NOVEMBER 2017

Energy and Development

Providing Access and Growth

AUTHORS
Sarah Ladislaw
Philippe Benoit

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

A Report of the
CSIS ENERGY AND NATIONAL SECURITY PROGRAM

NOVEMBER 2017

Energy and Development

Providing Access and Growth

AUTHORS
Sarah Ladislaw
Philippe Benoit

A Report of the
CSIS ENERGY AND NATIONAL SECURITY PROGRAM

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

About CSIS

For over 50 years, the Center for Strategic and International Studies (CSIS) has worked to develop solutions to the world's greatest policy challenges. Today, CSIS scholars are providing strategic insights and bipartisan policy solutions to help decisionmakers chart a course toward a better world.

CSIS is a nonprofit organization headquartered in Washington, D.C. The Center's 220 full-time staff and large network of affiliated scholars conduct research and analysis and develop policy initiatives that look into the future and anticipate change.

Founded at the height of the Cold War by David M. Abshire and Admiral Arleigh Burke, CSIS was dedicated to finding ways to sustain American prominence and prosperity as a force for good in the world. Since 1962, CSIS has become one of the world's preeminent international institutions focused on defense and security; regional stability; and transnational challenges ranging from energy and climate to global health and economic integration.

Thomas J. Pritzker was named chairman of the CSIS Board of Trustees in November 2015. Former U.S. deputy secretary of defense John J. Hamre has served as the Center's president and chief executive officer since 2000.

CSIS does not take specific policy positions; accordingly, all views expressed herein should be understood to be solely those of the author(s).

Acknowledgments

This report is made possible by the generous support of Chevron Corporation.

Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.csis.org

Energy and Development

Providing Access and Growth

Sarah Ladislaw and Philippe Benoit[1]

Energy has played, and will continue to play, a pivotal role in the economic development of the world's major emerging economies and other developing countries. Increasingly, these countries will serve as the centers of energy-demand growth and energy investments. As such, the decisions they make about how to develop their energy sectors will be important to not only their own development but also in determining future levels of energy consumption, fuel choices, patterns of trade, and other factors. These countries are influenced not only by their own domestic priorities, policies, and regulations, but also by the international investor and donor communities. Several major shifts are taking place in the energy and development landscapes that warrant increased attention from policymakers, academia, and the private sector.

In late 2016 and early 2017, the CSIS Energy and National Security Program conducted research and held workshops to understand these changing dynamics and determine the key questions facing the energy and development sectors about how best to facilitate sustainable strategies for further growth. The initial focus of these workshops was on expanding access, but the issues addressed extended beyond this important poverty-alleviation aspect to broader development objectives. This report summarizes our findings and proposes additional areas for further research. It is structured as follows:

- Overview of the shifts in global energy demand, particularly the emergence of developing countries as the drivers of future energy demand
- The opportunities for the private sector presented by this shift in the energy landscape to emerging economies
- The increased focus on energy access and the international goal of universal access, renewable energy, and energy efficiency
- The influence of sustainability and climate change considerations on energy production and use in developing countries
- Specific actions to enhance the role of energy in promoting sustainable economic growth in developing countries.

[1] Sarah Ladislaw is director and senior fellow in the CSIS Energy and National Security Program. Philippe Benoit is a senior associate of the CSIS Energy and National Security Program and managing director of the Global Infrastructure Advisory Services 2050.

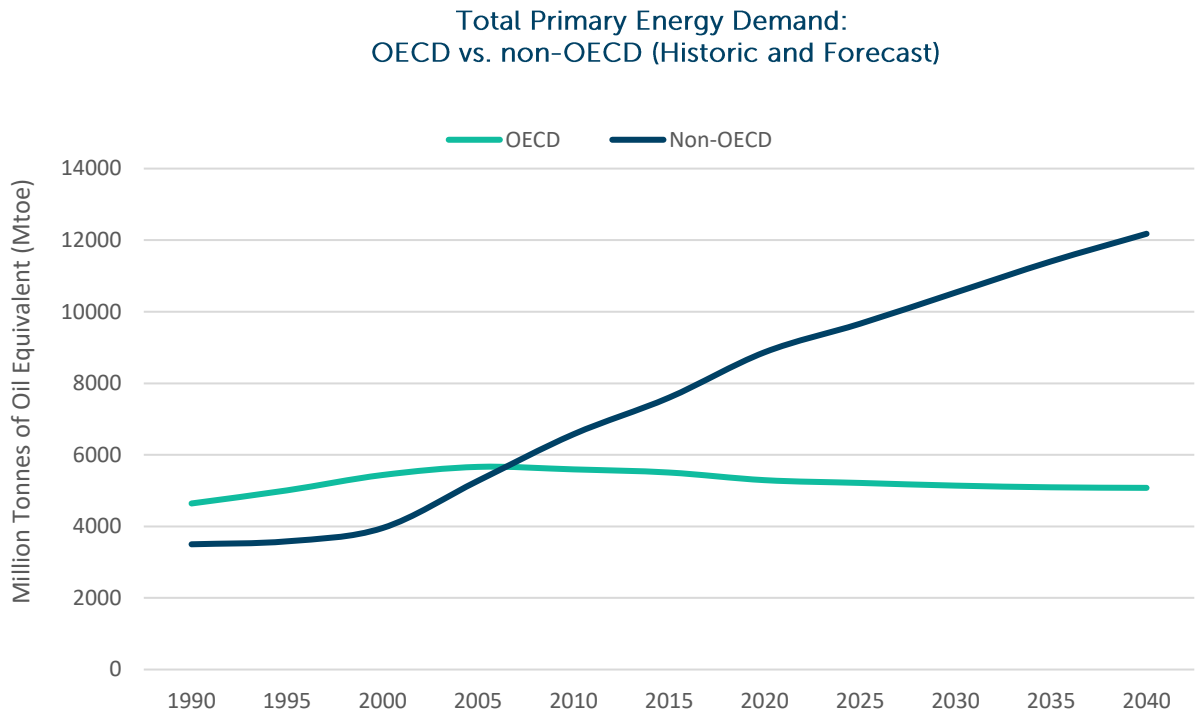
Energy will remain central to future efforts to promote further economic and social growth in developing countries. The public and private sectors have a shared interest in maximizing the economic growth generated by their energy investments and in devising strategies to take advantage of new opportunities that emerge. Accordingly, we plan to explore these themes further in the future.

An area of particular importance for energy producers and users, as well as other energy stakeholders, is to better understand how developing countries will be using energy in the future and the corresponding implications for international trade and security. From more natural gas trade, to more solar, to continued albeit moderate growth for oil, a better understanding of the forces driving energy demand in the developing world will improve our ability to manage our future. Areas of interest include urban development strategies that will need to cope with a population increase of 2 billion people in urban areas over the next several decades, and a transportation sector poised to explode in size as it serves not only a massively increasing global population but also richer inhabitants demanding more personal and freight services. Other key areas of further inquiry are the role of natural gas in various developing country contexts, the evolving role of state-owned enterprise, and the role of innovation in meeting the energy needs of developing countries. Further workshops and research will address these aspects.

Virtually all future energy demand growth is coming from developing economies

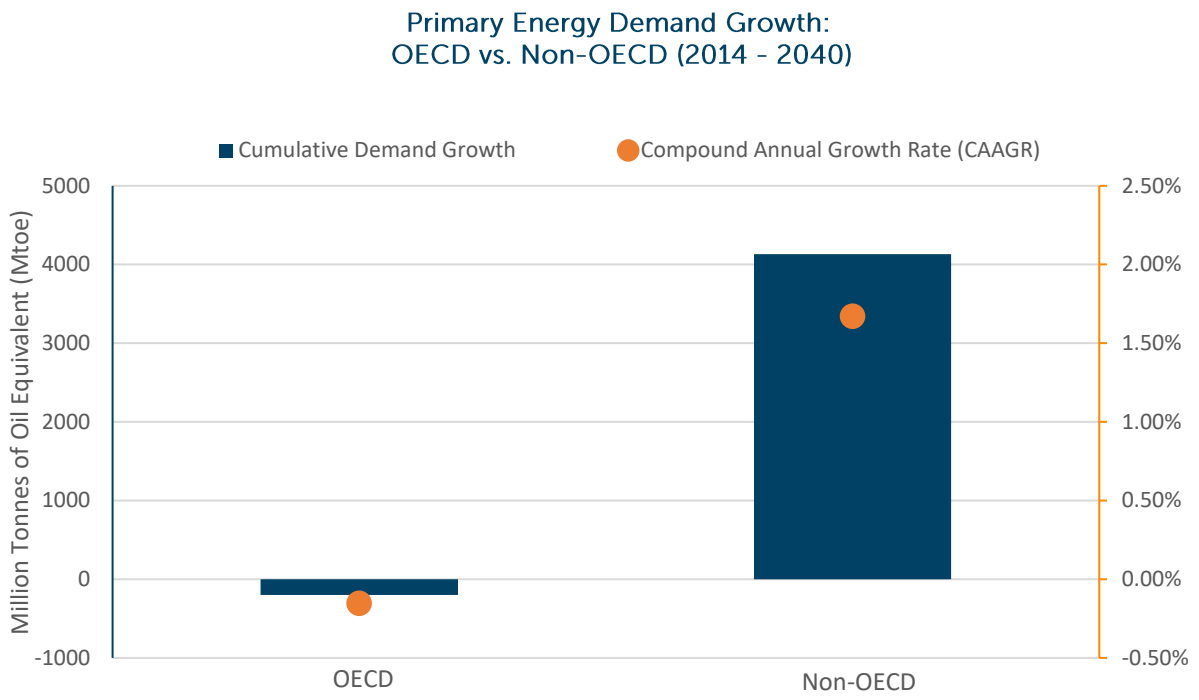
One thing all major energy outlooks agree upon is that future growth in energy demand is a developing-country story. While developed economies will still need additional energy investment and are projected to experience some periods of demand growth over the coming decades, energy demand is expected to remain largely flat or decline across these economies, including in the United States, Europe, and Japan. It has been just over a decade since developing countries overtook developed countries in terms of overall energy consumption.[2] Developing economies now account for 58 percent of total energy consumption relative to developed countries at 42 percent.[3]

