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Bridging the gaps in global energy governance

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Energy constitutes a rich, but underexplored, arena for global governance scholars and policymakers. The world is currently on an unsustainable and conflict-prone track of volatile and unreliable supply of energy fuels, vulnerable infrastructure, massive environmental degradation, and failure to deliver energy services to an enormous proportion of the global population. Changing to a different path will be a monumental global governance endeavor that will require bridging multiple issue areas, regimes, and policy silos. Meeting that challenge will require a greatly expanded research agenda aimed at understanding the institutions, interests, and concerns that do and could shape global energy governance. In this article, we lay out key energy-related global issues and explore some of the connections among them to suggest an initial research agenda for global governance scholars. **Keywords:** *global governance, energy policy, global energy governance, energy security.*

Issues connected to the provision of energy services and the deployment of energy technologies form a common thread across many of the most pressing global problems, cutting across geopolitical, environmental, and economic dimensions. Yet although the international relations, governance, and global policy literatures address energy concerns to some degree, they still reflect policy structures and remain divided into silos, handicapping efforts to adequately understand how energy policy and technology concerns cross domains. As energy concerns come to feature ever more prominently, such divides pose a serious impediment to the prospects for effective global governance on a variety of issues.

Even a cursory assessment makes clear that contemporary global energy governance arrangements are falling far short of meeting pressing needs to foster efficient markets, deal with externalities (notably, but not only, climate change), extend access to energy services to the billions of people not adequately served by markets, and address the many trade-offs involved with improving energy security. Indeed, as numerous studies have documented in recent years, the world is currently on an unsustainable and conflict-prone energy track of volatile and unreliable supply, brittle and vulnerable energy infrastructure, massive environmental degradation, and failure to deliver energy services. As former head of the International Energy

Agency Claude Mandil notes, a continuation of existing trends in energy production and use is "not compatible with reality."[1] Changing to a different track is, however, a monumental governance endeavor. Few if any countries have effective energy governance arrangements and policies, and the global rules that shape and constrain national policy choices are an incoherent and inadequate mishmash.

Improved global energy governance will need to address numerous interrelated areas, covering issues normally dealt with in distinct scholarly and policy silos:

- Geopolitics and security questions, including competition for energy resources, the nuclear nonproliferation regime, and terrorism and other cross-border threats to vulnerable energy infrastructure;
- The global environmental politics of energy, including climate change and other negative externalities that transcend national borders;
- The international political economy of energy, including the investment agreements, trade rules, and intellectual property rights regimes that influence energy choices and capital flows;
- Economic development policies and foreign assistance programs that shape energy policies and investments;
- Emerging issues in global governance and resource management that have major energy implications, such as water and agriculture.

Each of these areas is the subject of a considerable literature, but for the most part existing analyses do not explicitly connect them to broader questions of global energy governance. That is starting to change, with new works that indicate a startling lack of effective global rule making even within, much less across, policy silos.[2] Such key institutions as the International Energy Agency and the International Atomic Energy Agency (IAEA) are hobbled by inadequate resources and mandates even by the often dismal standards of intergovernmental organizations, despite technically competent staffs. Dries Lesage, Thijs Van de Graaf, and Kirsten Westphal's work on the G8 concluded that it has "failed to exert global political leadership" where most needed.[3] Although the G8 has contributed to expanding the scope of the International Energy Agency and establishing a global organization to promote energy efficiency, overall it has proven incapable of producing effective global energy governance because of competing interests within the institution, a dearth of effective monitoring and mechanisms to ensure compliance, and an inability to accommodate nonmember countries. Given the absence of alternative overarching global energy governors, this failure leaves a void not easily filled, and it points to the urgent need for a rich investigation of global energy issues and institutions, with careful attention to the connections among them.

Geopolitics and Security

Energy issues lie at the heart of major geopolitical flash points and security concerns. The renewed great game of major power rivalries in Central Asia, the degree of Russian willingness to play constructive roles in world affairs, the conundrums of the Middle East, the likelihood of the use of nuclear weapons, and terrorist threats are all tightly intertwined with energy policy decisions. Below, we highlight a few of the leading issues.

