

# RENEWABLE RESOURCES JOURNAL



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# About RNRF

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## Purposes

The Renewable Natural Resources Foundation (RNRF) is an I.R.C. §501(c)(3) nonprofit, public policy research organization, founded in 1972. It is a consortium of scientific, professional, educational, design and engineering organizations whose primary purpose is to advance science, the application of science, and public education in managing and conserving renewable natural resources. RNRF's member organizations recognize that sustaining the Earth's renewable resource base will require a collaborative approach to problem solving by their disciplines and other disciplines representing the biological, physical and social sciences. The foundation fosters interdisciplinary assessments of our renewable resources requirements and advances public policies informed by science.

## Members

RNRF's members are membership-based nonprofit organizations with member-elected leaders. The founda-

### MEMBER ORGANIZATIONS

American  
Geophysical Union

American  
Meteorological Society

American Society of  
Civil Engineers

American Society of Landscape  
Architects

American Water  
Resources Association

Geological Society  
of America

Society of Environmental  
Toxicology and Chemistry

Society of Wood Science and  
Technology

tion is governed by a board of directors comprised of a representative from each of its member organizations. Directors also may elect "public interest members" of the board. Individuals may become Associates.

## Programs

RNRF conducts national conferences, congressional forums, public-policy briefings and round tables, international outreach activities, and a national awards program.

## Renewable Resources Journal

The quarterly journal, first published in 1982, features articles on public policy related to renewable natural resources. It also includes news from member organizations, general announcements, meeting notices, and international conservation news. The journal is provided as a program service to the governing bodies of RNRF member organizations, members of the U.S. Congress and staff of its natural resources- and science-oriented committees.

### RNRF Board of Directors

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Architects

# News and Announcements

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## Renewable Natural Resources Foundation

### *Round Table Meeting on U.S. Arctic Energy Policy*

The RNRF Washington Round Table on Public Policy met on June 23, 2015, in Washington, D.C. with Sydney Kaufman, Foreign Affairs Officer for the U.S. Department of State Bureau of Energy Resources. She discussed the governance and priorities of the Arctic Council and implications for energy development in the region.

The Arctic Council was created in 1996 to facilitate international scientific cooperation and environmental protection. The Council includes eight Arctic member states: Russia, Canada, the United States, Denmark (via Greenland), Finland, Sweden, Iceland, and Norway. Six indigenous councils and associations and twelve non-Arctic observer countries also participate in the council.

The United States became an Arctic

nation after purchasing the state of Alaska from Russia in 1867. In 2015, the U.S. assumed its second two-year term as chair of the Arctic Council. The theme for its current chairmanship is “One Arctic: Shared Opportunities, Challenges, and Responsibilities.” To promote international cooperation for the management of this region, the U.S. chairmanship has three focus areas:

- Arctic Ocean Safety, Security, and Stewardship
- Improving Economic and Living Conditions
- Addressing Impacts of Climate Change

Two U.S. priorities in the Arctic region are national energy security and climate change. The Arctic contains as much as 13% of the world’s undiscovered oil reserves and 30% of its undiscovered natural gas reserves. The region is also warming at a rate twice the global average. As such, the Obama Administration is using the Arctic as a talking point for broader climate change policy.

Due to warming and diminished ice cover, the Arctic region is facing infrastructure challenges, fishery disruptions, acidification, increasing oil and gas development, and increasing potential for maritime transportation. Arctic countries are not uniformly affected by these challenges, and therefore have different interests and priorities. For example, the Scandinavian countries tend to be more developed at higher latitudes, and their climate is moderated by the Gulf Stream. In contrast, other member states face greater challenges regarding rural community infrastructure development and energy security, as well as more volatile ocean conditions for offshore oil and gas exploration.

Although Arctic Council membership is very cooperative, the larger political landscape can affect relationships. For example, U.S. sanctions against Russia because of its invasion of Crimea have halted operations of U.S. companies engaged in offshore oil exploration and production in Russia.

As climate change increases access to Arctic waters, member nations must contend with regulating oil and gas exploration. Currently, drilling regulations are inconsistent among the countries. Research needs for the region, particularly in light of increased energy exploration/production and maritime transportation, include early warning signals for the effects of climate change, seafloor mapping, and global sources and destinations of black carbon. International cooperation for environmental protection and management of the region’s resources has never been more important.

For more information on the Arctic Council, visit its official website at <http://www.arctic-council.org/>.



*(L-R): Nancy Somerville (American Society of Landscape Architects), Tom Chase (American Society of Civil Engineers), Dick Engberg (American Water Resources Association), Bradford McKee (American Society of Landscape Architects), Sydney Kaufman (U.S. Department of State), Ian McTiernan (American Institute of Architects), Melissa Goodwin (RNRF), Jennee Kuang (RNRF), Howard Rosen (Society of Wood Science and Technology). Robert Day (RNRF) present but not pictured.*

*Gerald E. Galloway, Jr. is Recipient of 2015 Sustained Achievement Award*



*Gerald E. Galloway, Jr.*

Gerald E. Galloway, Jr. received RNRF's 2015 Sustained Achievement Award. The Sustained Achievement Award recognizes a long-term contribution and commitment to the protection and conservation of natural resources by an individual.

Galloway is the Glenn L. Martin Institute Professor of Engineering at the University of Maryland—College Park and an expert on disaster resilience and mitigation, sustainable infrastructure development, water resources and energy policy, and management under climate change. He serves as a consultant to federal, state, and nongovernmental agencies on water resources policy development and flood risk management.

Over the course of his 60-year career, Galloway has served in a wide range of water management, advisory and research roles. Recent appointments include Louisiana's Advisory Commission on Coastal Protection, Restoration and Conservation (2008) and Maryland's State Smart Coast Council (2014). In 2014 he was also appointed by the government of Singapore to a

panel of experts advising on sea-level rise challenges faced by that country.

Galloway is currently serving as a member of the U.S. National Academies' Resilience America Roundtable, a consultant on flood risk management for the U.S. Army Corps of Engineers, a member of the American Society of Civil Engineers' Task Committee on Flood Safety Policies and Practices, a consultant to The Nature Conservancy on its Yangtze River Program, and a consultant to the Natural Heritage Institute's study of Climate Impacts of Dam Construction on the Mekong River Basin. He has been a member of 13 National Academies committees studying complex water resources and geospatial management issues including U.S. ocean research science and technology priorities, and FEMA Flood Maps.

Gerald Galloway is a civil engineer, public administrator, soldier, educator and geographer. He graduated from the U.S. Military Academy with a Bachelor of Science degree and was commissioned as a second lieutenant in the U.S. Army Corps of Engineers. He served in various command and staff assignments in Germany, Southeast Asia and the U.S. during his 38-year military career. He was promoted to brigadier general in 1990 before retiring from active duty in 1995.

Galloway holds a masters degree in engineering from Princeton; a masters in public administration from Penn State (Capitol Campus), a masters in military art and science from the U.S. Army Command and General Staff College, and a Ph.D. in geography (water resources) from the University of North Carolina Chapel Hill.

*Collaborative Forest Landscape Restoration Program is Recipient of 2015 Outstanding Achievement Award*

The U.S. Forest Service's Collaborative Forest Landscape Restoration Pro-

gram (CFLRP) received RNRF's 2015 Outstanding Achievement Award. This award recognizes a project, publication, piece of legislation, or similar concrete accomplishment in the natural resources field.

The CFLRP is an innovative approach to managing and conserving our natural resources. Authorized by the 2009 Omnibus Public Land Management Act, it accelerates restoration of high-priority landscapes through a science-based, collaborative approach. Such restoration enhances forest and watershed resiliency and promotes social, ecological and economic sustainability.



The program consists of 23 landscape projects in 14 states, all of which are greater than 50,000 acres in size. Projects are selected based on proposals collaboratively developed with diverse partner communities, accounting for over 250 local partners including counties, businesses, tribes, utility companies, nongovernmental organizations, advocacy groups and private citizens.

Through its collaborative approach, focus on integrated landscape-level work, and emphasis on adaptive management, the program addresses both the needs of forest ecosystems and the communities that rely on them. The CFLRP successfully encourages economic well-being and job growth,

wildlife risk reduction, and ecosystem restoration including wildlife habitat, invasive species management, and watershed health.

More information on the Collaborative Forest Landscape Restoration Program is available at <http://www.fs.fed.us/restoration/CFLRP/>.

The award will be presented on October 28, 2015 at the annual meeting of the RNRF Board of Directors in Potomac, Maryland.

*“Louisiana Loses Its Boot” is  
Recipient of 2015 Excellence in  
Journalism Award*

“Louisiana Loses Its Boot,” published on the platform Medium by freelance journalist Brett Anderson, is the recipient of RNRF’s 2015 Excellence in Journalism Award. The award honors and encourages excellence in print journalism about natural resources, part of RNRF’s goal to advance public educa-



tion and understanding of important natural resources issues through dissemination of accurate and scientifically-based information about the environment.

According to the USGS, the state of Louisiana lost just under 1,900 square miles of land between 1932 and 2000, an area roughly equivalent to the entire state of Delaware. Today, an area ap-



proximately the size of a football field is lost every hour; as much as 1,750 square miles will likely be lost by 2064.

“Louisiana Loses Its Boot” aims to answer a simple question: If Louisiana has lost so much land, why has its map, specifically the iconic boot shape of Louisiana, not changed in modern history to reflect that loss? In exploring the natural and human history of lower Louisiana, Anderson reveals the complexities of confronting the reality of sea level rise and coastal management in the state. He goes on to demonstrate the magnitude of change hidden by outdated maps and imagery of Louisiana’s boot; the results are shocking and sobering. Anderson ultimately puts forth a call to action: Change the map. Show the truth.

The article can be read online at <https://medium.com/matter/louisiana-loses-its-boot-b55b3bd52d1e>.

The award will be presented on October 28, 2015 at the annual meeting of the RNRF Board of Directors in Potomac, Maryland.

