Climate Wire*, May 3, 2016, https://www.scientificamerican.com/article/japan-bets-on-a-hydrogen-fueled-future/.

14 Fuel cells are energy conversion devices that can power anything from handheld devices, to personal vehicles, trucks, and buses, and can directly convert chemical energy in hydrogen to electricity, with pure water and heat as the only byproducts. Hydrogen's scalability also makes it an attractive energy alternative to power a variety of applications, including laptop computers (50-100 watts), homes (1-5 kilowatts), vehicles (50-125 kilowatts), and central power generators (1-200 megawatts or more). US Department of Energy, Hydrogen Program, *Hydrogen Fuel Cells Fact Sheet*, October 2006, www.hydrogen.energy.gov/pdfs/doe_fuelcell_factsheet.pdf.

15 Norihiko Shirouzu, "Hydrogen Fuel-Cell Car Push 'Dumb'? Toyota Makes a Case for the Mirai," Thomson Reuters, October 26, 2017, https://www.reuters.com/article/us-autoshow-tokyo-hydrogen/hydrogen-fuel-cell-car-push-dumb-toyota-makes-a-case-for-the-mirai-idUSKBN1CV0I2.

16 Joe Romm, "Tesla Trumps Toyota: Why Hydrogen Cars Can't Compete with Pure Electric Cars," ThinkProgress, August 5, 2014, https://thinkprogress.org/tesla-trumps-toyota-why-hydrogen-cars-cant-compete-with-pure-electric-cars-326468e3dbc2/.

The 2017 Toyota Mirai, which uses hydrogen fuel cell technology, on display at the Washington Auto Show in Washington, DC. Initially launched in 2015, the 2018 Mirai is expected to have a 312 mile range and a combined fuel economy of 67MPGe (miles per gallon equivalent). *Photo credit:* Mariordo/Wikimedia.

petroleum and minimize its exposure to an otherwise volatile oil market.

Could Hydrogen Put Japanese Industry Back in the Lead?

In Japan, public and private sector partnerships are instrumental in realizing the country's vision of a hydrogen society. The government has teamed up with several local and international corporate sponsors, and it continues to offer heavy subsidies for corporate hydrogen projects. One major motivation for this strategic collaboration is to present itself as a global leader in the clean energy space ahead of the 2020 Summer Olympics in Tokyo. Furthermore, Japan's push for hydrogen projects occurs as China is emerging as a climate leader, while the United States continues to downgrade its commitment to reducing carbon emissions.

Aside from establishing Japan as a global leader in clean energy, the hydrogen campaign could also reintroduce Japanese automakers, such as Honda and Toyota, as leaders in developing alternative power trains, similar to in the late 1990s and early 2000s. In fact, Japan aims to have forty thousand fuel cell vehicles in operation by 2020, two hundred thousand by 2025, and eight hundred thousand by 2030.[17]

To facilitate this societal transformation, Japan plans to make significant advances in the establishment of a carbon-free hydrogen manufacturing process, including the development of a nationwide hydrogen distribution system. The cost of creating a hydrogen distribution system remains one of the biggest barriers to more rapid adoption, particularly with respect to safety regulations around refueling stations.

17 Hans Griemel and Okamura Naota, "Japan Dreams of a Hydrogen Society," *Automotive News*, April 24, 2017, www.autonews.com/article/20170424/OEM06/304249965/japan-dreams-of-a-hydrogen-society.

Japan's Ministry of Economy, Trade and Industry Continues to Support Visions of a Hydrogen Society

By 2025, METI plans to have 320 hydrogen stations in operation, with 900 stations by 2030. The government currently pays for as much as two-thirds of the cost of each hydrogen station and heavily subsidizes hydrogen fuel, reducing the price to less than $10 a kilogram. The government also continues to provide heavy subsidies to consumers. Indeed, a buyer can receive up to $17,960 in subsidies for the purchase of fuel cell vehicles, while local governments offer incentives on top of that. For example, Tokyo's local government provides another $8,980 to fuel cell vehicle buyers. At this rate, the country's annual hydrogen and fuel cell market is forecast to hit 1 trillion yen ($9 billion) in 2030, and roughly 8 trillion yen in 2050.[18]

The Japanese government's strategic alignment of public and private sector interests has been vital to its pursuit of a hydrogen society. Strong ministerial support, government investment, and buy-in from key local and international corporate sponsors may help wean Japan off decades-long fossil fuel dependence and shift the focus to hydrogen technology.