Resource Competition

Modern economies and modern militaries depend heavily on oil, natural gas, coal, and uranium, which are often imported. The resulting pattern of extensive international trade in energy sources—particularly oil—triggers major security concerns whenever supplies are concentrated or production capacities constrained. Such tensions figure heavily in many of the twentieth century's major wars, including World Wars I and II, the Gulf War, and the Iraq War, and underlie key current conflicts.[4] The International Energy Agency's emergency oil stockpile system, born of the first oil crisis in 1973–1974, has for decades helped mitigate fears of deliberate cutoffs. But that system is showing its age—it is limited to members of the Organisation for Economic Co-operation and Development (OECD), excluding such major new oil consumers as China and India. Although demand for oil eased with the global financial crisis, recovery will quickly restore the tight conditions of recent years. Moreover, China's strategy of investing overseas to secure access to oil raises concerns that it is pursuing a mercantilist rather than market-based approach to energy security. Now resurging are fears that interstate competition over energy resources could turn contentious, even violent.

But such conflict is not inevitable. Recent scholarship has argued that major changes in oil markets since the 1970s have rendered international conflict over oil far less likely. Andreas Goldthau and Jan Martin Witte comprehensively document the transformation from long-term fixed contracts between specific suppliers and consumers—the pattern that prevailed at the time of the first oil crisis—to a more open free global market in oil at present.[5] That change, they argue, has altered the trade of energy from a mercantilist, zero-sum game fraught with the potential for interstate conflict to a positive-sum market that merely needs better institutionalization to overcome the fundamental problem of energy security. They suggest that the "rules of the game" structuring these markets underpin an effective form of "global governance" that promotes financing for energy investments, hedges risk, and facilitates international agreements. While they identify areas for improvement, Goldthau and Witte assert that a number of existing institutions—such as the Agreement on an International Energy Program, the International Energy Forum, and the Energy Charter Treaty—suffice to correct market failures and set rules and standards for market exchange, if governments use them correctly.

Goldthau and Witte have made an important, and needed, contribution to understanding one part of the energy governance puzzle. At present, however, the peaceful and economically rational approach that they present remains a distant prospect. On the demand side, the opacity of Chinese energy policy raises fears that the oil China is contracting to buy from many sources could at some point be directed solely to China, rather than traded on global markets. On the supply side, the world's known oil reserves are concentrated in a handful of largely volatile and uncomfortably unpredictable countries; notably, in the oil rich countries of Russia, the Middle East, Nigeria, and Venezuela. As long as oil continues to be the single largest source of primary energy supply and virtually the sole source of transportation fuel for most of the world, investigating the interplay of geopolitics and resource markets will be a crucial component of the global energy governance research agenda.

Nuclear Energy and Nonproliferation

An extensive literature already exists assessing this most developed of international regimes dealing with energy issues.[6] That regime, centered on an intergovernmental organization (the IAEA) and a fairly comprehensive treaty (the Nuclear Non-Proliferation Treaty [NPT]), is clearly under severe stress, just when nuclear energy is proving popular as a response both to soaring energy demand and to the need to develop less carbon-intensive energy sources. In 2008, more than 440 nuclear power plants operated in thirty-one countries and supplied about 15 percent of the world's electricity, and over sixty additional countries, including Egypt, Indonesia, and Turkey, have formally expressed interest in introducing nuclear power to their energy systems.