[2] These figures are based on comparing data for Organization for Economic Cooperation and Development (OECD) countries representing "developed" and non-OECD countries representing "developing."
[3] Data from BP, *BP Statistical Review of World Energy—underpinning data, 1965–2016* (London: BP, 2017), http://www.bp.com/content/dam/bp/en/corporate/excel/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-underpinning-data.xlsx.



Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from BP and IEA Data (August 2017)

Global energy demand is forecast to grow by 25 percent between 2014 and 2040, but that growth differs significantly between developed and developing countries. By 2030 developing countries are projected to account for twice the level of aggregate energy demand of developed economies. According to the International Energy Agency (IEA) projections, developed-country energy demand is slated to shrink by 0.1 percent per year on average between now and 2040 while developing countries grow by 1.6 percent per year. To put this in perspective, developing-country energy demand is forecast to grow by almost the equivalent of two times current U.S. energy demand over the next couple of decades. The largest increments of growth in absolute terms will come from Asia, followed by Africa and the Middle East; the Middle East will grow at the fastest rate, followed by Africa and Asia. India experiences both the fastest and largest total growth between 2014 and 2040 but its absolute energy consumption will still lag behind China's even by the end of the forecast period.



Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from IEA Data (August 2017)

Over the next couple of decades virtually all energy demand growth is forecast to come from three main groups: China, India, and a block of 10 other developing countries.

The growth in developing-country energy demand is evenly split into thirds attributable to China, India, and a group of 10 "key countries": Brazil, Mexico, South Africa, Nigeria, Egypt, Turkey, Saudi Arabia, Iran, Thailand, and Indonesia.[4] Most global energy outlooks agree upon these countries as the centers of growth, though they differ on the fuel mix that will satisfy the various countries' demand for energy. Much of the uncertainty stems from assumptions about the energy policy and investment decisions that will be made in each country.

China and India are particularly noteworthy in capturing the emerging role of developing countries in the energy landscape. These two countries, by themselves, account for over 2.6 billion of the developing-world's population, more than double the aggregate population of the developed countries.

China remains a large and important consumer of all energy resources and an increasingly large player in the clean-energy market.

Over the last 15 years the world has become accustomed to the notion that energy demand growth has shifted to developing countries and that those developing economies will have an ever-increasing role in regional and global energy markets. This has undoubtedly been the case

[4] Exxon Mobil, *The Outlook for Energy: A View to 2040* (Irving, TX: Exxon Mobil, 2016), 11, http://cdn.exxonmobil.com/~/media/global/files/outlook-for-energy/2016/2016-outlook-for-energy.pdf.

for China, the largest developing country in the world. Chinese energy demand growth between 2000 and 2016 grew by 2,045 Mtoe and accounted for 87.5 percent of global energy demand growth over that period.[5] Fifteen years ago, China ranked 3rd in oil consumption, 8th in oil imports, 1st in coal consumption, and 15th in nuclear power generation. Based on the most recent data from 2016, China is now ranked 2nd in oil consumption, 2nd in oil imports, 1st in coal consumption, and 3rd in nuclear power generation.[6] China has also become an important producer of energy, although mostly for domestic consumption.

[5] Data from BP, *BP Statistical Review of World Energy, June 2017* (London: BP, 2017), http://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf.
[6] Ibid.

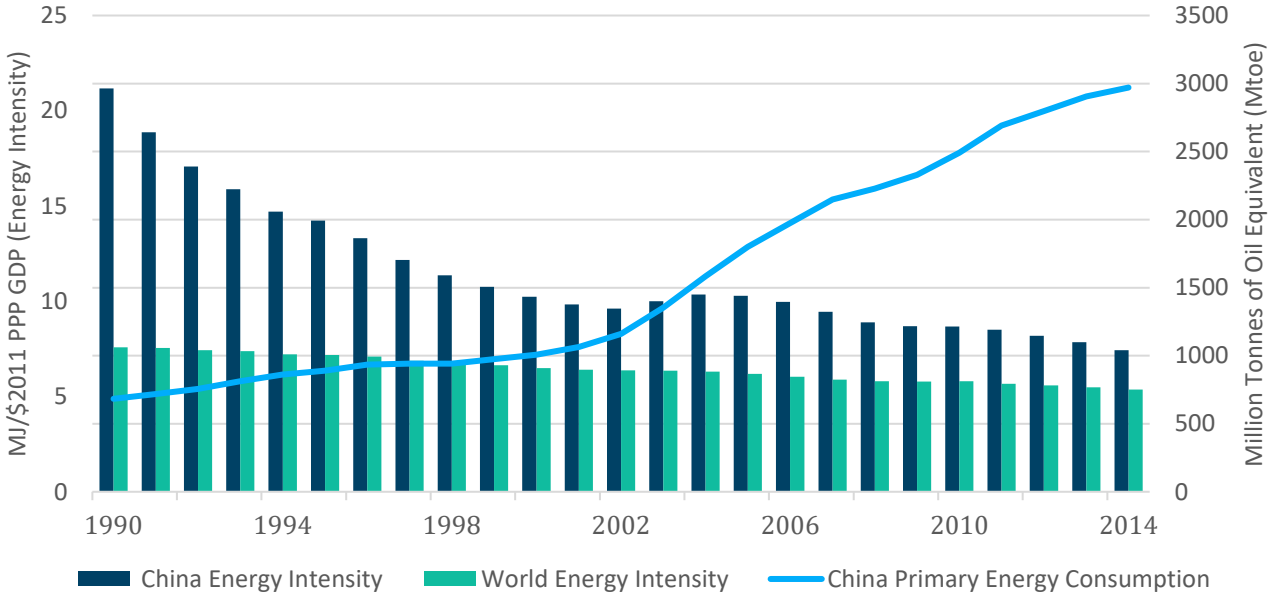
China's Ranking in Top 10 Energy Statistics

Oil Consumption (Thousand Barrels per Day, 2016)	Oil Production (Thousand Barrels per Day, 2016)	Net Oil Imports (Thousand Barrels per Day, 2016)	Coal Production (Million Tonnes of Oil Equivalent, 2016)	Coal Consumption (Million Tonnes of Oil Equivalent, 2016)	Wind Capacity (Gigawatt, 2016)	Hydro-electricity Consumption (Million Tonnes of Oil Equivalent, 2016)	CO2 Emissions (Million Metric Tonnes of CO2, 2016)	Primary Energy Consumption (Million Tonnes of Oil Equivalent, 2016)	Electricity Generation (Terawatt Hours, 2016)	Nuclear Electricity Generation (Terawatt Hours, 2016)
U.S. (19,631)	U.S. (12,354)	China (8,382)	China (1,686)	China (1,888)	China (149)	China (263)	China (9,123)	China (3,053)	China (6,143)	U.S. (805)
China (12,381)	Saudi Arabia (12,349)	U.S. (7,277)	U.S. (365)	India (412)	U.S. (82)	Canada (88)	U.S. (5,350)	U.S. (2,273)	U.S. (4,351)	France (384)
India (4,489)	Russia (11,227)	Japan (4,037)	Australia (299)	U.S. (358)	Germany (50)	Brazil (87)	India (2,271)	India (724)	India (1,401)	China (211)
Japan (4,037)	Iran (4,600)	India (3,634)	India (289)	Japan (120)	India (29)	U.S. (59)	Russia (1,490)	Russia (674)	Russia (1,087)	Russia (180)
Saudi Arabia (3,906)	Iraq (4,465)	South Korea (2,763)	Indonesia (256)	Russia (87)	Spain (23)	Russia (42)	Japan (1,191)	Japan (445)	Japan (1,000)	South Korea (154)
Russia (3,203)	Canada (4,460)	Germany (2,394)	Russia (193)	South Africa (85)	United Kingdom (16)	Norway (32)	Germany (761)	Canada (330)	Canada (633)	Canada (97)
Brazil (3,018)	U.A.E. (4,073)	France (1,602)	South Africa (142)	South Korea (82)	Canada (12)	India (29)	South Korea (662)	Germany (322)	Germany (648)	Ukraine (81)
South Korea (2,763)	China (3,999)	Singapore (1,382)	Colombia (62)	Germany (75)	France (12)	Japan (18)	Iran (631)	Brazil (298)	Brazil (582)	Germany (80)
Germany (2,394)	Kuwait (3,151)	Spain (1,268)	Poland (52)	Indonesia (63)	Brazil (11)	Turkey (15)	Saudi Arabia (622)	South Korea (286)	France (553)	United Kingdom (65)
Canada (2,343)	Brazil (2,605)	Italy (1,154)	Kazakhstan (44)	Poland (49)	Italy (9)	Sweden (14)	Indonesia (531)	Iran (271)	South Korea (551)	Sweden (61)

Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from BP, EIA, and World Nuclear Association Data (September 2017).