Yet, the path ahead is a challenging one, and Japanese automakers are already hedging their bets on hydrogen by increasing investments in hybrid and plug-in EVs, with an eye to fierce competition from China and South Korea.[19] Hydrogen is not yet playing a significant role in reducing Japanese oil dependence, but government commitment will ensure that it remains one of the leading technologies in its clean transportation portfolio for the next several years.

South Korea Dreams of a Low-Carbon, Green-Growth Society

Because of rapid economic progress and urbanization between the 1990s and early 2000s, South Korea has the fastest-growing GHG emissions of any member country in the Organisation for Economic Co-operation and Development. Like China and Japan, South Korea is also reliant on energy imports, and its dependence on foreign and fossil-based energy has reached unsustainable levels in recent years. In 2010, 95 percent of total emissions came from fossil-based energy sources, and 97 percent of total energy need came from imports.

To address this issue, South Korea launched the "low-carbon, green-growth" initiative, which aims for a 30 percent reduction in GHGs by 2020, and a 37 percent reduction by 2030. This strategic plan rests on three pillars: development of a fossil fuel–independent and low-carbon society, mobilization of green industries as an engine for economic growth, and establishment of South Korea as an international leader against climate change.

The successful mobilization of green industries for economic growth in South Korea, similar to Japan and China, has been driven by several strategic public and private partnerships. The South Korean government continues to partner with essential corporate stakeholders on a variety of green initiatives, ranging from emissions reduction to the development of smart-city infrastructure, to end the nation's dependence on fossil fuels.

As a major component of this vision, South Korea established the national Emission Trading Scheme (ETS) in January 2015. The ETS covers approximately 525 of the country's largest emitters, which account for around 68 percent of national GHG emissions.[20] Like Japan, South Korea looks to several public and private sector partnerships to fund its green initiatives. ETS stakeholders include several private sector partners and ministries, including the Ministry of Environment and the Ministry of Strategy and Finance, while the government continues to fund these green-growth initiatives by using public expenditures to spur private finance.

The government has already pledged $2 billion in public support, and it spends about 2 percent of its gross domestic product annually on green-growth measures, while government research and development

18 Lefteris Karagiannopoulos et al., "Norway Races Australia to Fulfill Japan's Hydrogen Society Dream," Thomson Reuters, April 28, 2017, www.reuters.com/article/us-japan-hydrogen-race/norway-races-australia-to-fulfill-japans-hydrogen-society-dream-idUSKBN17U1QA.

19 Patrick George, "Japan's Automakers Finally Wise Up to the Electric Future," The Morning Shift, November 28, 2016, https://jalopnik.com/japans-automakers-finally-wise-up-to-the-electric-futur-1789423109; Julian Spector, "Why Toyota's Next Move Is Solid-State Batteries," Green Tech Media, July 28, 2017, https://www.greentechmedia.com/articles/read/toyotas-next-move-solid-state-batteries.

20 "National Green Growth Strategy of the Republic of Korea," National Green Growth Strategy of the Republic of Korea, Partnership on Transparency in the Paris Agreement, www.transparency-partnership.net/gpa/national-green-growth-strategy-republic-korea.

(R&D) investment in green technologies increased by 40 percent between 2009 and 2012. In 2012 alone, R&D investment reached $2.6 billion, the majority of which was invested in more than twenty core green technologies, while private sector investment in such technologies increased by 75 percent between 2008 and 2010. Following President Moon Jae-in taking office in 2017, there is a renewed sense of urgency around green growth, including a proposed phaseout of diesel passenger vehicles and new support for EVs.[21]

South Korea's Smart Cities

In addition to launching the low-carbon, green-growth program, the South Korean government has invested heavily in smart-city infrastructure. Smart cities are a new focal point of urban planning and seek to combine high-density housing, efficient use of mass transportation, pedestrian- and bicycle-friendly streets, as well as closed-loop clean systems for power generation, waste management, and heat. Smart cities are designed to reduce the need for single-passenger vehicles and long-distance trips for work and shopping, while also improving traffic flow and curtailing emissions from idling vehicles.[22] Smart cities are viewed as an important strategy for building sustainable cities and communities and are listed as a priority United Nations Sustainable Development Goal.[23] Through its smart-city endeavors, the South Korean government hopes to make significant advances in the development of ICT-based eco-technologies.