Such a large-scale shift to nuclear power will demand much-improved governance structures to manage the proliferation risks associated with the vastly increased quantities of nuclear fuel and the spread of nuclear technology and expertise. The twin pillars of the nuclear nonproliferation regime—the NPT and the IAEA—are nowhere near sufficiently robust to stand up to such a vast increase in reliance on nuclear energy. The IAEA is already badly overstretched and needs to be considerably strengthened to address the need for monitoring and safeguarding what is likely to be an explosion in the number and size of nuclear energy programs, particularly in Asia.[7] The agency's 2,000 or so full-time staff have been struggling under a zero-growth budget and spread thin across very different mandates. The IAEA, for example, must not only devise technical safeguards relating to nuclear power plant safety and perfect tools for assessing the economics and planning for new nuclear reactors, but also oversee the use of nuclear isotopes for medical diagnostics and treatment, manage research programs on new waste management systems, and undertake basic science in experimental nuclear physics. Yet at a time when the IAEA urgently needs additional resources to carry out its mandates, consensus on the basic bargain that underlies the nonproliferation regime and le-

gitimizes the IAEA—that nuclear weapons states will pursue disarmament and help other states with peaceful nuclear technology on a nondiscriminatory basis and with defense against threats of nuclear attack—is breaking down.[8]

Indeed, four decades into the life of the NPT, there are serious questions whether the international nonproliferation regime is in danger of collapse. The five authorized nuclear weapons states are not yet close to the goal of disarmament. States that are not among the five authorized under the NPT to possess nuclear weapons have not paid a significant price for their pursuit of weapons capabilities. States that were never party to the NPT—Israel, India, and Pakistan—have at various stages after 1968 attained nuclear power status. The US-India nuclear agreement, which essentially rewarded India's contempt for the NPT, has constituted another nail in the regime's coffin, as have Iran's and North Korea's defiance of their treaty obligations to the IAEA.

Terrorism and Disruption of Energy Infrastructure

Most existing energy infrastructure is designed in ways that are inherently vulnerable to interruptions, deliberate or accidental. The prevailing tightly coupled, centralized, capital-intensive forms of energy supply can be easily disrupted by changing weather, small animals, balloons, rocks, bombs, and bullets. Operators have provided little storage to buffer successive stages of energy conversion and distribution, meaning that failures tend to be abrupt and unexpected rather than gradual and predictable. Companies and firms have also located sources of supply remotely from users, so that supply-chain links have to be long and the overall system lacks qualities of user controllability and comprehensibility.[9]

Even when no one is trying to do damage, the resulting infrastructure is highly accident prone, accounting for a large percentage of industrial accidents.[10] But these design features make energy infrastructure an attractive, and frequent, target for deliberate disruptions of many types. Suicide bombers have attacked oil infrastructure in Saudi Arabia, Iraq, Nigeria, Sri Lanka, and Yemen. In Pakistan, gunmen have frequently stormed Pakistan Petroleum Limited facilities, fired rockets at pipelines, and kidnapped employees of the Water and Power Development Authority.[11] In Colombia, the 480-mile Cano Limon-Covenas pipeline has had so many holes blown in it that the locals refer to it as "the flute."[12] In Sudan, Arakis Energy Corporation and the Greater Nile Petroleum Company sometimes have had to repel daily attacks on their oil pipelines.[13] London police foiled a plot by the Irish Republican Army in 1996 to bomb oil and gas infrastructure across the city with thirty-six explosive devices.[14]

That vulnerability is set to worsen, ironically due to the expected ravages of climate change, which itself is largely caused by that same energy sector. Hydroelectric and nuclear facilities are already being affected by unpredictable rain patterns and unusual heat waves, and more dramatic impacts are

expected as the effects of climate change increase.[15] Other large-scale investments in energy infrastructure, however, remain committed to producing fossil fuels (and result in climate change). As just a small sample of projects, Saudi Aramco, the largest oil producer in the world, invested $70 billion to complete its five-year plan to expand oil production capacity to 12.5 million barrels per day in 2009. Petrobras, a majority state-owned oil company in Brazil, plans to increase investment in oil and gas production by $174 billion from 2009 to 2014.[16] Iraq is signing large contracts in the hope that an end to the violence there will enable massive increases in oil production, the Mexican government is rapidly broadening investment of Pemex, and the Nigerian government plans to significantly increase investments once it quells attacks against oil infrastructure.