Energy will continue to play an important role in raising the standard of living of China's aspiring middle class. On a per capita basis, China's energy consumption is 16.5 percent above the global average[7]; it has increased from 6.4 barrels of oil equivalent per capita in 2000 to 16.0 barrels per capita in 2016, a 2.5-fold increase.[8] China will also continue to play a significant role in global energy consumption as both the largest consumer of energy and the second-largest source of energy demand growth. China's energy economy is forecast to change in some important ways as its overall level of economic growth slows and the structure of its economy transforms away from energy intensive industries like steel and cement, and further spurred by the government's energy and environmental policies and investments. While China's economy grew by an average of 10 percent per year from 2000 to 2010, that rate slowed to 7 percent between 2010 and 2017. China's energy intensity (the amount of energy it uses to create a unit of GDP) has fallen since 1990, except in the early part of this century when it rose due to the energy-intensive industries fueling its development. Since 2010, China's energy intensity has declined by 25 percent but remains 25 percent higher than the world average.

China: Total Primary Energy Consumption and Energy Intensity (1990-2014)

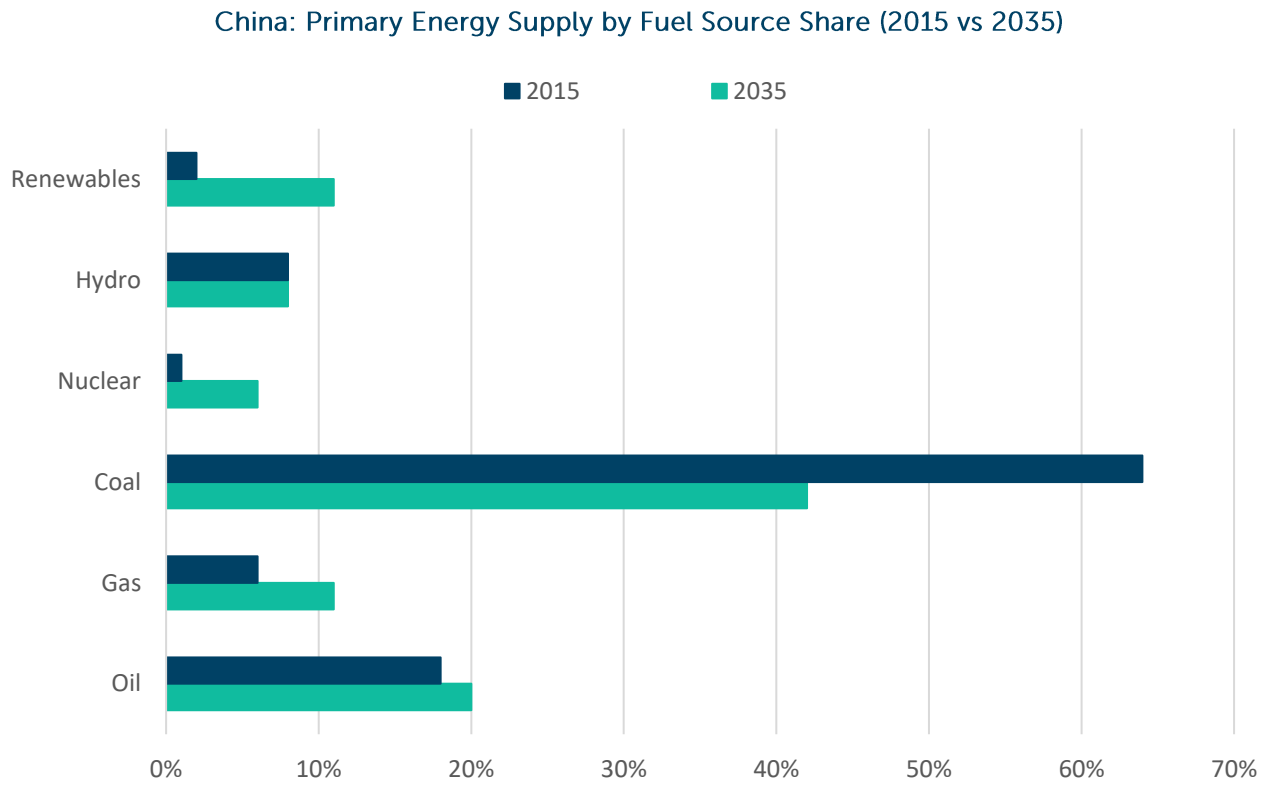


Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from World Bank Data (August 2017).

China's is projected to account for more than one-quarter of total world energy demand by 2035.[9] Renewables, nuclear, and gas are expected to grow rapidly while coal demand is expected to peak in the mid-2020s and then decline. China has taken aggressive policy

[7] Data from World Bank, "World Bank Open Data—Energy Use (kg of oil equivalent per capita)," 2014, https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE.
[8] Ibid.
[9] BP, *BP Energy Outlook 2017 Edition* (London: BP, 2017), 12, https://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf.

measures to reduce the role of coal in its economy. Despite their progress so far and expected into the future, China will still make up a large portion of global coal demand for decades to come. China has shown that it is committed to using policy levers to drive change in its domestic energy landscape and while those changes have impacted global and regional energy markets, sweeping change to a country with an economy as large as China's has been hard to come by. On some fronts the Chinese have achieved remarkable gains, though not without unintended consequences (for example, the build-out of huge amounts of wind capacity that was unable to be connected to the grid for some time). China is expected to be able to make shifts in their long-term fuel mix, knocking down the share of coal from 64 percent to 42 percent and doubling the share of natural gas from 6 to 11 percent.[10] China will continue to become more import dependent as it maintains its position as the world's largest importer of energy, so energy security is likely to maintain its importance as a policy issue.[11]

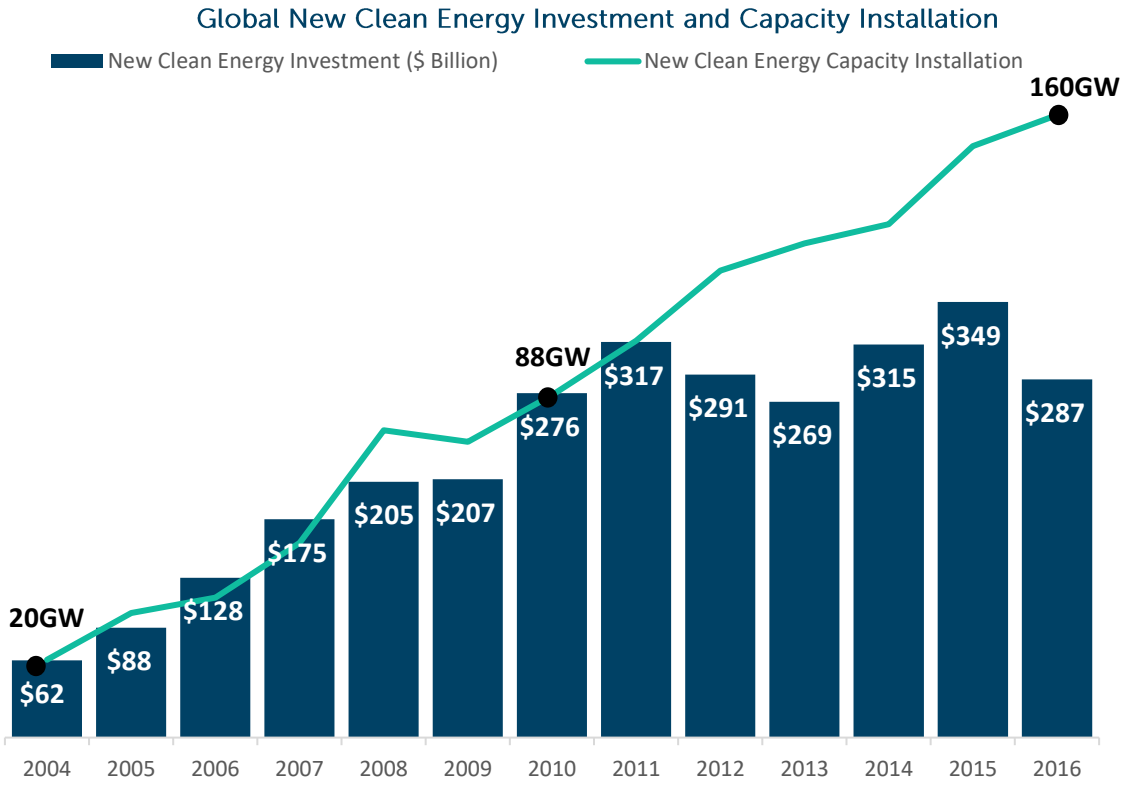


Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from BP Data (August 2017).