South Korea's most notable smart-city project, Songdo U-City, covers 52.4 km in the Incheon Free Economic Zone (IFEZ). It has been very successful and is considered a model smart city by many urban planners, as all aspects of the city are effectively integrated with state-of-the-art ICT. This project, into which $308.4 million has been invested, is also the result of a public-private partnership.[24] Indeed, the Incheon U-City Corporation, established in 2012, is aimed at taking care of IFEZ's U-City business. This corporation was established by CENTIOS, a partnership between Incheon City, KT Corporation, and Cisco.

It is important to note that smart cities are not only confined to developed geographies, such as Japan,[25] South Korea, and Singapore, but are also of growing interest in frontier Asia. One regional study listed Manila, Kolkata, Mumbai, Bangalore, and Ho Chi Minh as Asia's most "stagnant" cities in need of smart-city-type innovation.[26] Indeed, Thailand, Malaysia, Vietnam, Indonesia, and the Philippines have all pursued smart-city initiatives of their own in hopes of developing more streamlined, fuel-efficient systems, particularly in the mass-transport sphere.[27] One regional study listed twenty cities in the Association of Southeast Asian Nations as pursuing various stages of smart-city initiatives.[28] As these are also high-growth markets for oil and related GHG emissions from the transportation sector, the successful transplant of smart-cities innovation to emerging markets in southeast Asia and south Asia will be a key signpost for future oil demand and climate/pollution problems across the region.[29]

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21 John Burton, "Green Growth Revival," *Korea Times*, last updated May 17, 2017, http://www.koreatimes.co.kr/www/opinion/2017/09/396_229535.html; Kim Bo-gyung, "Moon to Foster EVs as New Growth Engine," *Korea Herald*, last updated May 24, 2017, http://www.koreaherald.com/view.php?ud=20170522000776.

22 This definition is skewed toward the focus of this paper on transportation and energy; in fact like "clean energy" there are multiple and at times conflicting definitions of "smart city." See: Nada Nohrova et al., "Smart Cities," Centre for Cities, May 29, 2014, http://www.centreforcities.org/reader/smart-cities/what-is-a-smart-city/1-smart-cities-definitions/.

23 Todd Ashton, "How Can We Ensure Asia Future Cities Are Both Smart, and Sustainable?" World Economic Forum on ASEAN, May 11, 2017, https://www.weforum.org/agenda/2017/05/creating-smart-and-sustainable-cities/.

24 Kyunam Kim, Jung-Kyu Jung, and Jae Young Choi, "Impact of the Smart City Industry on the Korean National Economy: Input-Output Analysis," *Sustainability* 8, no. 7, 2016: 649, http://www.mdpi.com/2071-1050/8/7/649.

25 Japan is including hydrogen in its smart city designs. See "Panasonic and Nomura Real Estate Unveil Concept Plan for New Smart Town in Yokohama," Business Wire, March 28, 2016, http://www.businesswire.com/news/home/20160328005785/en/Panasonic-Nomura-Real-Estate-Unveil-Concept-Plan.

26 Kate Ng, "What Is a 'Smart City' and How Does Asia Rank among the World's Best?" Tech Wire Asia, August 24, 2016, http://techwireasia.com/2016/08/smart-city-asia/.

27 In Thailand, multiple mass rapid transit lines are currently under construction in Bangkok, and there are proposals to also develop a high-speed rail network. In Malaysia, the electrified double track project in Klang Valley is nearing completion. In the Philippines, the Department of Transportation and Communications has awarded light rail transit 1 Cavite Extension project. Several other projects are underway, including the development of further LRT extensions and a 900 km integrated railway in Luzon. In Indonesia, the Jakarta MRT is under construction, and phase one of operation is planned to start by 2018. More broadly, urban transit rail projects have been planned for numerous cities, including Bali, Bandung, South Sumatra, Surabaya, and Surakarta.