Transboundary Externalities

The environmental externalities imposed by current energy systems now rival security issues in importance on the global agenda. This is due largely to the powerful and increasingly alarming evidence on the scale and pace of climate change, which threatens the entire planet with altered temperatures and weather patterns, rises in sea level, loss of species, and destruction of habitats. But energy systems are also at the heart of many other problems of the commons such as: (1) catastrophic risks such as nuclear meltdowns, oil spills, coal mine collapses, natural gas wellhead explosions, and dam breaches that cross national borders; (2) movement of toxic pollutants such as mercury and acid rain, which do not respect national borders and cause chronic disease, morbidity, and mortality among humans, destroy crops, and damage ecosystems; and (3) continual maintenance of caches of spent nuclear fuel, a common heritage issue because of the long-lived radioactive nature of high-level nuclear waste.[17]

Yet climate change deserves its star billing on the global governance agenda. It is arguably the most challenging collective action problem ever to hit the international stage, and energy and transportation are at the core, accounting for some two-thirds of greenhouse gas emissions. Avoiding potentially catastrophic warming may require a 50 percent cut in planetary CO_2 emissions by 2050. Determining whose emissions should go down and by how much, and when, to achieve that planetary average is an excruciatingly difficult global governance challenge.

As the large and rapidly growing literature on climate governance indicates, the institutional development and political will needed to address the temptation to free ride is still lacking. Moreover, agreement on a post–Kyoto Protocol pact to mitigate climate change is, relatively speaking, the easy part. Implementation of an accord that is sufficiently ambitious to address the problem may be much harder. Experiments with novel transborder governance ap-

proaches such as cap-and-trade systems and the Kyoto Protocol's Clean Development Mechanism have shown limited efficacy to date.[18] Industrialized countries that signed up to the Kyoto Protocol agreed to collectively reduce greenhouse gas emissions by 5.2 percent below 1990 levels by 2008 to 2012, but prior to the recession their collective emissions had increased 8.4 percent over 1990 levels.[19] Given that Kyoto imposed only minor reductions on just the handful of countries most able and willing to afford such reductions, this track record does not bode well for the implementation of more ambitious agreements.

Yet even if climate change were not an issue, current fossil fuel dependence would still impose costly, often cross-border, environmental externalities. One megastudy of the peer-reviewed literature found that negative externalities from only the electricity sector in the United States amounted to $420 billion in damages in 2006, some $143 billion more than that sector's entire revenue for the year.[20] For some fuels such as coal or oil, the negative externalities associated with their use are even greater than the existing market price for the electricity that they produce.

The Political Economy of Energy

Meeting the growing global demand for energy will require massive investment of tens of trillions of dollars, with significant challenges relating to anachronistic regulations, trade constraints, and intellectual property rights. Moreover, national subsidies currently encourage the channeling of energy investments heavily in the direction of fossil fuels and nuclear energy, exacerbating the security and environmental governance challenges described above. Yet both scholarship and policymaking in these areas is compartmentalized in ways that have prevented energy from being understood as a single political economy realm.

Decisions about cross-border energy investment are influenced by multiple sets of actors, both private and public. Investments in cross-border energy infrastructure (and, indeed, many other forms of infrastructure) are regulated primarily by a large, interlocking web of bilateral investment treaties (BITs), whose terms can actively discourage governments from making the regulatory changes needed to encourage the development of cleaner systems that pollute less. The treaties aim to protect foreign investors from any financial loss arising as a result of state action. Those state actions include not only direct expropriation, but also the enactment of new laws or regulatory policies that force investors to make changes that result in a loss. Thus, regulatory changes aimed at encouraging the development of clean energy could lead to expensive expropriation claims. Under most BITs, such claims are settled by international arbitration panels that generally have favored investor interests.