*Congressional Forum on Climate  
Change and U.S. Food Production*

RNRF hosted a congressional forum on climate change and U.S. food production at the Cannon House Office

*Continued on page 28*

## RENEWABLE RESOURCES JOURNAL

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**Editorial Policy:** The editors seek general interest articles concerning public policy issues related to natural resources management. Recommended maximum length of manuscripts is 4,000 words. All manuscripts will be reviewed by the editors and, where appropriate, by experts in the subject matter. (A “Guide for Contributors” is posted at RNRF’s website.) **Editorial Staff:** Robert D. Day, editor; Melissa M. Goodwin, associate editor; Jennee Kuang, assistant editor.

# Lessons Learned from Germany's *Energiewende*:

## The Political, Governance, Economic, Grid Reliability, and Grid Optimization Bedrock for a Transition to Renewables

Peter Sopher

*The German example is rife with lessons—pertaining to politics, governance, economics, grid reliability, and grid optimization—for other countries, such as the United States, to internalize as intermittent renewables become more prevalent in their generation mixes. The German example reveals that, while aligning politics and governance structure for an energy sector transition is a heavy lift reliant on sustained popular sentiment among the public, implementation can occur quickly once these pieces are in place. Economic lessons are nuanced. Macroeconomic costs of Energiewende have placed substantial burdens both on energy-intensive industries and on residential consumers. Associating as an Energiewende proponent requires belief that macroeconomics benefits—such as large employment gains and the establishment of significant market share in an already large industry that's poised to boom—*

*This article by Peter Sopher, energy policy analyst at Environmental Defense Fund (EDF), was originally published in Volume 6 (2015), Issue 2 of the Renewable Energy Law and Policy Review (RELP). The original version of the article can be accessed at <http://relp.lexxion.eu/article/REL-P/2015/2/3>.*

*as well as microeconomic indicators, such as rapidly declining prices for renewables, justify such high short-term costs. Regarding reliability, the German example shows that a grid that derives over a quarter of its power from renewables can become a global leader in supply security given ample reserve capacities and well-developed inter-*

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*Energiewende...is a “mammoth policy project” and by far the most aggressive clean energy effort among the G20.*

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*connections with neighbouring grids. However, extensive and expensive transmission and distribution (T&D) infrastructure must be built to minimize renewables-induced grid congestion that threatens grid reliability both domestically and for neighbors.*

### Introduction

As the home of Einstein, Nietzsche, Beethoven, Heisenberg, and many other iconic academic and artistic game

changers, it should come as no surprise that Germany is at the forefront of modernizing an industry as complex as energy.

*Energiewende*—the “transformation of Germany’s energy supply system to renewables” through juxtaposing over 20 different quantitative, energy-related targets<sup>1</sup>—is a “mammoth policy project”<sup>2</sup> and by far the most aggressive clean energy effort among the G20. While *Energiewende* comprises energy efficiency, nuclear phase out, and emissions targets, this paper focuses on its goals for renewables fuelling the electricity sector.

The law catalysing Germany’s energy transition is the “Renewable Energy Sources Act” (EEG), the first iteration of which was passed in 2000. *Energiewende* was later conceived in September 2010 when the Federal Government adopted the Energy Concept, which was revised in 2011 after the Fukushima meltdown inspired the German government to cut nuclear power from its envisioned electricity mix.<sup>3</sup> While *Energiewende* has forged ahead “essentially on the basis”<sup>4</sup> of the 2010 Energy Concept and its 2011 revision, an August 2014 reform “fundamentally overhauled” the EEG, restructuring it to enable the achievement of *Energiewende*’s goals in a more affordable manner.<sup>5</sup>



A little over a decade after the EEG and just a few years after *Energiewende*'s birth, the German energy landscape has been completely transformed. Renewables' share in Germany's electricity generation has increased from 7% in 2000<sup>6</sup> to close to 28% during 2014,<sup>7</sup> double America's 2014 renewables percentage, about 13%.<sup>8</sup>

If successful, *Energiewende* can serve as a blueprint for expediting the broad scale integration of technologies that will be necessary to wean the world off fossil fuels and combat climate change.<sup>9</sup> So far, the German example has revealed that, while aligning politics and governance structure for an energy sector transition is a heavy lift requiring robust agenda-setting efforts, implementation can occur quickly—and with macroeconomic benefits that include boosting net employment and winning market share in a budding sector, albeit at a high financial burden—once these pieces are in place.

This article examines lessons learned from the German experience from a frame of how they might apply elsewhere, with a focus on the United States. It is broken into sections that focus on politics and governance, economics, and grid reliability and optimization.

## Politics Governance

Political actors in countries with coordinated market economies, such as Germany, prefer dialogues, strategic concessions, and trade-offs that give rise to policy decisions unanimous among main stakeholder groups. However, for *Energiewende* unanimity is constrained.

That is because two interest groups, the Conventional Energy Coalition (CEC) and the Sustainable Energy Coalition (SEC), support fundamentally different energy systems that oppose each other.

The CEC strives “to maintain the status quo of the energy system.”<sup>10</sup> A criti-

cal mass of major CEC proponents hold a financial stake in the current energy system, and CEC arguments center on risks—such as potential grid reliability problems, as well as high costs eroding the country's industrial sector's global competitiveness—inherent in pioneering a shift away from a century-old paradigm.<sup>11</sup>

Opposing the CEC, the SEC's foremost ambition is for *Energiewende* to maintain momentum and the transition to renewables to occur in a timely and strategic manner.<sup>12</sup>

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At the federal level, six ministries have relevant jurisdictions concerning the *Energiewende*. The three most important actors are the Federal Ministry of Economics and Energy (BMWi), the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), and the German Network Agency (BNetzA). While there has been recent progress in clarifying ministries' authorities, there is still overlap among ministries' responsibilities. For example, ‘energy efficiency’ improvement is an objective for the BMWi and BMUB, as well as for the Federal Ministry of Transport and Digital Infrastructure (BMVI).<sup>13</sup> At present, Barbara Hendricks and Sigmar Gabriel are ministers leading the BMUB and the

BMWi, respectively. Both are members of the Social Democratic Party (SPD), a political party that aligns itself in the middle between the SEC and the CEC, but leans SEC. For details on the *Energiewende* responsibilities of the relevant federal ministries and other governing bodies, refer to Kemfert and Horne (2013).<sup>14</sup>

According to the BMWi, *Energiewende*'s approval rating is between 56% and 92%,<sup>15</sup> and, according to Bloomberg New Energy Finance (BNEF), “67% think the country isn't doing enough to move to renewables.”<sup>16</sup>

Despite being vastly outnumbered, the CEC continues to fight the energy transition. This state of affairs reveals the importance of political stamina in the energy transition context. The German government understands the importance of *Energiewende*'s popularity in moving it forward, and BMWi emphasizes consistent and transparent communication with the public, as well as affordability, as crucial “actions to sustain the popularity of its energy transition.”<sup>17</sup>

Political stamina becomes doubly relevant when considering the governance challenges *Energiewende*'s implementation presents. *Energiewende* comprises diverse political levels and jurisdictions—global, European, federal, state, and municipal—as well as interest groups, cooperatives, alliances, banks, and individuals. To this end, BMWi asserts that “only through effective coordination with the German Länder and close collaboration with actors from business and society will it be possible to successfully transform our energy sector.”<sup>18</sup>

Partisan politics renders individual governing bodies' positions dynamic; and, thus, how the moving parts of an energy transition work together as a unit frequently fluctuates. While *Energiewende* is a program with long-term 2050 goals, the heads of these governing ministries fluctuate more regularly;

since *Energiewende*'s official start in 2010, there have been three different heads of the BMWi. The political leanings—specifically, whether ministers are proponents or opponents of *Energiewende*—of these ministries in the future is an unknown that will impact the efficiency and effectiveness of *Energiewende*'s implementation.<sup>19</sup>

This state of affairs reveals inherent risk from when an ambitious energy transition with long-term goals relies on a sustained, favourable political backdrop. For future energy transitions elsewhere, it should be noted that there are ways to organize governance—such as creating administrative positions for appointees with indefinite terms, and/or delegating a greater share of power to independent stakeholders, such as BNetzA—that are less prone to the instabilities associated with partisan politics.

Germany's federalism adds another wrinkle of complexity to *Energiewende*'s governance. States (Länder) have their own agendas; so, inconsistencies between federal and state goals are inevitable. To date, according to IEA, "many grid projects have been delayed or stopped at Länder borders." Beyond managing infrastructure at state borders, a concern of IEA "is competition between Länder for renewable developments, which provide a source of revenue to the host area."<sup>20</sup> For example, both northern and southern states would like to increase their supply of renewables, but all these states moving forward on this ambition could lead to over-capacities,<sup>21</sup> thereby stressing and potentially damaging transmission and distribution infrastructure, leading to reliability concerns.

While states have recently agreed to improve cooperation and relinquish more planning competencies to the federal level (the Act to Accelerate the Expansion of Electricity Networks in 2011 streamlined approval and transferred competencies from states to the federal

government), unclear jurisdictions and lack of accountability are still prevalent and, thus, planning and implementation problems are likely to persist.<sup>22</sup> There must be a clear, accepted understanding that the higher level of government has authority if conflicting agendas among lower levels of government arise.

Along with ensuring state activities fall in line with the national *Energiewende* vision, the national government must steer *Energiewende* so that it is compatible with the plans for the European Union (EU). According to

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BMWi, "implementing the *Energiewende* in the context of the single European market for electricity and gas makes a close exchange with our neighbors and at the European Union level necessary."<sup>23</sup>

#### Economics/Costs

Critics consider *Energiewende*'s costs unjustifiable, arguing they hurt the country's international competitiveness, and systemic inefficiencies exacerbate these costs. Supporters, by contrast, trumpet investments in *Energiewende* as having benefited employment rates, as well as the country's market share in a budding industry, and they believe that current costs will manifest as medium- and long-term net

macroeconomic gains.