28 Economist Intelligence Unit, *Startup My City: Smart and Sustainable Cities in Asia*, the *Economist*, February 6, 2016, http://social-innovation.hitachi/sg/about/startupmycity/pdf/EIU-Startup-My-City-Briefing-Paper.pdf.

29 The Institute of Energy Economics, Japan (IEEJ) suggests in its latest outlook that India and Southeast Asian oil demand growth will both outpace that in China over the 2015 to 2050 forecast period. See The Institute of Energy Economics, Japan, "IEEJ Outlook 2018: Prospects and Challenges until 2050," presentation

Songdo U-City, formally known as the Songdo International Business District, is a $35 billion "ubiquitous" city with over 20 million square feet of LEED-certified space. Located near the port of Incheon, Songdo uses "smart" infrastructure to improve resiliency and access to public services. *Photo credit*: Ken Eckert.

Conclusions

While the United States and Europe are considered the pioneers of renewable energy, Asia is emerging as a major player in the renewable energy transition and will likely lead the competition as clean energy transportation technology advances. For the past eight years, China has been the single largest developer of renewable power and heat, with investment in renewable power and fuels surpassing that of the United States in 2016.[30] The rest of Asia is following China's lead, applying inclusive green-growth strategies to several leading industries. Government policies and incentives bolstering energy efficiency, electrification, and decarbonization of vital sectors will continue to reduce fossil fuel dependence. The largest oil-consuming countries in the region, including China, Japan, and South Korea, have implemented national climate strategies—all of which align industrial and environmental policy, while also addressing their respective energy insecurity needs.

The Made in China 2025 plan aims to redress Chinese energy insecurity by applying electrification to several critical sectors and spurring innovation-driven manufacturing. In doing so, China hopes to further widen its lead in global clean manufacturing technology. In Japan, a hydrogen revolution not only presents a potential solution to decades-long energy insecurity, but also offers several opportunities for its automotive industry. The South Korean government has leveraged several strategic public-private partnerships to address energy inefficiency and to mobilize green industries for economic growth. Both the ETS and the Songdo U-City are the result of corporate investment and government R&D.

presented at the 427th Forum on Research Work, Tokyo, Japan, October 12, 2017, 6, http://eneken.ieej.or.jp/data/7577.pdf.

30 Kristin Seyboth and Freyr Sverrisson, "Advancing the Global Renewable Energy Transition," Renewable Energy Policy Network for the 21st Century (Ren21), June 2017, www.ren21.net/wp-content/uploads/2017/06/GSR2017_Highlights_FINAL.pdf.

As for the rest of developing Asia, the electrification of mass transport is simply a scratch on the surface of a broader energy—and societal—transition just waiting to take hold. To be sure, the barriers to success are high, given the lack of effective public-private partnerships for industrial policy, overwhelming pollution problems, lack of capital for new infrastructure, and weak governance in many emerging Asian markets. However, these problems are in many ways the catalysts for action, and emerging Asian governments are turning to China, South Korea, and Japan for support in managing their own transitions to a clean transportation economy.

If successful, this transition will help cement new trade and investment relationships, reduce the rate of oil consumption growth in the region, and present hope for more manageable GHG emissions reductions over time. Whether that reduction in the oil consumption growth rate will in turn lead to "peak demand" for oil is a considerably different, albeit related question. There are many arguments looking at the resilience of oil demand, from population growth to challenges scaling alternative transportation technologies, to the cyclical nature of oil supply and demand. Nonetheless, even with these questions, it is probably safe to say that without material changes in the trajectory of oil demand in the Asian transportation sector, peak demand is highly unlikely.[31]

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31 Michael Lynch, "What the Prophets of Peak Oil Demand Are Missing," *Forbes*, May 26, 2017, https://www.forbes.com/sites/michaellynch/2017/05/26/peak-oil-demand-a-little-history-lesson/#664b69a12fbb.

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