Trade rules, although not necessarily hostile to socially or environmentally motivated energy policy, generally fit awkwardly. Global trade in energy fuels and services amounts to more than $1 trillion a year. Many energy exporters, including members of the Organization of Petroleum Exporting Countries (OPEC), Central Asian countries, and Russia, are negotiating the terms of accession for their entry into the World Trade Organization (WTO). Thus, the WTO is taking on increasing importance as a focal point for energy-relevant trade rules. Trade rules cover most of the policy instruments that governments have available to them to improve energy efficiency and govern their energy sectors from taxation to subsidies to standards and labeling requirements. Yet WTO rules may inhibit good energy policy. It is not clear, for example, whether the rules would allow tax policies to discriminate between methods of energy production such as favoring electricity from renewables over other sources of electricity. Similarly, direct support to renewable energy industries may fall afoul of WTO prohibitions on subsidizing specific industries within a sector.

In addition, the current global structure of intellectual property rights creates impediments to the diffusion of new energy technologies across countries. A debate has been raging in many industries over the role of intellectual property in innovation, with some arguing that strong intellectual property protections spur innovation while others posit that strong patents deter innovation and raise prices. In the case of energy technologies, intellectual property rights have been used to block entry into the wind turbine, solar panel, and hybrid electric vehicle markets in Japan and the United States and prevent the acquisition of clean coal technology by Chinese firms.[21] Many countries in the developing world, moreover, do not own the intellectual property rights for the newest or most efficient energy systems, meaning that they have to license Western technology to avoid reliance on fossil fuels, particularly in markets such as China and India. One assessment of the barriers facing energy systems that reduce greenhouse gases (such as clean coal and carbon capture and sequestration, nuclear power, energy efficiency, and renewable power plants) found that many firms were reluctant to distribute new energy technologies to developing markets for fear that their intellectual property rights would not be respected and enforced by the WTO and other relevant authorities.[22]

Yet at the same time, perverse but long-established subsidies—which benefit fossil fuel and nuclear energy sources at the expense of emerging alternatives—abound. Indeed, among the most pernicious entrenched factors militating against a rapid transformation to a secure and sustainable global energy future is the widespread use of energy subsidies supporting exactly the opposite. The global energy industry receives at least $328 billion in subsidies per year. These subsidies distort the price signals that consumers receive for energy fuels and services, and artificially create demand for both energy and its associated infrastructure. Moreover, existing energy subsidies have heavily

favored those technologies that are the least efficient (from a thermodynamic standpoint) and most destructive to the environment, with the bulk of research subsidies going toward nuclear and fossil fuel systems.

In many industrialized countries, especially the United States, coal producers still receive a percentage depletion allowance for mining operations, deductions for mining exploration and development costs, special capital gains treatment for coal and iron ore, special deductions for mine reclamation and closing, research subsidies, and black lung benefits paid for by national governments. Oil and gas producers still receive a similar depletion allowance, bonuses for enhanced oil recovery, tax reductions for drilling and development costs, fuel production credits, and research subsidies. Nuclear energy operators and manufacturers benefit from massive loan guarantees, research funds, public insurance and compensation against construction delays, tax breaks for decommissioning, tax credits for operation, and government-funded off-site security and nuclear waste storage. From 1974 to 2002, nuclear power received almost 50 percent of all government subsidies related to energy and fossil fuels, about 25 percent of all subsidies; cleaner sources of energy such as wind farms, solar panels, and biofuels received about 12 percent, energy efficiency just 1 percent.[23] And such distortions are not limited to rich countries. The world's poorer countries (non-OECD members) subsidize oil exploration and production at more than $90 billion a year.

Energy subsidies have global governance ramifications in two senses. First, many take the form of trade barriers and protectionist tariffs. Brazilian exporters, for example, face tariffs that add at least 25 percent to the price of ethanol imported to the United States and more than 50 percent to the European Union.[24] On top of these tariffs, many of the same governments, especially at smaller scales such as counties and cities, have exempted local production of biofuels from fuel excise and sales taxes, a possible violation of free-trade rules since they do not give foreign imports the same exemption.