According to the European Commission (EC), "the expansion of renewable energies reaching a share of 63% by 2030 would result in additional costs of EUR 137 billion compared to a fossil-fuel based reference scenario."<sup>24</sup> BNEF estimates the total cost to date of Germany's clean energy expansion at €106 billion.<sup>25</sup>

*Energiewende*'s costs primarily manifest via the "EEG levy"—the difference between the set feed-in price for renewable energy sources and the trading price of electricity.<sup>26</sup> This levy amounted to €20.4 billion in 2013 and increased to €23.6 billion in 2014, reflecting EEG surcharges of €0.0528/kWh and €0.0624/kWh in 2013 and 2014, respectively. Recent wholesale and retail electricity price trajectories convey the financial impacts of Germany's electricity tariffs, of which the EEG comprised 37% in 2013; from 2008-2013, wholesale prices fell by 18%, while retail prices increased by 8%.<sup>27</sup> Eurelectric's explanation for this state of affairs is that, between 2008 and 2012, "taxes & levies rose by as much as 31%, wiping out any benefits derived from functioning wholesale markets."<sup>28</sup>

These costs burden energy-intensive businesses that compete in the global market. According to BMWi minister Sigmar Gabriel, "energy costs in industry amount to up to 60% of the total business costs (cellulose, paper)... In Europe, electricity costs are roughly two-and-a-half times as much as in America... So you can see the danger that entire industries will relocate."<sup>29</sup> The European wing of the International Federation of Industrial Energy Consumers (IFIIEC) echoes Gabriel's message, asserting that electro-intensive companies "will need to be shielded from these ever increasing costs."<sup>30</sup>

This "shield," at present manifests as significant EEG discounts for energy intensive industries; by September 2013, "2,295 companies and business compo-



nents were exempt from the EEG levy.”<sup>31</sup> A complaint stemming from these EEG discounts for industries, however, is that a disproportionate burden is allocated to residential consumers; according to the EC, “the EEG levy could be diminished by €ct 1.35, if all exemptions for German companies were revoked.”<sup>32</sup>

Of particular note is the impact of the EEG on low income households. According to the EC, “in 2011, households spent on average 2.34% of their consumption expenditure on electricity. This share increased to 2.5% in 2013. For the lowest income group this share is significantly higher at 4.55% in 2013. However, the EEG levy accounts for 0.5%.”<sup>33</sup> All sides agree that the impact of the EEG on low income households is a serious issue. *Energiewende*’s supporters, however, note that, according to IEA, “energy poverty is equally driven by the steep increase in fossil fuel costs,” as many of the non-EEG electricity tariffs support fossil fuel generation.<sup>34</sup> In addition, when compared to some of the most developed countries in the world, such as the United States, energy poverty is less prevalent in Germany.<sup>35</sup>

While short run costs are substantial, *Energiewende*’s proponents find it is appropriate to frame them in relative terms. First, Germany’s annual investment in fossil fuels has been €90 billion; and, unlike investments in *Energiewende* that primarily support electric grid upgrades, a large amount of fossil fuel investment manifests as one-off payments for fuel to foreign countries.<sup>36</sup> According to BMWi, “In 2013 Germany imported fossil energy sources to the tune of 92 billion euros. At the same time, around 9 billion euros in fuel costs were avoided thanks to renewable energy sources alone.”<sup>37</sup> Second, there are signs EEG surcharge costs have hit a plateau; according to the BMWi, “For the first time since the Renewable Energy Sources Act (EEG) was introduced in

2000, the amount to be reallocated via the surcharge levied on electricity prices is to drop compared to the previous year... In 2015, the surcharge will be 6.17 ct/kWh.”<sup>38</sup> And, also according to BMWi, the 2014 EEG amendment aimed to “slow any further rise in costs.”<sup>39</sup> Third, according to the EC, “the share of payments for electricity compared to nominal GDP was 2.5% in 2011 (as well as in 2009 and 2010) which is the same level as in 1991.”<sup>40</sup>

Another consideration supporters voice is the benefits that have arisen from past spending on *Energiewende*. Research from BMWi and BMUB suggests that investments in *Energiewende* have led to Germany establishing a 14% market share—second behind China—of the global green technology sector; a

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sector appraised at €2.5 trillion in 2014 and projected to double to €5.3 trillion by 2025. According to BMUB, “between 2013 and 2025, the domestic green tech market is expected to rise from EUR 344 billion to a volume of EUR 740 billion... In 2013, green tech accounted for 13% of Germany’s gross domestic product.”<sup>41</sup> To this tune, according to BMWi, “Germany has been one of the biggest exporters of technology and equipment for use in exploiting renewable energy sources. The value of exports just recently totalled around 10 billion euros.”<sup>42</sup> BMUB estimates that these exports will increase to €47–69 billion by 2030. Projected net macroeconomic profit ranges from having committed to *Energiewende*, relative a

business as usual (BAU) scenario, for 2020 and 2030 are €28 billion–€42 billion and €43 billion–€60 billion, respectively.<sup>43</sup>

In addition, *Energiewende*’s positive and pervasive employment impact is difficult to refute. In 2004, Germany’s renewable energy sector employed 160,500 people, and that number doubled to 363,100 by 2013. Furthermore, 2013 employment directly attributable to the EEG was 261,500, 70% of total employment from renewables.<sup>44</sup> The net employment gain from renewable energy in 2009 alone was 70,000–90,000, compared to a BAU scenario. And this trend is only expected to continue. The projected net employment gains for 2020 and 2030 are 23,000–117,000 and 105,000–241,000, respectively. Furthermore, all regions of Germany are set to benefit from renewable energy expansion.<sup>45</sup> These benefits extend to the most remote regions of the country; as of 2013, farmers and individuals owned renewable energy investments amounting to over €100 billion.<sup>46</sup>

Transitioning to a microeconomic frame, supporters of *Energiewende* find the improving cost competitiveness of renewables encouraging. At present, premier wind farms produce electricity at a price comparable to that of gas and coal plants. In addition, the levelized cost of energy for solar PV has fallen 78% over the past five years, and PV is now competitive with residential electricity tariffs in many countries, including Germany.<sup>47</sup> By contrast, Germany’s costs of importing oil, gas, and hard coal have increased by factors of 2.77, 2.68, and 2.26, respectively, over the past ten years.<sup>48</sup> While the costs of transitioning to an electricity grid based on renewables are high, revamping infrastructure now to support fuels with downward price trends and replace fuels with upward price trends could prove to have been a savvy investment.

## Reliability & Grid Optimization

The System Average Interruption Duration Index (SAIDI) measures the average interruption time per electricity customer, and it is the foremost metric used internationally for assessing electric grid reliability. This past August, Germany's Network Agency announced that the country's SAIDI value improved from 15.91 minutes in 2012 to 15.32 minutes in 2013.<sup>49</sup> This improvement is especially impressive considering Germany's 2012 SAIDI score was the third best in Europe<sup>50</sup> and less than a tenth of 244, the most recent statistic from the United States.<sup>51</sup>

Germany's impressive SAIDI validates BMWi's claim that, even after installing 70GW of intermittent wind and solar<sup>52</sup> and sporting a 2013 electricity generation mix with 25.3% renewables, "electricity supply in Germany is one of the most reliable in the world."<sup>53</sup> While Germany's SAIDI score paints a rosy picture regarding the country's past performance, it lacks nuance when assessing renewable energy's impact on infrastructure and other grid features that could impact future reliability.

A major reliability-oriented concern is the spike in grid congestion—both domestically and for neighbours—attributable to Germany's increased renewables generation. According to the EC, "most urgently, lines from the North to the South of Germany are needed to eliminate internal bottlenecks and help avoid unscheduled 'loop flows' which are currently congesting the borders with Germany's neighbours."<sup>54</sup> According to IEA, "these loop flows occur when Germany has insufficient grid infrastructure to handle power production... and the power is diverted through neighbouring countries' grids."<sup>55</sup> Poland and the Czech Republic are Germany's neighbours most negatively impacted by these "loop flows." In the Czech Republic, "transmission capacity is reduced because of loop flows origi-

nating mostly from Germany."<sup>56</sup> For Poland, "at times, no transmission capacity is available to the market because of significant transmission reliability margin (TRM) problems resulting from, inter alia, substantial loop flows from Germany."<sup>57</sup>

While the four TSO's have invested €1.15 billion on expanding high-voltage electricity networks that might mitigate grid congestion and resulting loop flows, "the expansion of the electricity transmission network has been advancing slower than planned. By July 2014, about 416 of 1,877 kilometers (22%) of

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the projects listed since 2009 in the Electricity Grid Expansion Act (EnLAG) were realised."<sup>58</sup> Furthermore, while, in 2012, BNetzA approved 2,800 km of new lines and 2,900 of network enhancement beyond EnLAG, the EC finds it "becomes increasingly doubtful in view of delays, whether the actual speed of network infrastructure construction is sufficient."<sup>59</sup>

Beyond the need for improved transmission and distribution infrastructure, the influx of intermittent renewables online in Germany has and will continue to require robust backup capabilities, especially during winter months. For the 2012-2013 winter, BNetzA contracted 2.6MW of reserve capacity and compensated these reserve plants for being prepared to generate power if needed.