China is the single largest investor in renewable energy and the largest producer of several clean-energy technologies such as solar PV, wind turbines, and lithium ion batteries.[12]

[10] Ibid.
[11] BP, "BP Energy Outlook: Country Insights: China," http://www.bp.com/en/global/corporate/energy-economics/energy-outlook/country-and-regional-insights/china-insights.html.
[12] Tim Buckley and Simon Nicholas, *China's Global Renewable Energy Expansion: How the World's Second-Biggest National Economy Is Positioned to Lead the World in Clean-Power Investment* (Cleveland, OH: Institute

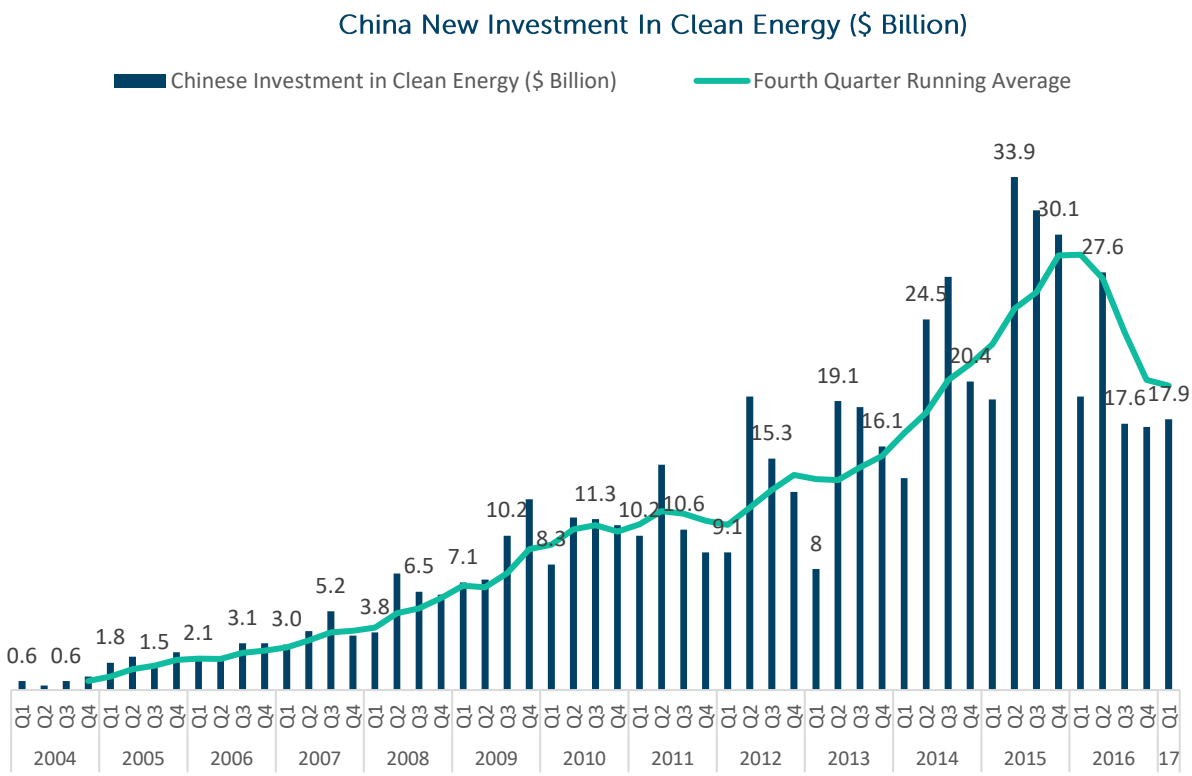
According to Bloomberg New Energy Finance, China accounted for one-third of global new investment in clean energy in 2015, contributing $115 billion to the sector out of the global record-setting total of $349 billion. In 2016, investment in clean-energy technology fell in total as well as in China, but clean-energy capacity additions have continued to rise despite the reduced spending.[13]



Center for Strategic and International Studies | Energy and National Security Program
Source: Bloomberg New Energy Finance (August 2017).

for Energy Economics and Financial Analysis), http://ieefa.org/wp-content/uploads/2017/01/Chinas-Global-Renewable-Energy-Expansion_January-2017.pdf.

[13] Michael Liebreich, "State of the Industry Keynote" (presentation, Bloomberg New Energy Finance Summit, New York, April 25, 2017), https://about.bnef.com/blog/michael-liebreich-state-industry-keynote-bnef-emea-summit-2017/.



Center for Strategic and International Studies | Energy and National Security Program
Source: Bloomberg New Energy Finance (August 2017).

China is also building more nuclear reactors than any country in the world and is a growing source for selling energy technology, like nuclear reactors, but also solar and wind, electric vehicles, and coal-fired power-generation equipment to countries all over the world. China is also an important source of capital and financing for energy projects around the globe. As China continues to move into its middle-income status and further away from its developing country roots, other countries see China's experience as a model for how to not only acquire energy resources sufficient for developing but also capitalize on becoming a vendor of energy technologies and services along the way.

India's energy demand is growing at twice the rate of the developing-country average and while access is a key priority, the central government has set forth a number of additional ambitious economic- and energy-related policy objectives that will drive overall energy demand growth.

India has emerged and will continue to develop as an increasingly important global energy consumer as well. It is the third-largest economy in the world with 18 percent of the global population consuming 6 percent of world primary energy demand. Indian energy consumption is expected to more than double by 2040 and account for fully one-quarter of all energy demand growth during that period. According to the IEA, by the end of this period India's coal demand will more than double and be half the size of China's coal market (larger than all other coal markets combined today), consume 10 million barrels per day of oil (importing over 7 million barrels a day from other countries), and add 600 million new

electricity consumers to the market. India's energy demand is growing at double the rate of the non-OECD average and faster than any other BRICS (Brazil, Russia, India, China, South Africa) country.[14] On its own, India's projected growth in energy demand will exceed the total for all developed countries.[15]

India has already made great progress in some of it main energy policy goals and has set ambitious targets for the future. Under the Modi government, India has also set out some very ambitious targets and reform plans to increase and improve the quality of electricity supply through the 24x7 Power for All program, improve urban development and energy use through the Smart Cities Program, deploy renewable energy through aggressive LED mandates and a truly ambitious Solar Vision to deploy 100 GW of solar by 2022, create innovation opportunities through innovation clusters, and manufacturing in clean energy through the Made in India program. One of India's principal policy drivers is to achieve universal access by providing electricity to the more than 240 million people who lack it today. As a whole India has made great progress on its electrification agenda, rising from 60 percent electrification to 80 percent today, though the performance at an individual state level varies and the quality of electricity access is still an issue in many places.[16]

The government has a number of ambitious energy-sector objectives including a renewable energy target of 175 GW by 2022, a solar power generation target of 100 GW by 2022, an efficiency target of 40 GW worth of energy savings by 2027, and a goal of 100 percent rural electrification by 2022. While these ambitious initiatives have captured a great deal of international attention, many barriers exist to achieving them and it will take time to gauge the success of each policy effort. One notable example is the Ujwal DISCOM Assurance Yojala or Uday reform scheme that targets the deeply indebted electricity distribution companies. Despite shifting debt off the books of the distribution companies onto the state government balance sheets in exchange for improving technical, operational, and regulatory practices, many distribution companies are still plagued by technical losses, nonpayment issues, and political intervention in tariff setting and collections. Despite these challenges progress is being made and an increasingly diverse set of investors, universities, and international organizations are getting involved in the Indian energy sector.

[14] International Energy Agency (IEA), *World Energy Outlook 2016* (Paris: IEA, 2016), 61.
[15] Ibid.
[16] Data from Global Tracking Framework (GTF), "Access to Electricity," 2014, http://gtf.esmap.org/results.

2012 India NASA Image | 2016 India NASA Image

Source: Joshua Stevens and Miguel Román, "Earth at Night," NASA Earth Observatory, 2016.