Second, national subsidies for energy tend to be self-replicating and distortionary on a global scale. Once one country subsidizes a particular technology or energy sector, others are at a competitive disadvantage unless they follow suit. Such subsidies, once enacted, create powerful constituencies linked with their disbursement that interfere not only directly with global energy markets, but also with closely connected sectors such as transportation, manufacturing, and agriculture. In the case of the latter, subsidies for biofuels have resulted in higher prices for crops such as wheat, rice, soy, maize, and oilseeds that have, in turn, caused the price of staple foods and consumer products to sharply rise. One study estimated that domestic energy subsidies for palm oil contributed to global price increases of maize by 60 percent.[25]

In short, there is an enormous agenda for international political economy research of vital importance to improving global energy governance. Scholarship on international investment, trade, subsidies, and protection of intellectual

property rights is essential both to understanding current patterns of energy decisionmaking and to developing policy options that can help to bring about vitally needed changes in energy systems.

Development and Energy

Improved access to energy services is arguably the key defining characteristic of economic development. Worldwide, nearly 2.4 billion people use traditional biomass fuels for cooking and heating, constituting more than half the population in China, India, and much of Southeast Asia. More than 1.5 billion people (greater than 10 percent of the global population) do not have access to electricity. Even accounting for significant increases in development assistance and rural electrification programs in emerging economies, by 2030 about 1.4 billion will remain at risk of having to live without modern energy services.[26] Such energy poverty contributes to hunger, with women and children spending long hours gathering fuel rather than earning income. And the health consequences are dire: reliance on traditional fuels and indoor combustion are monumental. Indoor air pollution kills on the order of 2.8 million people every year, almost even with the number dying annually from HIV/AIDS.[27] Environmentally, energy poverty forces its victims to harvest more polluting and less energy dense fuels such as woody biomass or charcoal, often causing land degradation, deforestation, and contamination of soil and water resources. Such depletion instigates conflicts over land, decreases food supply, diminishes sources of traditional medicine, and accelerates malnutrition.[28]

These are global concerns. Many if not most developing countries lack the capacity and technology to shift to more sustainable and affordable supplies of energy without external assistance. One survey of the twenty-four Least Developed Countries in the world found that twenty-two of them each had less than 1 percent of their region's total energy resources.[29] With scarce energy resources of their own, these countries must rely either on the global trading system or development assistance. Although most financing for energy development goes through private sector hands, various agencies of the UN system and the multilateral development banks (in particular, the World Bank) play a key role in setting the terms of the debate and in providing funding. By far, the lion's share of World Bank funding on energy continues to support traditional centralized fossil fuel plants. There is no coherent discussion on energy among the donor community, or between donors and developing nations. Those countries that do have significant energy sources still often must rely on outsiders to help develop those resources. That is frequently a troubled process, often accompanied by accusations of corruption, rent seeking, major human rights violations, and extreme environmental despoliation.[30]

Nonetheless, many countries that have successfully eradicated energy poverty have relied on international support such as borrowing and development assistance instead of national measures alone. Brazil was able to increase

use of liquefied petroleum gas for cooking fuel from 16 percent in 1960 to 100 percent in 2004, and China, Morocco, and Tunisia were able to expand electrification efforts so that more than 70 percent of their respective populations in 2001 had reliable access to energy services. Yet each of these programs was dependent on assistance from international donors.[31]

When done right, external investment and development assistance aimed at the promotion of appropriate energy technologies can promote key development goals and alleviate human rights abuses, issues that are of paramount importance to the global community. Ending poverty, reducing hunger, avoiding major disease and health effects, and reducing environmental degradation are all connected to cleaner forms of energy supply. Modern energy services have multiplier effects on health, education, transportation, telecommunications, safe water, sanitation, and economic growth. Exploring the conditions under which external assistance and private investment produce these varied effects offers a rich agenda for scholarship.

Emerging Issues in Global Governance and Energy Policy

As if the above issues were not enough, many new governance challenges are arising as public and private actors try to improve their energy security and respond to climate change. Among the particularly salient issues, just beginning to be understood, are water governance and agriculture. Even though energy, food, and water are addressed by almost entirely separate communities of scholars and policymakers, they are in fact deeply intertwined. Energy fuels and production cannot be managed without attention to water and land, with every single energy source (including energy efficiency practices and renewable resources) using at least some water and taking up space. And many components of the water sector (conveyance, treatment, purification, desalination, pumping, and distribution) are reliant on electricity and energy.