Despite this protocol, however,

"In respect of the national balance between demand and supply, ENTSO-E calculated a negative reserve margin of -0.6% for Germany for the winter of 2012/2013 which indicates the national demand of electricity could be higher than generation capabilities. Germany may therefore need to rely on imports in certain situations."<sup>60</sup>

In addition to reliance on imports, Eurelectric emphasizes that,

"In power systems that face growing intermittency, there will be growing demand for flexibility services... Additional flexibility services for system operators, related to smart grid, have to be developed. All different sources of flexibility, such as generation (including storage) [and] demand response... should be considered."<sup>61</sup>

Three flexibility mechanisms highlighted in this quotation are demand response (DR), smart grid enhancement, and storage. While DR has its critics and development is nascent in much of Europe, including in Germany, Eurelectric advocates for DR as "one of the building blocks of future wholesale and retail markets."<sup>62</sup> Germany has programs in place, such as the Ordinance on Agreements on Interruptible Loads—which is "designed to increase system stability by enabling system operators to remove industrial loads from the grid flexibly in critical situations"—that support DR.<sup>63</sup>

Smart grid enhancement is a second grid optimization measure on which Germany has lagged. However, short term forecasts from BNEF are optimistic. By 2018, 6 million smart meters are predicted to be installed, up from 1 million in 2014.<sup>64</sup>

Similar to smart grid infrastructure and DR, little energy storage capacity has accumulated; from 2000 through 2013, storage capacity in Germany grew from 301MW to 303MW, according to BNEF.<sup>65</sup> According to BMWi, howev-

er, “the German government is pushing research and development for storage technologies forward and has made 200 million euros available for the ‘Energy Storage Funding Initiative.’”<sup>66</sup>

While flexibility mechanisms and imported power function as reliability enhancers, few dispute the integral role fossil fuels have played—and promise to continue to play—as a critical source of backup power for ensuring grid reliability. According to IEA, “conventional power plants are still needed, also in the long-run (~50GW with 80% RES).”<sup>67</sup> What’s potentially problematic for grid reliability is that the influx of renewables in the generation mix is hurting the profitability of these essential fossil fuel generators in three ways. First, these plants are tapped far less frequently than in the past. Second, lower wholesale prices due to the increase of renewables, whose operating costs are negligible, “further discourage firm capacity providers from remaining active.”<sup>68</sup> Third, according to Eurelectric, “greater RES intermittency on the supply side coupled with greater demand participation, energy efficiency, and macroeconomic impacts on the demand side are making market outcomes increasingly difficult to predict.”<sup>69</sup>

To this point, the Heinrich Böll Foundation asserts that “even the strongest proponents of Energiewende agree that Germany needs to reform its energy system to accommodate the next influx of renewable energies.”<sup>70</sup> As a potential solution, Heinrich Böll and others, such as Eurelectric, advocate a shift away from the “energy-only” market—in which utilities are only paid to produce and deliver energy—to one that is more profitable for utilities as renewables take over the generation mix. The German government is confident in its short term grid reliability, and IEA seconds this notion asserting that “Germany has time to adjust its energy-only market design; it runs a sufficiently high reserve margin and is well interconnected with

neighbouring countries.”<sup>71</sup> Hence, the German government is carefully—prioritizing a sound decision over a quick one—approaching potentially reforming the structure of its electricity market in a way that ensures reliability through fair compensation for backup power providers.<sup>72</sup>

In addition to needing a more flexible grid and an electricity market that more fairly compensates backup power providers, in order to ensure reliability, grid operators must be prepared to manage more grid intervention events, which could lead to blackouts, as renew-

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ables gain market share. From 2010 to 2012, grid intervention events increased fourfold in Germany.<sup>73</sup> As evidenced by Germany’s strong and improving SAI-DI score, grid intervention events have yet to significantly impact the country’s reliability of electricity supply. However, grid intervention events promise to become more prevalent and require more management effort as renewables capacity grows.

Lastly, an environmentally framed criticism of how Germany ensures grid reliability centres on coal’s sizable share of Germany’s generation mix. According to the EC,

“In the short term, the shutdown of the nuclear power plants is likely to

result in a higher use of gas and coal... The share of coal in the energy mix has increased by one percentage point between 2008 and 2012... Recent energy trade data show that imports of coal have increased significantly in Germany (+37% between 2011 and 2012).”<sup>74</sup>

Furthermore, while many sources, including the EC and IEA, are not bullish towards coal’s long term prospects in Germany, IEA highlights that the construction of some coal plants in Germany in recent years will ensure a role for coal “as a cornerstone of Germany’s electricity production well into the medium term.”<sup>75</sup>

The German government, to its credit, has acknowledged that the country has “too much coal in the grid” and has been proactive in steering its electricity sector in a direction that minimizes coal usage. In March 2015, Germany advocated for a “very quick” reform to the EU emissions trading system that would benefit power plants fired with natural gas over coal.<sup>76</sup> Furthermore, IEA and others predict the decommissioning of “substantial volumes” of coal-fired capacity due to the phase out of hard coal subsidies by 2018 coupled with the implementation of the EU Large Combustion Plant Directive and the fact that just under 60% of coal capacity was commissioned between 1970 and 1990.<sup>77</sup> To this tune, Poyry (2013) concludes that “there will be no major new unabated coal or lignite projects in Germany for the foreseeable future beyond those currently under construction.”<sup>78</sup>

## Conclusion

The German example is rife with lessons—pertaining to politics, governance, economics, grid reliability, and grid optimization—for other countries, such as the United States, to internalize as intermittent renewables become more prevalent in their generation mixes.

Proponents of an energy transition in the United States face a tall order politically. Four American based oil companies (Exxon, Chevron, Phillips 66, and Valero) and two motor vehicles companies (General Motors and Ford) are members of Fortune's top ten companies.<sup>79</sup> Powerful people have depended on fossil fuels for making their fortunes, and the Koch brothers and other fossil fuel magnates are not shy about financing political campaigns. Such an old guard is also prevalent in Germany, so studying how German renewables integration advocacy efforts have succeeded in building and maintaining popular support via emphases on consistent, transparent communication with the public, as well as cost minimization, is fruitful for those in favour of an energy transition in the United States.

Related to politics, *Energiewende's* dynamic development illustrates the importance of continued flexibility in governance structure for energy transitions. Inherent to a "mammoth" policy initiative with political, social, and economic relevance, overlapping responsibilities of federal ministries must be minimized as an energy transition evolves and the various levels of government (local, state, federal, etc.) must work together to optimize the country's strategic integration of renewables. This flexibility must extend to governance structures that enable countries to re-work policies used for achieving renewables targets, but that do not make it easy for politicians to weaken targets. A key to an energy transition's success is how it develops within the political agendas of fluctuating heads of state, some of whom might oppose the energy transition in future years.

The German example provides both encouraging and cautionary lessons regarding the economic and grid reliability impacts of proactive renewables integration. Regarding economics, macroeconomic costs of *Energiewende* have placed substantial burdens both on ener-

gy-intensive industries, whose shares of their respective global markets are at risk due to high power prices, and on residential consumers, especially those from low-income households, who bear a disproportionate share of *Energiewende's* costs. Associating as an *Energiewende* proponent requires belief that macroeconomics benefits—via large employment gains and the establishment of significant market share in an already large industry that's poised to boom—as well as microeconomic indicators, such as rapidly declining prices for renewables, justify such high short-term costs.

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Regarding reliability, the German example shows that a grid that derives over a quarter of its power from renewables can become a global leader in supply security—in terms of SAIDI—given ample reserve capacities and well-developed interconnections with neighbouring grids. However, extensive and expensive transmission and distribution (T&D) infrastructure must be built to prevent renewables-induced grid congestion that damages both T&D infrastructure and threatens grid reliability both domestically and for neighbours. In addition, what is essential for long term reliability for a power system in which renewables comprise a large share is an electricity market structured in a way that fairly compensates backup

power providers. Also desirable for a reliable grid are well-developed flexibility tools, such as demand response, smart grids, and energy storage.

*Energiewende* is entering the fifth year of what is intended as a forty year undertaking. As it evolves, lessons will continue to manifest. The German Institute for International and Security Affairs argues, "If the [German] energy transition succeeds, it will serve as an international model."<sup>80</sup> Germany has gifted the world an example of an energy transition. It is the rest of the world's prerogative to learn from the German example.

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# Climate Change: A Risk Assessment

## Climate Change Risks to National and International Security

David King, Daniel Schrag, Zhou Dadi, Qi Ye, & Arunabha Ghosh

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The security risks of climate change<sup>1</sup> may be the hardest of all climate risks to assess, because they involve the longest chains of causation or influence, and the most unpredictable factors. However, since they may be the biggest risks of all,<sup>2</sup> assessing them to the fullest extent possible is essential.

There is potential for confusion and underestimation of risk if assessments of climate security risks do not make clear the degree of climate change they are considering. A focus on risks in the current climate may well be enough to inform policy on adaptation and resilience, but to inform decisions with long-term implications (such as those relating to global emissions), a longer-term view is also necessary. Here we deliberately make clear distinctions wherever possible between risks in the present climate, risks in the future under low degrees of climate change, and risks in the future under high degrees of climate change.

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Climate change risks to security in the present

A growing body of credible, empirical evidence has emerged over the past decade to show that the climate change that has occurred thus far—involving an increase of 0.8°C in global average temperatures—is already influencing dynamics associated with

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human, sub-national, national and international security. This evidence does not generally attempt to pinpoint precise causal relationships, but instead considers how climate change may have altered probabilities and interacted with other factors to increase the risks. Here we give two examples.

*Drought, displacement and conflict  
in Syria*

The Middle East, North Africa and Mediterranean region has experienced a drying trend over the last few decades, with a notable decline in winter precipitation. Climate change is thought

to have played a significant role in this trend, as was forecast by previous climate modelling,<sup>3</sup> and to have made the extreme drought suffered by Syria between 2007 and 2011 some two to three times more likely.<sup>4</sup> During the drought, crop failure and the loss of livestock were severe and widespread. This contributed to a mass internal displacement of farmers and herders—around two million people—many of whom fled to urban areas which were already stressed with Iraqi and Palestinian refugees.<sup>5</sup> By 2009, more than 800,000 Syrians had lost their entire livelihood as a result of the droughts; by 2011, around 1 million were extremely food insecure, and 2-3 million had been driven into extreme poverty.<sup>6</sup> While many other factors were important in driving the political unrest and conflict that followed, it is difficult to imagine that this widespread impoverishment and large-scale displacement did not play a role.

*Heat waves, food price spikes,  
and civil unrest*

In the summer of 2010, Russia suffered an extreme heat wave. Climate change is estimated to have made this event approximately three times more likely to occur than it would have been otherwise.<sup>7</sup> The heat wave combined with and contributed to drought and fire, and reduced Russia's wheat production that year by more than 30%.<sup>8</sup> At the same time, related droughts affected wheat harvests in Ukraine and China. Reduced production, protectionist measures, commodity speculation, and

large-scale purchases on the global market all contributed to a more than doubling of the global wheat price in the second half of 2010.<sup>9,10</sup> In highly import-dependent countries such as Egypt, the price of wheat rose by 300% in late 2010 and early 2011.<sup>11</sup>

The top nine wheat-importing countries in the world, on a per capita basis, are all in the Middle East and North Africa. Seven of these countries—Libya, Jordan, Algeria, Tunisia, Yemen, Egypt and Iraq—are ranked lower than “very high” on the Human Development Index, and spend between 35% and 45% of their average household income on food. All seven experienced political protests resulting in civilian deaths in 2011.<sup>12</sup> In many of these countries, food prices are recognized to have been one of the factors that led to the unrest—notably in Tunisia, Jordan and Yemen, where demonstrators waved baguettes on the streets.<sup>13</sup> In Egypt, although urban protests primarily focused on other social and economic concerns, bread protests occurred in rural areas across the country in parallel to the events in Tahrir Square, and may have broadened the appeal of the revolution to rural communities.<sup>14</sup>

Clearly, climate change did not on its own cause any of these events. But it appears to have played a role, combining with other stresses and weaknesses to destabilize environmental, economic, social and political systems.