Opportunities for the private sector presented by this shift in the energy landscape to emerging economies

The annual investments and projected investment requirements over the next several decades are massive, and are increasingly centered in developing countries. In 2016 nearly $1.7 trillion was invested in the energy sector globally, a number that was lower than previous years due to lower overall investment in and capital costs associated with upstream oil and gas and power generation, but still represents about 2.2 percent of global GDP.[17] About $649 billion of this was in oil and gas supply (upstream and downstream), $441 billion in power generation, $59 billion in coal mining, $277 in electricity networks, $19 billion in renewable heat and transport, and $231 billion in energy efficiency. Total cumulative energy investment between 2016 and 2040 is projected to exceed $44 trillion.[18] Most of this will go toward supply-side energy investment (things like fossil fuel exploration and production, power generation, electricity supply infrastructure) rather than energy efficiency.

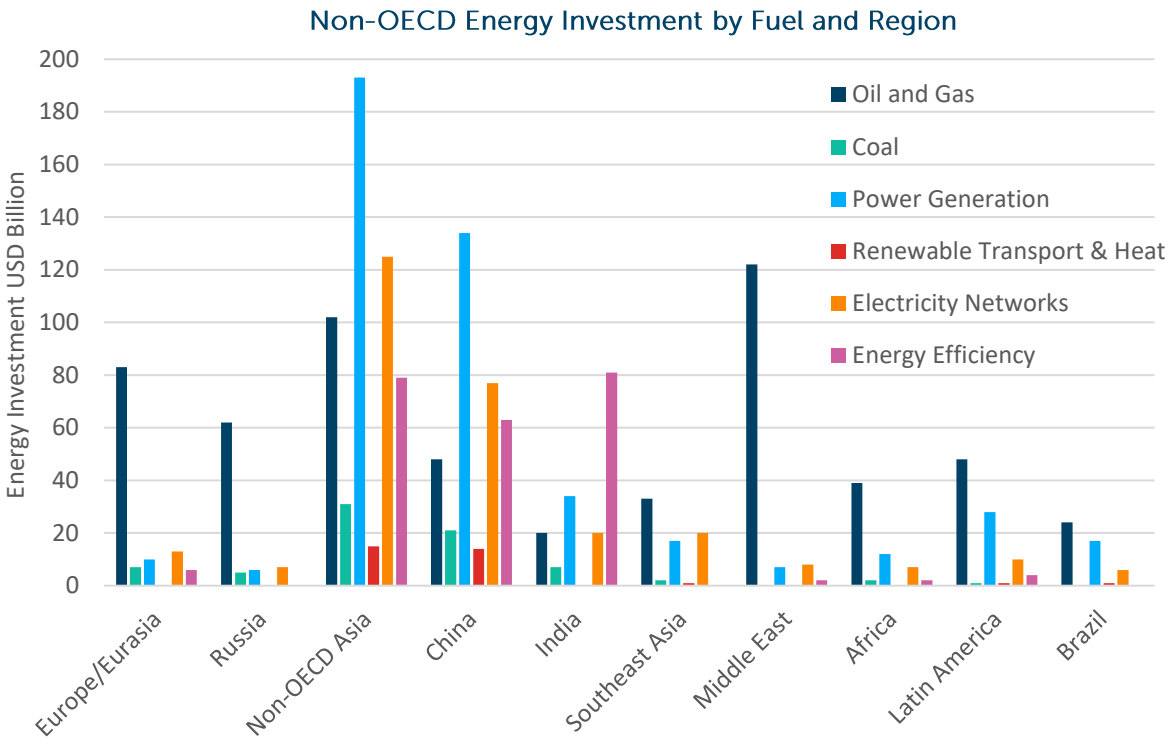
The majority of energy investment is occurring in developing economies. In 2016, $957 billion of energy investment took place in developing economies compared to $694 billion in developed economies. Within non-OECD economies Asia was the largest destination for investment with China accounting for 63 percent of the share (20 percent of global investment), followed by the Middle East, Eurasia, Latin America, and Africa (see chart below). Upstream oil and gas investment represents the largest share of investment, with electricity

[17] IEA, *World Energy Investment 2017* (Paris: IEA, 2017), 19, http://www.iea.org/bookshop/759-World_Energy_Investment_2017.
[18] Ibid., 22.

network and renewable energy power generation investment making up the second and third largest share. The Middle East accounts for well over half of all upstream oil and gas investment, whereas China accounts for more than half of all the electricity network and renewable energy power generation investment. With developing economies representing 58 percent of energy investment in 2016 and given that the vast majority of energy demand growth is projected to come from these countries, so too will the majority of the $44 trillion to be invested in the energy sector over the next couple of decades.

The private sector will have a major role in financing this investment. Although the share of investment coming from public sources has risen in recent years to 42 percent of energy investment (up from 39 percent in 2011, according to the IEA investment report)—including state-owned enterprises (SOEs) and national oil companies (NOCs)—the private sector continues to provide the majority of resources. The relative shares of investment by the private and public sectors varies by segment, and the trend toward a higher share of public spending in energy is impacted by the increased investment by China in the electric power sector and Middle East countries in upstream oil and gas. Fully 70 percent of all electricity network investment, 44 percent of upstream oil and gas, 33 percent of power generation investment, and 15 percent of energy efficiency investment is covered by public-sector investments.[19] Whether this trend toward public-sector investment in developing-country energy sectors continues could have implications for the role of the private sector in these markets. The shift of the locus of energy investments toward developing countries will similarly draw private investment there. However, it is also possible that given the relatively larger role of public financing sources in countries such as China, the private sector may be looked to for a smaller share of investments. At the same time, many developing countries are increasingly looking to catalyze private investment to meet their increasing domestic energy investment needs, which may counteract the greater traditional role of state-owned enterprises in these economies. The cumulative impact of these and other factors on the private-sector investment needs in developing countries is uncertain. However, even in the face of these trends, the need for massive additional private-sector investment in the energy sector in developing countries will remain.

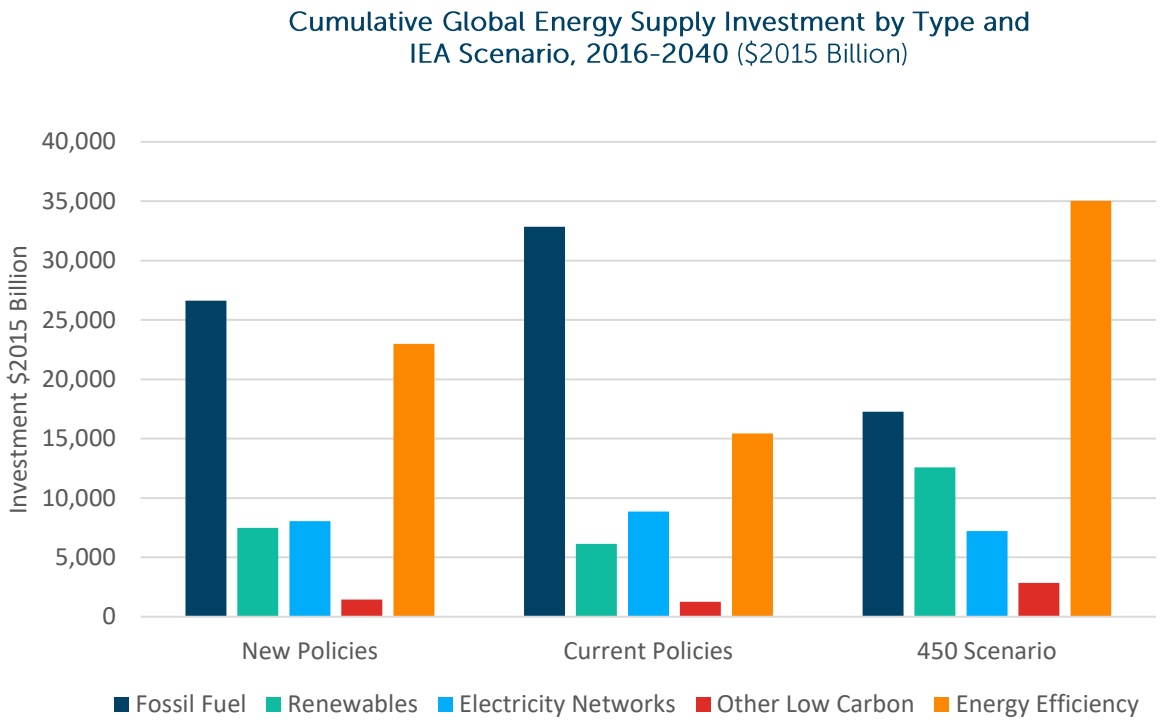
[19] IEA, *World Energy Investment 2017* (Paris: IEA, 2017).



Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from IEA Data (August 2017).