Most obviously, the more than fifty countries that rely primarily on hydroelectric dams to generate power in their electricity sectors depend on predictable water supplies. Beyond this, ambitious expansion of conventional power plants and transportation fuels would require vast amounts of water. Thermoelectric power plants running on coal, natural gas, oil, and uranium are water cooled, withdrawing trillions of gallons of water from rivers and streams, consuming billions of gallons of water from local aquifers and lakes, and contaminating water supplies at various parts of their fuel cycle. Oil and gas production facilities, refineries, ethanol distilleries, and manufacturing firms also rely on prodigious amounts of water to transform raw commodities into usable energy fuels, services, and technologies.

But the water that these energy facilities need may not be available. Nearly 1 billion people already lack adequate access to water, a figure that may rise to more than 3 billion by 2015. Water tables for major grain-producing areas in northern China are dropping at a rate of 5 feet per year, and per capita water

availability in India is expected to drop 50–75 percent over the next decade.[32] About two-thirds of groundwater withdrawals in India, responsible for one-quarter of the country's harvest, are from rapidly depleting aquifers that could soon run out. Groundwater consumption in Yemen exceeds the natural recharge rate by more than 70 percent, and other crisis levels could soon exist in urban areas across Asia, parts of Mexico, the Oglalla aquifer in the midwestern United States, and Saudi Arabia.[33] Some of the driest and poorest countries that are completely reliant on water for agriculture also lack it. Ninety percent of water use in Egypt, Libya, and Sudan is in support of irrigation and agricultural systems, meaning droughts and shortages can cause widespread shortages of food.[34] By 2025, demographers, geologists, and water managers anticipate that more than 60 percent of the global population will live in countries with significant imbalances between water supply and demand.[35]

The global governance implications of this water use are twofold. First, the nexus between energy production and water consumption and withdrawals intersects with many of the other key challenges that we have presented in this article. The availability and quality of water, for example, is intimately connected to climate change and the issue of transboundary externalities discussed above. One study relying on satellite data and monitoring from aircraft noted that power plant emissions of sulfur dioxide, nitrogen oxides, and other pollutants from one country can completely shut off precipitation from clouds that then affect other countries.[36] Greenhouse gas emissions also contribute directly to climate change, which negatively affects water resources by increasing temperatures, altering precipitation patterns, changing the availability of snowpack, and magnifying the risk of flooding and drought.

Increasing levels of water needed to provide and use energy resources could also exacerbate geopolitical conflicts and tensions. An exposé in the *New York Times* noted that one potential flash point could be the Euphrates River Valley, where Turkey has expended $30 billion to build dams and irrigate fields, already forcing Syria to reduce its withdrawals and Iraq to cut back on its consumption.[37] Two of the largest freshwater sources in Asia, the Haihe River Basin in China and the Ganges River Basin in India, have also been slowly depleted by upstream users with less water available for wheat and maize producers and major metropolitan areas, making supply of water a key national security concern.[38] The potential for conflict and international dispute over water, especially with rates of energy consumption (and, thus, water use) expected to rise dramatically, highlights the urgency of finding cross-border solutions for distributing water resources between upstream and downstream states in ways that parallel the security concerns related to energy.[39]

Second, existing mechanisms for resolving transnational water disputes are failing to address the causes behind water scarcity. The classic approaches to global water problems, enshrined in international agreements, have focused on interbasin water transfers, capacity building, water exports, and intergovern-

mental bargaining and cooperation over shared river basins. Each, however, faces significant constraints. Interbasin water transfers, where canals and pipes transport water between countries, are capital intensive, are potentially harmful to the environment, make downstream communities dependent on upstream communities, and tend to accelerate water consumption, as inhabitants of villages and cities along the canals and pipes often demand equivalent access to the water, adding to total demand from the source.[40] Capacity building is time consuming and expensive as well as reliant on the goodwill of developed countries that have the technology and expertise, many of which are not willing to give it away. Water exports are a technically simple way of addressing scarcity, but actual exports have been extremely controversial. Intergovernmental bargaining, multilateral agreements, and efforts to cooperate over transnational river basins do not fare much better. These efforts have largely faltered because knowledge of watersheds tends to end at national borders even when water problems are international, when private sector actors gradually erode the authority of the state to control and manage water resources, and when the agreements that have been reached are seldom enforced.[41]