### Climate change risks to security in the future

In the near term future, population and economic growth are expected to significantly increase pressure on resources. Global demand for food, water and energy is projected to increase by approximately 35%, 40% and 50% respectively, by 2030 as compared to 2012.<sup>15</sup> At the same time, climate change could negatively affect the availability of these resources. National

security and intelligence assessments of several governments have recognised the potential for this confluence of trends to contribute to security risks.<sup>16</sup>

With regard to security risks in the long term, relatively little analysis is available. The IPCC found that: “*Much of the current literature on human security and climate change is informed by contemporary relationships and observation and hence is limited in analyzing the human security implications of rapid or severe climate change.*”<sup>17</sup>

To support our assessment of how security risks could vary between low degrees of climate change in the near term, and potentially high degrees of climate change in the long term, we commis-

sioned the CNA Corporation, experts in futures analysis and wargaming, to design and conduct a wargame and scenarios exercise. This was held in Delhi in March 2015, hosted by the Council on Energy, Environment and Water. The 24 participants included senior scientists, security experts, diplomats, and retired military personnel from countries including India, China, the US, the UK, Bangladesh, Germany, the Netherlands, and Finland. The game investigated the decisions made by participants as they played the roles of leaders of major countries and regions, aiming to further national economic and security interests in the context of a changing climate over the next half-century or more. The sce-

#### **Box 1. A perspective on climate change and the risk of state failure**

Vice Admiral Pradeep Chauhan, AVSM & Bar, VSM, I.N. (Retd.)

Nation-states are far from being inherently stable. Many have suffered near-continuous internal tensions throughout their histories, arising from ethno-religious differences and socio-economic inequalities. The extent to which the writ of nation states runs is often quite limited, both in terms of its robustness, and in terms of geography. Historically, the resilience of government structures in the face of unexpected and large-scale crises has frequently been found to be severely wanting. State failure is not a precisely defined term, but it may be characterised by: (a) an inability to provide security to the population resulting from failure to retain a monopoly on the legitimate use of force; (b) an inability to provide and equitably distribute essential goods and services; (c) a serious erosion of the power to make and enforce collective decisions; and (d) the involuntary movement of populations including refugees.

High degrees of climate change could increase the risks of state failure in countries that are economically underdeveloped, resource stressed, or already unstable for other reasons. In South Asia, drought in Afghanistan and Pakistan, and incessant flooding and loss of land to the sea in Bangladesh, could put those countries’ governments under great stress, and precipitate large-scale migration into India. In India, this would combine with an internal population shift from rural to urban areas, further increasing demographic pressure in cities—many of the largest of which—including Kolkata, Chennai and Mumbai—are coastal, and will be increasingly vulnerable to flooding both from sea level rise and from more intense rainfall. At the same time, both the influx of internal and external migrants, and the increasing variability of the monsoon, could further destabilise the “Red Corridor,” a swathe of economic deprivation and misgovernance that cuts through almost all the eastern states of India, in which Marxist-Leninist rebels are waging a campaign of violence against the state. The temptation to solve this problem through military intervention could become overwhelming.



narios exercise consisted of round-table discussions to identify the most significant near-term and long-term security risks in a scenario where climate change progressed at a rate close to the upper end of what is currently assessed as the likely range.<sup>18</sup> Both exercises were conducted by four independent groups of participants operating in parallel. The assumptions used in both exercises were reviewed for reasonableness and plausibility by the Climate Change Science Institute of Oak Ridge National Laboratory.

Here we discuss some of the biggest security risks identified, grouping them by theme. Analysis from the wargame and scenarios exercise conducted for this assessment is presented together with some more detailed comments from individual participants, and with relevant findings from a few other published studies that have explicitly considered the security risks of high degrees of climate change. References note where other assessments have reached similar conclusions.

### *State failure*

Our scenarios exercise found that in the near-term future, climate change would be most likely to increase the risks of state failure in states that are already highly water stressed or food insecure, at the same time as suffering from poverty, social tensions, and poor governance. We considered that countries in the Middle East and North Africa region may be at particular risk: most are already water-stressed, many of them to an extreme degree.<sup>19</sup> The large population increases projected for many countries in the region—in the range of 50% for Egypt, 70% for Syria, 90% for Yemen, and 130% for Iraq, between 2010 and 2050—will further decrease per capita water resources. At the same time, climate models predict a drying trend for the region. One study projects a reduction in streamflow of 10-30% in

large parts of the region, and of 30-50% in the worst affected areas, with a global temperature rise of 2.7°C.<sup>20</sup>

We also considered that countries where a high proportion of the population relies on subsistence farming may be at particular risk of instability due to climate change impacts on agriculture. Sub-Saharan Africa already has the highest proportion of food insecure people in the world, with more than a quarter of the population undernourished in 2010-2012, and more than half in some areas.<sup>26</sup> Many of the countries in the region—more than 30 in the continent as a whole—are projected to double their populations by mid-century,<sup>22</sup> and for a significant number, this will reduce arable land per capita to below a threshold of extreme stress.<sup>23</sup> At the same time, land temperatures in Africa are projected to rise faster than the global land average, and it is thought very likely that

climate change will reduce cereal crop productivity, with strong adverse effects on food security.<sup>24</sup> Clearly, economic development and adaptation to climate change will be critical, and the risks will be greatest where these efforts are less successful.

Climate change is likely to increase environmental stresses on many countries at the same time. A report by the German Advisory Council on Global Change suggested that this, in combination with the tendency of failed states to destabilize their neighbours, could lead to the emergence of “failing sub-regions” in parts of the world where climate change impacts are particularly severe.<sup>25</sup> Vice-Admiral Chauhan (Retd.) of the Indian Navy gives an example of how stresses affecting the countries of South Asia could interact with each other (Box 1).

At the high degrees of climate change

### **Box 2. A perspective on climate change and terrorism**

Vice-Admiral Lee Gunn, US Navy (Retd.) Former Inspector General of the Department of the Navy (Navy and Marine Corps), formerly Commander of Expeditionary Strike Group Three, and most recently President of the Institute for Public Research at CAN

No society, however prosperous overall it may be, appears to be entirely immune to terrorists’ recruiting. Terrorism can arise when two essential conditions are met: the presence of an appealing, unifying, or disruptive idea, and the social disenfranchisement of a section of society. The more the members of a segment of society feel themselves to be economically, culturally, or politically disenfranchised or marginalised, and the more difficult or distasteful their circumstances, the more fertile their community may become for terrorists’ recruiting.

Even in the current climate, some nations already struggle to provide for the basic needs of their populations (security, health, employment, freedom from want); while other nations have failed to do so entirely. As a result there are already marginalised populations where the appeal of terrorism is strong, and territories that are effectively ungoverned where terrorist groups are left to operate with little constraint. Climate change will disproportionately affect the countries that are already the weakest, and the people within them who are already the most vulnerable. It has the potential to significantly increase the ranks of disenfranchised populations within countries, as well as to increase the extent of ungoverned spaces.<sup>27</sup> At the same time, terrorism is becoming more dangerous as some of these groups take advantage of new technologies and globalisation, and we can expect this trend to continue.

possible in the long-term future, participants in our scenarios exercise considered that there could even be risks to the political integrity of states that are currently considered developed and stable. These could arise from the combined effects of food and water insecurity, social stresses caused by inequality and large-scale internal migration, the increasing expense and difficulty of protecting coastal cities, and the breakdown of infrastructure systems subject to multiple stresses.<sup>26</sup>

### *Terrorism*

Participants in our exercise saw the risk of terrorism as closely linked to the risk of state failure. While terrorism has complex causes, the power vacuum left by a failing or collapsed state provides conditions in which terrorist groups can become established and grow stronger. Participants considered that the inequality of climate change impacts between countries and the potential for large-scale displacement of people could further increase the risk. Vice Admiral Lee Gunn (Retd.) describes how climate change could increase the appeal of terrorism while terrorism itself is becoming more dangerous (Box 2).

### *Migration and displacement*

There are many ways in which climate change could lead to migration and displacement, with attendant security risks, as described by Major General A N M Muniruzzaman (Retd.) (Box 3).

All four groups of participants in our scenarios exercise identified migration—both within and between countries—as a significant security risk. Concerns were as much about the management of political and social tensions as about economic costs and pressure on resources. Participants from large countries were particularly concerned about how governance structures could cope, and social cohesion be maintained, in

### **Box 3. A perspective on climate change and security risks from migration and displacement**

Major General A N M Muniruzzaman, ndc, psc (Retd.), President of Bangladesh Institute of Peace and Security Studies, Chairman of Global Military Advisory Council on Climate Change

Historically, people have moved from place to place in search of a better life and to escape danger. Usually, their decision to migrate has a number of influences, and cannot be attributed to a single cause. In the coming century, climate change could emerge as an increasingly powerful influence. The ways in which this could happen include:

- Sea level rise, with attendant flooding and coastal erosion, is likely to displace populations from low-lying coastal areas, and small island states. Millions of people in Bangladesh could be displaced, and around 40 small island states could face partial or complete submergence.
- River flooding can displace people both directly, and indirectly through disruption of agricultural livelihoods. Flooding is projected to increase in many regions, but it could be a particular problem in South Asia due to the contribution of melting glaciers.
- Desertification and drought are both projected to increase with climate change. Both can be drivers of migration, especially of pastoral societies or those depending on rain-fed agriculture.
- Natural disasters tend to lead to short-term displacement, but persistent extreme events in a region can lead to migration. In future, this could include persistent dangerous heat extremes.