In recent years the outlook for energy-sector investment has been changing. Low oil and gas prices have stymied investment in upstream oil and gas resources and before that a preference for investing in North America's tight oil and shale gas resources.[20] As markets begin the long, slow recovery to higher oil prices, many oil-producing developing economies are suffering the economic effects of a prolonged oil price downturn. Some countries, like Saudi Arabia, have launched ambitious domestic reform agendas to lessen domestic reliance on oil revenues over the longer term while many others simply imposed fiscal austerity measures and are waiting for prices to recover. Major oil-consuming countries have experienced an economic boost because of the low oil price environment but many are still wary of a potential price spike over the next few years due to the underinvestment in developing new resources.

[20] According to the U.S. Energy Information Administration, tight oil is "oil produced from petroleum-bearing formations with low permeability that must be hydraulically fractured to produce oil at commercial rates." Shale gas is "natural gas produced from wells that are open to shale formations. Shale is a fine-grained, sedimentary rock composed of mud from flakes of clay minerals and tiny fragments (silt-sized particles) of other materials. The shale acts as both the source and the reservoir for the natural gas." Together, these two resources are often referred to as unconventional oil and gas production and comprise the majority of the massive oil and gas production increase experience in the United States over the last decade.



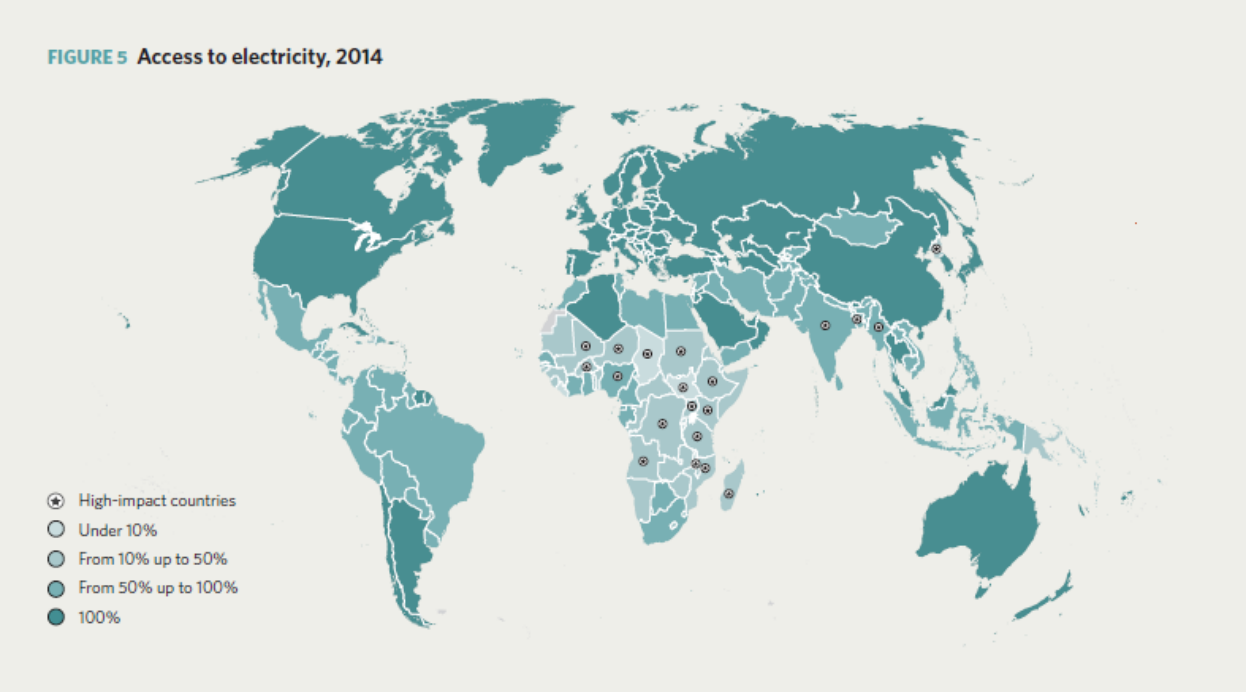
Center for Strategic and International Studies | Energy and National Security Program
Source: Adapted from IEA Data (August 2017).

On the electric power side of the equation, new business models, the declining cost of renewable energy technology, and government policies have shifting investment in many developing parts of the world. According to Bloomberg New Energy Finance, more investment went into renewable energy resources in 2015 than in fossil-based power generation resources. In addition, the breakeven cost for renewable-based power generation has become competitive (both with and without subsidies) with fossil-based energy resources. New and distributed energy technologies are also changing the ownership and finances structures available in many electric power markets around the world with potentially more meaningful consequences for the future structure of those markets down the line.

Increased focus on energy access and the international goal of universal access

Around the world over 1 billion people have no access to electricity and 3 billion have no access to modern, clean cooking fuels. Bringing an end to energy poverty is a major goal of the international development community and for the many countries where high levels of energy poverty exist. In 2012 the United Nations adopted the goal to achieve universal access to modern energy services by the year 2030 under the Sustainable Energy for All initiative. The initiative, which also included the goal to double the rate of energy efficiency improvement as well as the share of renewable energy in the global energy mix, was further validated as a priority in 2015 when it was adopted as part of the UN Sustainable

Access to Electricity (2014)



Center for Strategic and International Studies | Energy and National Security Program
Source: GTF2017 ESMAP, Global Tracking Framework.

Development Goals, which are meant to serve as a set of organizing goals and metrics for the development community, governments, civil society, and certain corporations.

According to the Global Tracking Framework 2017 report, despite many countries making progress toward these three goals, the current pace is not sufficient. With just 13 years left to meet the targets, current projections indicate that none of the goals will be met without more effort. The International Energy Agency estimates that by 2030 access rates will stand at 91 percent for electricity and 72 percent for clean cooking, compared to 85 and 57 percent respectively. Energy intensity will fall short of the 2030 objective, improving only 2.1 percent per year over the last two years rather than the 2.6 percent required. Finally, the share of renewable energy in total final energy consumption will reach 21 percent, compared to 18.3 percent today and well short of the 36 percent goal.[21] In order to meet these goals, countries and companies will have to implement new strategies and programs in coming years.

Distributed-energy technologies create opportunities for the introduction or use of new sources and systems and with proper planning can be incorporated without presenting tradeoffs.

According to several major energy outlooks, distributed-energy resources are poised to provide a growing market in developing- and developed-country contexts. The energy

[21] IEA and World Bank, *Sustainable Energy for All, 2017: Progress toward Sustainable Energy* (Washington, DC: World Bank, 2017), http://gtf.esmap.org/data/files/download-documents/eegp17-01_gtf_full_report_for_web_0516.pdf.

access community has seized upon this opportunity and is working to improve policies, donor programs, commercial environments, and private-sector technology vendors to advance these distributed-energy resources, particularly as a source of tier-one and tier-two energy access. According to one recent World Bank study, solar home systems (SHS) and standalone solar lanterns, technologies for which there was virtually no market 10 years ago, now have supplied nearly 21 million people in Asia and Africa with a basic-level energy access. Through the Lighting Africa and Lighting Global programs, the World Bank and International Finance Corporation (IFC) have helped to catalyze the creation of this market through product certification and other forms of technical assistance. Other forms of distributed-energy resources like micro and mini-grids have not experienced as much success scaling up private-sector opportunities.

At one point, it was believed that the promotion of distributed-energy resources stood at odds with the extension of centralized power-generation assets to communities without access. While this may still be true in some instances, increasingly there are examples where both off-grid and centralized grid-connected resources can exist in tandem and eventually be connected. Recent experiences with distributed-energy resources in countries like Bangladesh, Sri Lanka, Rwanda, Kenya, Morocco, and Myanmar all differ in terms of the impetus of the program and whether it was planned as part of a country's electrification strategy or incorporated into a strategy later on. A recent World Bank report provided the following insights about how to avoid the tradeoffs presented between grid-based and off-grid electrification solutions while providing universal access:

- A national roadmap for achieving universal access that includes urban, peri-urban, or rural areas can help to "avoid or counter tendencies toward 'cherry picking' geographical service areas or beneficiaries, whether for grid or off-grid rollout."[22]

- Off-grid access can play a "complementary and coordinated role alongside grid rollout in the process of achieving universal access," especially when grid rollout has yet to get under way, has stalled, or advances in starts and stops.

- National least-cost geospatial electrification implementation plans for universal access can help to coordinate the efforts of the public and private sector, facilitate and direct financing support, and foster closer alignment of multiple and varied donor programs with national priorities and targets.

Finally, many of the development practitioners in the workshops noted that the existence of an alternative to traditional grid-based electrification strategies was forcing many countries and utilities within companies to overcome long-time barriers to connecting more communities with basic electricity services.

[22] Independent Evaluation Group, *Reliable and Affordable Off-Grid Electricity Services for the Poor: Lessons from the World Bank Group Experience* (Washington, DC: World Bank, 2016), https://openknowledge.worldbank.org/bitstream/handle/10986/25391/109573-WP-PUBLIC.pdf?sequence=1&isAllowed=y.