Different types of institution building are needed such as formal international regimes organized not around national territories but instead around river basins, international networks of water experts and professionals that can share knowledge, and strong civil society groups to oppose destructive projects such as some large dams and canals. Some of these new approaches are starting to emerge, but they are being implemented selectively and slowly. The fundamental driver of water governance problems is almost identical to that of climate change: the most immediate causes and effects of water problems are localized, meaning that benefits accrue to local communities, but the consequences are often global and distributed beyond national borders, implying that both local and global governance are required.

Conclusion

The world is offtrack on energy. The stakes are enormous, with geopolitical stability, environmental sustainability, and economic prosperity all heavily dependent on successful management of finding and using sustainable and affordable energy fuels and services.

Yet the obstacles are equally large. Many governments and large firms continue to make long-lived investments in fossil fuel infrastructure, even though those investments contribute to destabilizing climate change that could damage that very infrastructure. Multilateral development banks such as the World Bank and the Asian Development Bank are continuing to invest billions every year in fossil fuel undertakings.[42]

These complex energy issues provide an extraordinarily rich field for international relations scholars. Research questions abound. Some fit within ex-

isting scholarly paradigms and provide ample opportunities for theory testing. How will the nuclear nonproliferation regime cope with the challenges of rising global reliance on nuclear power at a time when the NPT faces fundamental challenges to its legitimacy? What are the implications of the growing web of bilateral investment treaties for energy policy choices? Under what conditions do states alter entrenched patterns of subsidies to energy industries? What insights does the emerging literature around water governance offer for investigations of global energy governance? What types of different governance challenges do electric vehicles and wind turbines, as well as nuclear reactors and carbon capture and storage sites, entail? But the real utility of an energy focus in global governance scholarship may be much broader. Energy offers an empirical core around which to explore new research directions. Signs of discontent with existing theoretical paradigms are already emerging. Regime theory, for example, has been enriched by a broader idea of regime complexes that would seem to have great utility in exploring the cross-cutting energy issues that we describe in this article.[43] Core paradigms that focus almost exclusively on interstate relations are giving way to approaches that attempt to incorporate the much wider range of "global governors" from intergovernmental organizations to for-profit corporations to civil society groups.[44] Contestation over the nature of world order and competing visions of future architectures are rife in international relations scholarly circles and policy communities alike.[45] Because energy is such a fundamental issue crossing so many disciplinary boundaries, it is ideally suited to framing discourses around new approaches.

Moreover, energy may offer great potential for bridging the theory/policy divide. As described above, complex and interconnected energy issues are failing to be addressed by governments, intergovernmental organizations, and markets. Provision of sustainable and secure energy services to all requires a broad assessment of existing and likely future needs for those services. Good policy would examine the full range of benefits and costs (including the environmental and social costs not currently included in price signals) of various energy sources. Such assessments cannot be carried out on a purely national basis, given most countries' inability to meet their own energy needs and the various spillover effects of energy production and consumption.

As energy problems take center stage on the world's agenda of pressing issues, the inadequacies of scattershot policymaking and incoherent governance loom ever larger. The existing institutions of global energy governance are demonstrably ill equipped to handle humanity's daunting energy challenges, which require simultaneous attention to issues related to geopolitical stability, the security of energy infrastructure, trans-boundary environmental externalities, the proliferation of nuclear technology, investment and trade rules, economic development, and water and agricultural policy. Together, these challenges constitute a compelling rationale for a sustained research agenda in global energy governance. ⊕

Notes

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