It has been speculated that the number of people displaced or migrating as a result of future climate change could run into the hundreds of millions,<sup>28</sup> but it is impossible to make an estimate with any confidence, and it will depend greatly on the rate and extent of climate change that is experienced. The security risks that could arise from large-scale migration have been widely recognized<sup>29,30,31,32</sup> and include:

- Destabilized borders: Migrants and refugees may be forcibly resisted by local populations or by governments. This can lead to conflict between groups, and potentially between states.
- Conflict over resources: Environmental migration has been found to be more likely to lead to conflict when the destination country is already resource stressed.<sup>33</sup> With climate change, this could often be the case, as countries within a region are affected in similar ways.
- Ethnic and cultural conflict: Migrants and displaced people often have to endure difficult living conditions and discrimination, which can lead to social division and tensions. Historically, conflict appears to have been more likely when migrants and destination country residents are from different ethnic groups, or when there is already distrust between their respective nations or social groups.<sup>34</sup>
- Disease: Displaced populations often lack appropriate sanitary and medical facilities. This can contribute to the spread of disease across borders.

situations where the differing local severity of climate impacts led to large-scale internal migration. At the same time, it was felt that the pressure of increasing numbers of international migrants and refugees could result in a rise of xenophobia and nationalism. In the game, it was notable that increasing numbers of refugees contributed to several large countries becoming more isolationist in their foreign policies.

Studies that have considered migration under high degrees of climate change have judged that the complexity of causes seen at present could be reduced to a more simple equation. The UK Government's Foresight report<sup>35</sup> found that: "some impacts of environmental change... may give rise to significant permanent displacement of whole populations as a result of existing settlements being, in effect, uninhabitable." Similarly, a study cited by the IPCC argues that "the most significant difference between the nature of human migration in response to 4°C of warming relative to 2°C would be to remove many people's ability to choose whether to stay or leave when confronted with environmental changes."<sup>36</sup> In this context, the number of people forced to move could be of an order of magnitude greater than anything experienced in human history.<sup>37</sup>

#### *Humanitarian crises, nationalism, and global governance*

Participants in our exercise considered it extremely likely that climate change would exacerbate humanitarian crises over the coming decades.<sup>38</sup> The greater uncertainty was around the extent to which the international community would have the capability and willingness to respond to these crises in the future. In the scenarios exercise, participants suggested that the multiple pressures could contribute to a shift towards nationalism, and away from values associated with human rights, democracy,

and cooperative global governance.

Post-game analysis found that as climate conditions had worsened, and the number of regions requiring aid and humanitarian assistance had increased, in all four instances of the game at least one major developed country reduced its assistance so as to concentrate on solving its own internal problems, and in some instances a majority of countries did so. In such cases, countries only turned their gaze outward again when prompted by refugees or terrorism. Countries

that persisted with an internationalist approach suffered an increasingly un-supportable burden.

A similar risk was identified by the German Advisory Council on Global Change, which argued that, given how difficult the international community finds dealing with a few failed states in the current climate, the consequences of high degrees of climate change could over-stretch conventional security policy, and pose a risk to the global governance system as a whole.<sup>39</sup>

#### **Box 4. A perspective on transboundary water resources and conflict risks**

Sarang Shidore, Visiting Scholar, University of Texas at Austin, formerly co-leader of strategic futures project at the Institute for Defense Studies and Analyses, New Delhi

While many research studies have considered the links between climate change and sub-national conflict, relatively few have taken on the question of climate-influenced inter-state conflict. Those that have, have tended to focus primarily on transboundary water resources, drawing on a long history of inter-dependencies and disputes.<sup>40</sup> In general, there is little support for the hypothesis of "water wars"—the idea that scarcity necessarily leads to increased armed warfare between states. In fact, a number of studies have dissected the many cooperative mechanisms that states have voluntarily put in place, even under fraught conditions. Some of these examples are the Indus Water Treaty between India and Pakistan, the Mekong River Commission, and treaties and consultations on the use of the Nile river in Africa.

Nevertheless, there is evidence that water scarcity and variability can increase political tensions between states sharing a common water resource, especially if their relations are poor due to other reasons, and can lead to diplomatic, trade, and other forms of non-military conflict.<sup>41</sup> Political tensions over water have arisen in South Asia with respect to the Indus, Ganges, and Brahmaputra rivers (India, Pakistan, Bangladesh, and China), in Central Asia with the Syr Darya river (Kyrgyzstan, Uzbekistan, and Kazakhstan), and in Africa with the Nile (Egypt, Ethiopia, and Sudan). Other potential sites for water scarcities enhancing latent interstate tensions include the Jordan river (Israel-Palestine and Jordan), the Tigris-Euphrates (Turkey, Syria and Iraq), and a number of rivers in the water-stressed regions of northern, eastern and southern sub-Saharan Africa such as the Kuito river (Namibia, Angola, and Botswana).

An important caveat to bear in mind is that most of the existing body of research relates to the current climate. The variabilities, scarcities, and (in some cases) surpluses induced by climate change in, for example, a 3°C world are likely to be much greater than any recorded in modern history, and could act as major destabilizing factors at a range well beyond the ambit of existing studies of past resource-conflict events.

### **Box 5. A perspective on global food security and conflict risks**

Professor Shi Yinhong, Professor of International Relations, Renmin University of China

The severity of the impact of high degrees of climate change on food production is not well known; neither is our ability to adapt to it. In a plausible worst case scenario where production does not keep up with growing demand, food could become the single most sought-after resource globally. Global markets could be destabilised, with prices high and volatile. Large fluctuations in price, or constraints on availability, could contribute to state failure in highly import-dependent countries.

In developed, high-consuming countries, pressure for secure, affordable supply, together with a loss of confidence in the markets, would result in a high priority being placed on the security of imports. This could lead to competition for the leasing or acquisition of arable land in developing countries, with contracts being enforced, where necessary, with both soft and hard national power. The risk of conflict would be significant in situations where the developing countries themselves faced shortfalls. At the same time, the importance of overseas assets to food security would lead great powers to invest more in defending strategic trade routes, which could themselves become subject to military confrontation.

None of these events are inevitable. While history contains many examples of hardship leading to aggression, examples of the contrary may be found as well—particularly in Asian nations, where Buddhism and Daoism are widely practiced. It is possible that the hardship of future climate change could lead to greater international cooperation in addressing common problems, and a positive transformation of the global political culture. However, from today's perspective, few would have firm confidence in such an outcome.

### *Resource competition and inter-state conflict*

We noted above how resource stress, intensified by climate change, could increase the risks of state failure. Here we consider whether the same stresses could be a factor in inter-state conflict. First, Sarang Shidore addresses the case of water stress (Box 4).

Post-game analysis found that in all four games, meeting national requirements for resources including food, fuel and water became an increasingly high priority—in some cases rising above traditional national security priorities—as time went on. One action that was noticeably absent from the game was the decision to use military force to invade a region to gain control of the region's

resources. This may have been related to the fact that climate change tended to have the most severe impact on the resources of countries that were already relatively weak in terms of both military and economic power, reinforcing inequality between countries.

The game was not resolved in enough detail to investigate the tensions that could arise over specific transboundary rivers; however, in the scenarios exercise it was considered to be a significant risk that over the long term, water stress in parts of the Middle East, Central Asia and South Asia could become so dire that the historical trend of water insecurity driving cooperation between conflicting parties could be broken. It was recognised that desalination could be an important technology, but its high ener-

gy cost could prove a constraint for some developing countries, especially for regions far from the coast.

Participants in the scenarios exercise highlighted the risks linked to the stability or otherwise of global food markets, as Professor Shi Yinhong describes (Box 5).

### *Climate geo-engineering*

In two of four instances of the game, participants invested in climate geo-engineering (in the form of solar radiation management) to limit global temperature rise. While this was widely perceived as having significant risks of its own, participants were balancing these against the increasing risks of loss of governance, national isolation, and resource depletion (food, fuel, and water). Participants considered that security risks could arise from the fact that there was no recognised authority for decision-making on climate geoengineering, and no means of preventing unilateral action by a country, region, corporation, or even an individual.<sup>42</sup>

### **Conclusions**

Participants in our exercise acknowledged the deep uncertainty involved in any attempt to consider how human society and civilization might develop even a few decades into the future. Technological development, and the future of governance at the national and global levels, were both identified as particularly important unknowns.

Certain areas of technology were identified that could have a direct bearing on some of the risks: rates of progress in desalination of water, breeding or modification of crops, and renewable energy with storage technologies would all be likely to affect relative levels of resource stress, and the risks that could arise from such stress. In addition, there were the 'unknown unknowns' of future technologies that have not yet

been invented. The contribution of any technologies to mitigate the risks would depend not only on rates of progress, but also on the equity or otherwise of their availability for use. This would depend in turn on governance.

Governance would play a critical role in determining whether systems broke down or remained resilient under stress. Participants in our exercise felt that beyond the familiar distinctions between democracy and dictatorship, centralised or decentralised, nationalist or internationalist, there were possibilities for future models of governance to emerge which, like unknown technologies, have yet to be imagined. The relative importance of markets, militaries, religions, states, alliances, regional associations, and global structures could all change.

Despite the depth of these uncertainties, it was recognised that the human economy existed within the natural physical environment, and could not be separated from it. Climate change would subject many parts of that environment to intense pressure, and create stresses that would be difficult for any system of governance to manage. As levels of stress increased, so would the scale of the systems at risk—from city infrastructure, to state governments, to international systems of transport and trade. The risk of disruption was considered likely to be very significant even at low degrees of climate change, and likely to increase in a non-linear manner as climate change progressed to higher degrees, or at a faster rate.

## Endnotes

<sup>1</sup> Contributors to this section: Vice Admiral Pradeep Chauhan (Retd), Vice Admiral Lee Gun (Retd), Major General A N M Muniruzzaman (Retd), Professor Shi YinHong, Sarang Shidore, Dr Arunabha Ghosh, Catherine Trentacoste, ED McGrady, Francesco Femia, Caitlin E. Werrell, Nadia Schweimler.