Sustainability and climate change considerations are affecting energy production and use in developing countries

Another significant factor influencing energy investments in developing countries is the continued role of environmental and climate policy issues and a surge of related policies and regulations that has emerged at the national and subnational level. Over the last decade the global movement toward policies and initiatives to lower energy greenhouse gas (GHG) emissions and to spur cleaner sources of energy has been dramatic. Much of this momentum is driven by a global movement to enact policies that reduce the rate and overall trajectory of global warming and its associated impacts.

Climate change considerations are driving policymakers in developing countries.

Unlike the climate change negotiations that took place in the lead-up to the Kyoto Protocol agreement a few decades ago, the most recent round of negotiations culminating in the Paris Agreement on global climate change included pledges of action from over 190 countries, including virtually all developing countries, as well as from over 12,500 members of the private sector and civil society. Country pledges (known as intended nationally determined contributions, or INDCs) include emissions-reduction measures (in both energy production and land use), adaptation measures, as well as finance and technology considerations.

Renewable Energy Policy Landscape

	Status	Achievements (by the end of 2015)	Trend
Electricity	Feed-in policies are the most widely adopted regulatory mechanism to promote renewable power.	By the end of 2015, 110 jurisdictions at the national or state/provincial level had enacted feed-in policies; at least 64 countries had held renewable-energy tenders; 52 countries had adopted net-metering / net-billing policies.	Policymakers focus on renewable power generation technologies
Heating and Cooling	Slow adoption of policies to support renewable heating and cooling technologies through 2015.	An estimated 47 countries worldwide had targets for renewable heating or cooling in place. At least 21 countries had mandates for renewable heating and cooling technologies during the year.	Fiscal incentives are used as a primary mechanism to support the renewable heating and cooling sectors.
Transport	Adopted policies are aimed at supporting biofuel production and use in road transportation. Slow development in promoting integration of renewable energy and electric vehicles, as well as the use of renewables in other transportations.	As of year-end 2015, biofuel mandates were in place in 66 countries at the national or state/provincial level.	Support has shifted increasingly toward the promotion of advanced biofuels.
City and Local Governance	Cities relied on a mix of regulatory policies, mandates, and direct purchasing to support the deployment of renewable energy within their jurisdictions.	Some cities committed to developing their renewable-heat sectors, and some adopted regulatory measures to promote renewable power. In the transport sector, some national governments introduced biofuel blend mandates as pilot initiatives in cities. The 100% Renewable Energy movement expanded.	Cities and municipalities continued to expand their influence as leaders in the global energy transition. Cities continued to work together to advance their common renewable energy goals through their membership in several high-profile global and regional partnerships.

Source: REN21, *Renewables 2016 Status Report.*

Not all pledges deal directly with the promotion of renewable energy but many do.[23] Most existing policies to promote renewable energy exist at the national or subnational (state and city) level and continue to expand though at different rates in different sectors. According to the Renewable Energy Policy Network for the 21st Century (REN21) organization, renewable energy targets now exist in 173 countries with the most number and diversity of policies focusing on the electric-power sector and the fewest in heating and cooling (see chart

[23] Global Climate Action, "NAZCA: Tracking Climate Action," http://climateaction.unfccc.int/.

below).[24] Renewable-electric power sector mandates exist at national, state, and local levels; these take many forms, including feed-in tariffs, renewable energy tenders, and net metering policies. Renewables also have an important role to play in heating and transport. For example, many renewable heating policies rely on fiscal incentives. Transportation policies promoting renewable energy lack diversity as well. Most of the policies in the 66 countries promoting renewable transportation focus on biofuels development and most of those on first-generation biofuels though there is a trend toward revision to focus on advanced biofuels.

As most energy data organizations report, renewables are the fastest growing source of energy around the globe—albeit from a very low base compared to other fuel sources—and is expected to continue that high growth rate due in part to declining costs but also a supportive policy environment. Global penetration of renewables stands at 14 percent but its role in various segments of the economy is very different as is its role in various countries. According to the IEA global investment report renewable-power generation capacity was the largest share or portion of electricity-generation spending in 2016 but was down 3 percent from the previous year. Renewables are providing more bang for the buck these days, however. Over the last five years, renewable-capacity spending has decreased 3 percent but capacity additions were 50 percent higher and the expected output from this capacity is about 35 percent higher, reflecting cost and performance improvements.[25]

Energy efficiency actions were also included in various INDCs. The inclusion of energy efficiency reflects the important role that this low carbon technology represents in efforts to reduce energy sector emissions. For example, the IEA's 2 degree scenario attributes about 40 percent of the energy sector emissions reductions through 2050 to energy efficiency actions, larger than any other technology, including renewables. However, as compared to renewables, the level of analysis of this low carbon technology remains relatively limited, in part reflecting the variety of energy efficiency actions and their complexity as compared to renewables power generation.

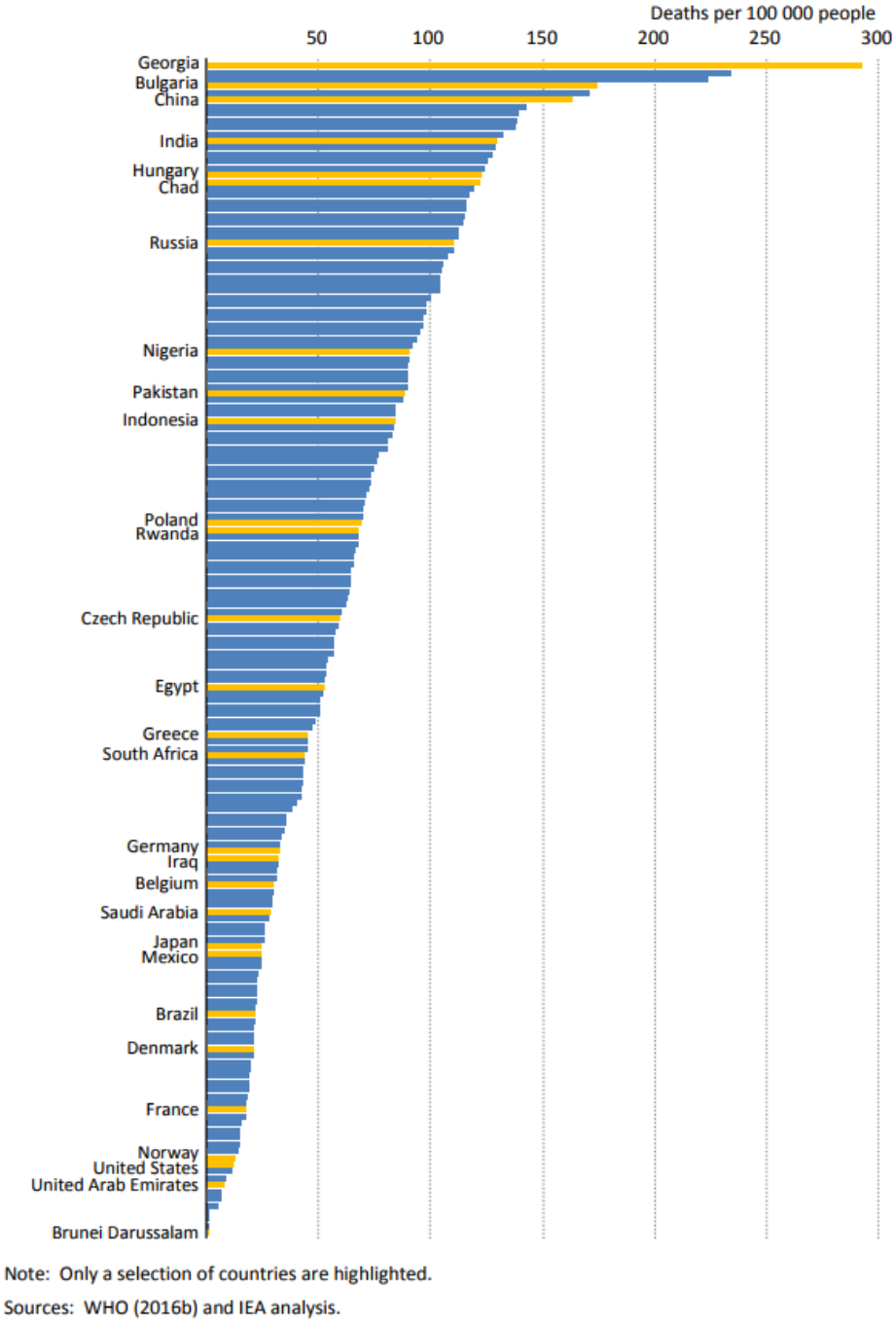
Air pollution is a major concern affecting energy policy for many developing economies, particularly in urban centers.