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# Fracking and the Climate Debate

Michael Levi

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In 2007, as alarm about climate change escalated and environmentalists struggled to stop construction of a wave of new coal-fired power plants, the Sierra Club forged an unusual alliance. Over the next three years, the venerable environmental group received \$26 million from executives at Chesapeake Energy to fund its “Beyond Coal” campaign. At the time, Chesapeake was a leading force in the still-obscure shale gas industry, which was just beginning what would be a meteoric rise. In hindsight, the odd couple—Oklahoma oilmen and California greens—seemed destined for divorce. But the underlying logic of their arrangement appeared sound. Because natural gas is less carbon-intensive than coal, if the United States could generate more electricity with it instead of coal, U.S. carbon dioxide emissions would fall and natural gas companies would profit, delivering wins for everyone involved.

The Sierra Club was far from alone among environmental advocates in its enthusiasm for the boom in shale gas produced by fracking. Robert F. Kennedy Jr., writing in the *Financial Times* in 2009, declared that switching from coal to gas “is President Barack Obama’s most obvious first step towards saving our planet.” Joe Romm, a prominent climate advocate at the Cen-

ter for American Progress, returned from a gathering of geologists that year to declare that natural gas “may be the single biggest game changer for climate action in the next two decades.” Such views were common.

And then it all fell apart. Kennedy now calls shale gas a “catastrophe.” Romm, tweaking claims that gas can be a “bridge” to a carbon-free future, now dubs it “a bridge to nowhere.” The Sierra Club, which broke ties with Chesapeake in 2010, now touts its “Beyond Natural Gas” campaign with the slogan

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*Shale gas is no panacea, but with the right policies...it can play a critical role in confronting global warming.*

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“Dirty, Dangerous, and Run Amok.” The Environmental Defense Fund, a lonely voice in the environmental community in favor of gas as a part of a solution to climate change, has been attacked for “greenwashing.” At colleges across the country, campaigns are demanding divestment not only from coal and oil but also natural gas.

Many of those who are most passionate about stopping climate change applaud this turn as an unmitigated victory for scientific and political realism—a triumph over naïve hope that a fossil fuel could ever help mitigate climate change. But their celebration is misplaced and

dangerous. Shale gas is no panacea, but with the right policies to protect communities where gas is produced and to harness the fuel as part of a broader climate strategy, it can play a critical role in confronting global warming. Without shale gas, U.S. greenhouse gas emissions would be higher, our climate policies would be weaker, and the odds of slashing future carbon dioxide emissions and meeting U.S. climate goals would be greatly reduced.

The turn against shale gas rests on three beliefs that have calcified into conventional wisdom among many environmental advocates. The first is that shale gas development causes massive damage to communities and the local environment—regardless of what regulations are put in place. This sets a daunting bar for any climate strategy that includes shale gas production. The second is that gas is no better than coal when it comes to climate change—at least not without big changes to the way gas is produced—and might even increase greenhouse gas emissions. This undercuts any imperative to wrestle with trade-offs between local risks and climate benefits from gas. The third is that renewable energy has made such rapid progress that a shift to a zero-carbon energy future is imminent. This makes natural gas unnecessary, and potentially a threat to a complete and speedy transition away from fossil fuels.

But each of these is a myth or half-truth. Strict rules and smart planning can safeguard communities. If policy drives natural gas to displace coal, the result can be much lower emissions. And, while renewables have made big strides, the biggest beneficiary of a setback to

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*This article is adapted from an article originally published in Issue #27 of the Democracy journal in Summer 2015. The complete article can be accessed at <http://www.democracyjournal.org/37/fracking-and-the-climate-debate.php?page=all>.*



natural gas would, for now, still be coal.

Each of these realities, in turn, points to an essential element of a wise strategy for exploiting natural gas to tackle climate change. Policy-makers should strengthen state and federal rules for shale gas development, and boost programs that help communities manage development sensibly. They should pursue policies that are newly enabled, economically and politically, by inexpensive natural gas—inevitably a mix of regulation under existing authority with, if possible, new legislation—to boost natural gas in place of coal while minimizing collateral damage to the climate. And they should redouble efforts to subsidize innovation in zero-carbon sources, including renewable energy, so that these can increasingly take the place of both gas and coal burned without capturing and sequestering their carbon dioxide emissions, driving U.S. power plant emissions close to zero.

### How Gas (Sort of) Killed Coal

On February 26, 2007, an unusual group of financiers and environmentalists announced the largest leveraged buyout in history, a \$45 billion acquisition of Texas Utilities (TXU). For years, several environmental groups had been suing to stop TXU from building 11 new coal-fired power plants, a threat that had scared off potential buyers. As part of the 2007 takeover deal, TXU would build only three of those giants, and the environmental groups would back off their campaign. “It is a big step forward for the state of Texas and for the American energy economy as a whole,” declared Frances Beinecke, president of the Natural Resources Defense Council, a major participant in the talks.

Today, TXU is in bankruptcy, and no environmental group would imagine agreeing to a deal that countenanced even a single new coal-fired facility. The biggest reason is simple: Natural gas has killed new coal-fired power.

The climate advantage of natural gas over coal is simple: Generating electricity with gas instead of coal cuts carbon dioxide emissions roughly in half. U.S. natural gas production peaked in 1973, and swung up and down over the next three decades, but by 2005, it appeared to be in terminal decline. Natural gas prices were projected to rise steadily above historical levels, hurting the economy; by the decade’s end, the United States would become dependent on large-scale imports, threatening its national security as well. Testifying before Congress in 2005, Federal Reserve Chairman Alan Greenspan warned of a natural gas industry in North America “already operating at close to capacity and [unable] to import large quantities of far cheaper, liquefied natural gas,” and called for expanded imports.

Scarce natural gas appeared to be a boon for coal-fired power. Between 1999 and 2005, the United States had added the equivalent of 200 nuclear power plants’ worth of natural gas-fueled electricity plants, even as U.S. coal-fired capacity actually fell. But by 2007, with natural gas prices rising, the U.S. government predicted a reversal: Over the next two decades, coal-fired power plants would be built at a furious pace, while natural gas would stagnate. This would be disastrous for U.S. greenhouse gas emissions: By 2030, it was predicted, the fleet of coal-fired power plants would belch three billion tons of carbon dioxide into the atmosphere each year, massively raising U.S. greenhouse gas emissions.

But beneath Texas’s Barnett Shale, a revolution was brewing. In the early 2000s, a handful of drillers figured out how to profitably extract natural gas from shale, dense rock buried thousands of feet underground. They drilled down and then, turning 90 degrees, horizontally through thin but expansive layers of shale rock. Then they pumped water, sand, and chemicals into the resulting well—and natural gas flowed back to

the surface. This last step—hydraulic fracturing in industry parlance, “fracking” for short—gave the process its now-household name.

Between 2005 and 2014, annual U.S. natural gas production increased by 36%, with shale gas production rising even more than total U.S. natural gas output did (other sources of U.S. gas continued to decline). In large part as a result, from 2008 to 2012, the price of natural gas dropped by a whopping 62%. Since the dawn of electric power, coal has been the largest source of U.S. electricity, with natural gas coming in a distant second beginning around 1960. But by April 2012, with natural gas prices at rock bottom, gas-fired power came within a hair of topping coal.

American carbon dioxide emissions simultaneously plummeted. U.S. emissions had risen nearly every year for decades, and few expected the pattern to change. But in 2007, emissions peaked. By 2012, U.S. emissions were 13% below their 2007 high, and at their lowest level since 1994. Emissions rebounded slightly through 2014 but remained 9% below their high-water mark.

Analysts have debated how to divvy up credit for the plunge. The financial crisis and ensuing economic downturn have been major factors. So has a boom in renewable energy—particularly wind power—along with the steady adoption of increasingly efficient cars and trucks. But the switch from coal to gas has been critical. Between 2008 and 2012, the United States increased its electricity production from natural gas by enough to power more than 30 million typical homes. Had that electricity come from coal instead, U.S. carbon dioxide emissions would have been much higher, canceling out more than a quarter of their decline.

### What Gas Can and Can’t Do

When it comes to climate strategy, though, history matters far less than

what natural gas might do for emissions in the future. Many—particularly those hostile to regulation—argue that cheap gas has obviated the need for climate policy. “Many federal lawmakers support President Obama in his desire to reduce carbon emissions by imposing the heavy hand of regulation,” wrote *Forbes* contributor Merrill Matthews in 2013. “What they consistently fail to appreciate, however, is that the free market is already curbing energy-related carbon emissions.”

This has indeed happened—but it’s hardly the whole story. Since 2012, coal-fired electricity has clawed back. In 2014, coal provided 39% of total U.S. electricity to natural gas’s 27%. The U.S. Energy Information Administration, an independent agency of the U.S. government, projects that without new policies, it will take until 2035 for natural gas to pass coal as the top source of U.S. electricity. It also projects that U.S. energy-related carbon dioxide emissions, instead of decreasing, will edge up by nearly 2% over the next decade.

Underlying this is a troubling discovery: Merely making natural gas more abundant may do little, if anything, to curb carbon dioxide emissions. On this point, analysts are in remarkable agreement. Between 2011 and 2013, a group at Stanford brought together 14 expert teams of energy modelers to each independently simulate the impact of booming shale gas production on U.S. carbon dioxide emissions over the next 20 years. Half found that more shale gas ultimately meant lower emissions—but the other half found the opposite. None of the teams concluded that shale gas would do much to U.S. emissions over that time unless new energy policies were put in place.

Why? Increasing shale gas supplies does two simple things to cut emissions. It shoves aside coal for electric power generation. It also (much more modestly) replaces some gasoline and diesel in cars and trucks. But four forces push in

the other direction. Cheaper gas boosts economic growth, and a bigger economy means more emissions. Low-priced gas gives an edge to industries that are heavy energy users and big emitters. It also hurts lower-carbon competitors, like renewable energy and nuclear power, just as it harms higher-carbon coal and oil. Cheaper gas also means that consumers will use more of it. Analysts consistently observe that the forces pushing in both directions mostly cancel each other out.