Not all sustainability policies are driven by a concern for global climate change. Air pollution continues to be a major driver of concern in many developing countries. According to the World Health Organization (WHO), 6.5 million deaths per year can be attributed to the impact of local air pollution. A recent IEA study noted that the technologies exist to tackle these air-pollution problems and in order to alleviate them it would take no more than a 7 percent increase in spending in energy end-use technologies between now and 2040.[26] The solutions are also oftentimes net positive in terms of economic gains and can go hand in hand with energy poverty alleviation goals. The main challenge to achieving these goals is in

[24] Renewable Energy Policy Network for the 21st Century (REN21), *Renewables 2016 Global Status Report* (Paris: REN21, 2016), 20, http://www.ren21.net/wp-content/uploads/2016/06/GSR_2016_Full_Report.pdf.
[25] IEA, *World Energy Investment 2017,* 12.
[26] IEA, *World Energy Outlook Special Report 2016: Energy and Air Pollution* (Paris: IEA, 2016), 3, https://www.iea.org/publications/freepublications/publication/weo-2016-special-report-energy-and-air-pollution.html.

planning and coordination across a range of stakeholders and creating the right policies and incentives to enable deployment of cleaner energy technologies.

Mortality Rate Attributed to Air Pollution (Household and Outdoor) by Country, 2012



Note: Only a selection of countries are highlighted.

Sources: WHO (2016b) and IEA analysis.

Center for Strategic and International Studies | Energy and National Security Program
Source: WHO and OECD; IEA, World Energy Outlook Special Report 2016: Energy Air and Pollution (Paris: IEA, 2016), https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlookSpecialReport2016EnergyandAirPollution.pdf.

Specific research to strengthen energy support to economic growth that could help inform policy and commercial decisionmaking.

Developing countries have a lot of choices to make about how to provide affordable, reliable, and sustainable energy supplies in ways that will optimize their economic development. Given the important link between energy and economic development, governments, companies, and the development community have and will continue to benefit from continued and improved learning how to promote the most positive development outcomes within their growing societies. There are many different dimensions to this problem, including supplying energy resources to drive further economic development among wealthier middle-income households to expanding access to promote poverty alleviation in poorer areas—with all efforts designed within a context of emerging sustainability and climate considerations. To advance the thinking and analysis in these areas, in November 2016 CSIS hosted a Research & Matchmaking (R&M) Conference with the Applied Research Programme on Energy & Economic Growth (EEG), funded by UK Aid with leadership from Oxford Policy Management in collaboration with researchers from several universities, including the University of California, Berkeley. The conference brought together researchers, policymakers, donors, and industry practitioners for a full day of presentations and conversation in Washington, D.C. Researchers presented 18 "state-of-knowledge" papers that they had drafted summarizing gaps in literature and policy related to 6 core themes (as well as the cross-cutting themes of gender, climate change, and data). Policymakers and industry practitioners were invited to discuss how the paper findings related to issues they are facing in their home countries. The final session of the conference allowed attendees to cocreate a set of research questions for a second round of research. The following table represents a sample of research questions that the EEG is interested in pursuing in the coming years.

The Energy and Economic Growth (EEG) Framework: Sample policy questions for each priority research area

	Reliability	Efficient & productive use	Grid access	Renewable energy
Decision support	How can short-term demand forecasting and longer-term tools, such as scenarios, improve capabilities to assess and respond to potential future trends?	What are the drivers of electricity consumption and acquisition of electrical appliances for households and firms?	What are the best ways (grids, mini-grids, or off-grid technologies) to connect households and firms in different locations?	What renewable-energy resources are available to developing countries? How should the data from renewable energy resource maps feed into energy planning?
Technology	Of the wide range of smart grid technologies being developed, which, if any, can effectively help improve the reliability of electricity systems in developing countries?	How can infrastructure, buildings, and appliances become more energy efficient? How can productivity enhancing electrical appliances be deployed?	How can new technologies, such as pay-as-you-go (PAYG), improve access to electricity and appliances?	How can intermittent supply be managed (power pools, storage, capacity markets, demand management)?
Policy	What policy reforms are needed to improve grid reliability? What are the financial, technical, and governance considerations to deploying more reliable grids in the future?	What policies should be used to promote energy-efficient appliances, buildings, and consumption? How does policy in other sectors (e.g., industrial or agricultural policy) influence demand for electricity?	What is the role of government in improving electricity access? How can tariff reform increase affordability for low-income households?	What can we learn from successful power-sector reforms? How can renewable-energy projects' viability be improved through electricity procurement strategies and financing mechanisms?
Productivity, gender, poverty & FCAS impact	What are the economic consequences of low-quality power supply? What is the economic impact of improving grid reliability?	What is the impact of improved efficiency on firm productivity and household incomes? How can policymakers maximise the impacts of expanding supply through integrated energy planning?	Should household access, reliability, or productive uses be prioritised? What is the link between time saved from electrification and women's empowerment?	What are the impacts of low-carbon energy transitions on economic growth in LIC settings? How are the costs of low-carbon energy transitions distributed across incomes?

Source: Applied Research Programme on Energy and Economic Growth (EEG). EEG is funded by UK Aid, with leadership from Oxford Policy Management.

Conclusions and Areas for Future Research

Much of the development community is focused on the twin challenges of providing universal energy access and working to address global climate change. A great deal of this work is targeted toward three main areas: (1) rural electrification, (2) distributed-energy resources, and (3) scaling up and integrating renewable energy resources. All three of these important topic areas can benefit from further research—some of which is suggested in the research agenda put forward above.

By comparison many, if not most, developing countries have a slightly different focus when looking at the issue of energy and development: while these countries continue to take important actions to expand access and increasingly to address climate change, their focus remains on developing and using energy to promote their domestic economic and social development, albeit with concerns of sustainability (notably environmental). As a consequence, the agenda of developing countries writ large arguably is more focused on: (1) ensuring continued secure access to energy sources, notably to larger resources as analysts project that expanding developing-country economies will generate increased domestic energy demand; (2) providing for lower-cost energy sources to enable the needed energy to fuel economic growth without absorbing excessive financial resources in the process; and (3) greater reliability (both in terms of continued access to supply, such as gas, but also in the delivery to customers, notably electricity).

Historically, many developing countries were able to exploit and export their natural resources to generate revenues to fund their domestic development (including in the Middle East and elsewhere). China, however, has established a clearly different model for energy and development, one in which energy resources (including national coal resources) were not exported but rather consumed locally to power economic growth. This approach is being replicated in other countries (note, for example, Indonesia's recent emphasis on building new power plants to power its economy as opposed to its previous role as a major exporter of oil to OECD countries). The energy/development path has changed over the last two decades. Domestic energy consumption is now the key concern for many emerging economies and other developing countries. The balance of energy is now tilting increasingly to developing countries. This has major implication for the future development of the global energy market and for energy companies. For example, as the new U.S. policy of energy dominance puts greater emphasis on exporting U.S. energy resources, potential importers will increasingly likely be developing countries. In response to these newer trends in energy demand in developing countries, an area of proposed future work will be to understand better the extent of the shift in energy demand to developing countries and its implications for international energy trade (including on U.S. energy trade).

Over the course of the workshops, several other areas seemed to warrant additional exploration for their strategic importance to the energy, economic development, and geopolitical landscape.

- **Urbanization**—As noted above, very little is known about the patterns of energy consumption in many of the world's developing urban centers and yet urban

environments will make up the majority of energy demand growth in coming decades. It is important to better understand how major urban environments are developing, and what new policies are being put in place to improve access to and reliability of electric power supply.

- Transportation—The focus on energy in developing economies was almost entirely on the electric power sector in nearly every workshop discussion on energy and development. While modern electricity services and clean cookstove facilities are major global and national priorities, the transportation sector is a major pillar of expansion in developing countries, one that is ripe for disruption with new multimodal transport policies and investments, new vehicle technologies, and changing business models. The future of the transportation sector is likely to be quite different in the coming decades.

- Natural Gas—Regional gas markets are becoming more interconnected as natural gas supplies become more abundant, cheaper, and more flexible in terms of destination, contract terms, and cost. Many developing-country economies see benefits to using more natural gas, including greater fuel diversity, fewer air pollutants, and the potential for the development of their own gas resources. Gas, often considered a niche fuel too expensive to consume or stranded by producers due to the difficulty of securing a proper return on investment, is not usually considered a fuel of choice by developing economies but may be experiencing a different and more competitive environment for gas vis-à-vis other fuels.

- State-Owned Enterprise (role in the energy transition)—As noted earlier in this report, a good share of energy investment comes from public entities including state-owned enterprises and national oil companies. These public entities face unique challenges and advantages relative to their private-sector counterparts. Many governments are relying on these enterprises to implement much of their energy-sector development investments and strategies, and are seeking to modernize (and in many cases to reform) these public-sector actors that are expected to play a central role in energy investments going forward.

- Innovation—Developing countries are playing an important and often overlooked role in promoting innovation. Right now a great deal of technological and business model innovation is taking place in developing countries around the world. What types of innovative technologies and solutions might come from the activity being witnessed today and how are these countries preparing to capitalize on these developments?

COVER PHOTO CHANDAN KHANNA/AFP/GETTY IMAGES

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

1616 Rhode Island Avenue NW
Washington, DC 20036
202 887 0200 | www.**csis**.org