This kills the free-market fundamentalist dream that a thriving shale gas industry will make climate policy unnecessary. But, contrary to what environmental advocates increasingly claim, abundant shale gas can be integral to a serious climate-change policy agenda. Plentiful (and thus inexpensive) gas makes it cheaper to deliberately wean the country off of coal—which accounts for three-quarters of carbon dioxide produced in U.S. electricity generation—and thus to reduce emissions. Cheaper policies are, for the most part, politically easier to enact. Moreover, as long as a shift from coal to gas is driven by well-designed policy rather than only by markets, increased use of gas isn’t in danger of cancelling out the benefits of shifting away from coal. For example, under proposed EPA standards, U.S. power plants will need to reduce their average emissions intensity (the amount they emit to produce a unit of electricity) to government-set targets. Operators are likely to meet that goal in part by increasing their use of natural gas—and, because the standards specify how polluting the resulting electricity system is allowed to be, more use of gas shouldn’t mean higher emissions. Similarly, it would be impossible for a carbon tax or cap-and-trade system to boost U.S. use of natural gas without reducing U.S. emissions.

Moreover, plentiful gas also means that, unlike in the 2000s, it is possible to replace coal with gas without making

the United States dependent on natural gas imports from hostile countries such as Russia. The shale gas boom thus opens a door to more aggressive and effective climate policies—but policymakers need to seize that chance.

The boom also changes the politics of energy production in a way that should help emissions-cutting efforts. During the cap-and-trade debates of the late 2000s, political strategists regularly pored over maps showing the coal-producing states that would be harmed by any serious climate plan, with West Virginia, Pennsylvania, and Illinois invariably among them. Shale gas, together with air pollution rules, has slashed the value of U.S. coal companies, with the share prices of many leading firms falling by 90% or more from their highs; in 2013 alone, more than 10% of coal-mining jobs were eliminated. At the same time, another set of maps has emerged, showing the many states that would benefit economically from greater shale gas production. Politicians who campaign on climate policy that boosts gas at the expense of coal in places like Pennsylvania and Ohio—as well as any national candidate who needs to win votes in those states—will have a compelling story to tell that goes well beyond the need to confront climate change. They will also need to advance policies that help people in coal-producing communities who are hurt by the shift away from coal—but with gas already edging out coal, that will be important even without new climate policies.

### What About Renewable Energy?

One can tell a stunning growth story for renewable energy, too. U.S. wind and solar capacity have more than tripled since 2008. Last year, more people got jobs installing solar panels than working on oil and gas rigs. Climate policy that encourages wind and solar to replace coal would also boost jobs in

those sectors—and, since much of the United States is either windy or sunny, the visible benefits would be broad.

Indeed, many climate advocates argue that renewable energy has become so compelling that natural gas isn't needed: Either the market alone or government policy can replace coal with renewables and slash U.S. emissions without the problems that fracking entails. They warn that by sinking hundreds of billions of dollars into new natural gas infrastructure instead of expanding renewable power, the United States could lock itself into a carbon-based future, making it more difficult for zero-carbon energy to eventually muscle in. And, perhaps most damning, they argue that because natural gas systems leak methane—a potent greenhouse gas—a shift from coal to gas could actually increase global warming. These three arguments, unsurprisingly, scare most people who contemplate the possibility of using natural gas to confront climate change. But each of these arguments is overstated or misplaced.

Several studies have contended that the world could slash its carbon dioxide emissions using only renewable energy. The most prominent is a series of papers by a team of Stanford professors. They claim that the United States could ensure that all new electricity-generating plants use wind, solar, or hydropower by 2020 and that the entire U.S. energy system could run on them by 2050, all without much change to energy costs. Perhaps this will turn out to be true: One of the biggest lessons of the shale gas boom is that predicting the future of energy with high confidence is foolish. But the all-renewables studies entail their own heroic assumptions. The Stanford papers, for example, assume that renewable energy costs will crater, electric vehicles will become the norm, and a massive network of hydrogen storage facilities and fueling stations will emerge at minimal cost. While those advances may happen, we certainly shouldn't bet

on them.

What about the prospect that, if the United States increases its reliance on natural gas, it will be difficult to move beyond it to a zero-carbon future? Part of this worry about “carbon lock-in” is economic. Billions of dollars spent upfront on natural gas infrastructure will give gas an entrenched cost advantage over renewables. That is certainly the case for coal: Most of the cost of coal-fired power is incurred when power plants are built; since the cost of continuing to operate them is minimal, it is difficult to push these plants aside. But the cost of gas-fired power is dominated by gas-producing wells that require continuous investment. Indeed, between 1998 and 2004, the United States built enough gas-fired power plants to deliver more than twice as much electricity as the entire fleet of U.S. nuclear power plants. But by 2005, with coal inexpensive and the economics of natural gas no longer compelling, almost 60% of that capacity was left unused, even when electricity use was highest. Companies will abandon gas-based infrastructure again if an economically attractive alternative emerges.

The more compelling concern is political: Once companies and communities have built businesses and livelihoods around natural gas, they'll use their clout to maintain the status quo, just as coal-producing states and companies have tried to do. The right response to this, however, is not to leave the system as it currently is. (It is difficult to imagine how a gas-dependent system could be any more entrenched than the coal-dependent one it would replace.) Instead, policy-makers ought to craft policies that reward emissions cuts regardless of the technologies that produce them—and, at the same time, adopt policies that drive down the cost of zero-carbon energy. These include funding for research and development in early-stage technologies, in addition to subsidies (including mandates or special tax

treatment) that help bring them to commercial scale, allowing new and more efficient business models to emerge as well. Then, as carbon-free sources become less expensive, broad-based policy that rewards emissions reductions will increasingly advantage these more climate-friendly fuels.

The final problem is methane. A few years ago, energy industry observers began worrying that massive amounts of methane were leaking from shale operations. Some concluded that this made gas worse for climate change than coal, obviating any need to think through trade-offs between climate benefits and local damages. Others were more cautious but still concluded that gas could only help slow climate change if methane leaks were drastically reduced. Many of the early and extreme estimates of methane leaks have stood the test of time poorly, but ensuing studies—notably a series sponsored by the Environmental Defense Fund—have revealed that methane leaks are, indeed, often substantial. (I am an unpaid member of the scientific advisory panel for one of those studies.) There is now no doubt that there are major opportunities to reduce climate change by slashing methane emissions.

But the idea that gas might be worse for climate change than coal is no longer persuasive. As Daniel Schrag, head of the Harvard University Center for the Environment, has argued, “Leakage of methane is not as important as some have argued because its short lifetime [in the atmosphere] limits its impact on anthropogenic climate change.” The result, he concludes, is that “even if shale gas production results in large methane emissions, burning natural gas is still much better for the climate system than burning coal.” In a 2013 article in the journal *Climatic Change*, I modeled a variety of scenarios in which natural gas was used as part of a transition from coal to zero-carbon fuels, and varied the level of methane leakage among them. I

found that while more methane leakage boosted short-term warming, it had little impact on peak temperatures—the ultimate metric of climate change, and the best indicator of whether the planet might pass dangerous climate thresholds. And in every case, keeping coal made things worse. Casual observers often worry that methane leaks, through their powerful near-term impact, might propel the world past “tipping points” lurking in the near future. The sad reality, though, is that any near-term tipping points that might be crossed in a world where methane leaks are large will still be crossed if those leaks are eliminated, though perhaps a few years later. The only way to avoid these sorts of dangers is to reduce our carbon dioxide emissions.

The bottom line is that the gas boom has created a real opportunity to curb U.S. emissions. Policy-makers should take advantage of it to shift U.S. power generation steadily away from conventional coal. “Clean Power Plan” regulations proposed by the EPA, which require each state to reduce its emissions but leave it to them to determine how, are a start—but, if shale gas supplies continue to be relatively inexpensive, the regulations could be tightened while still delivering benefits that exceed their costs. Ideally, Congress would pass legislation that rewards emissions reductions, whether through a carbon tax, a broad-based standard, or some other way. In the immediate future, though, the best hope is that Congress will simply let the EPA do its job.

### A Faustian Bargain?

No amount of climate benefit, however, will make a push for natural gas wise if producing it turns out to be too dangerous. New York state captures the dilemma starkly. In December 2014, after a four-year moratorium on shale gas development, New York Governor Andrew Cuomo—who has supported a

range of policies aimed at reducing emissions—declared a de facto ban on shale gas development in New York. “I don’t want my kids living [near shale wells], and I don’t want any New Yorker’s kids living there,” said Cuomo.

Indeed, the reality is that, just like any heavy industrial activity, shale gas development poses real public health risks. And, like any other risky industrial activity, it needs to be properly regulated. Both the shale gas industry and people who care about climate change have a common interest in getting regulation right. Smart policy will have four characteristics: It will be based on lessons learned from the wide range of regulatory efforts—some successes and some failures—already underway; it

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*...that gas might be  
worse for climate  
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longer persuasive.*

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will have comprehensive measurement and aggressive disclosure at its core; it will be grounded in the states but include minimum standards set at the federal level; and it will go beyond traditional environmental rules to also make sure that development is properly integrated into the communities where it occurs.

Identifying and fixing the biggest threats to air and water—the core of any traditional regulatory regime—is actually the easiest part of getting this right. One good step would be to implement the 22 “Golden Rules of Gas” developed by the International Energy Agency in 2012, which cover areas ranging from air pollution due to leaky equipment to avoiding cracks in wells that could lead to water pollution, and are based on lessons learned from regulation and practices in different countries. Another would be to leverage the work of the

Center for Sustainable Shale Development, a coalition that includes Chevron, Shell, the Environmental Defense Fund, and the Clean Air Task Force (another respected NGO) and that has developed voluntary rules for development that could easily be made mandatory. The federal government should also take advantage of the fact that some shale gas resources are on federal land to implement gold-standard protections there—a step that the Obama Administration took in March. Such a step could yield insights into what might be effective nationwide. Shale gas production has also added another risk that needs to be aggressively addressed: seismic activity, or, more colloquially, (mostly) small earthquakes that appear to be associated with disposal of wastewater in “injection wells.” Building on recommendations from the National Academy of Sciences, companies should be subjected to regulation that requires careful monitoring of any tremors generated by their operations and rapid steps to stop dangerous behavior that’s detected. Injection wells that are observed to generate unacceptable levels of seismic activity should be shut down. Following the Texas Supreme Court’s recent example, the burden of proof should be on producers to demonstrate that their wells aren’t causing harm.

Complementing any initial set of rules should be regular measurement of the impact of shale gas development and detailed disclosure of drilling activities. Better knowledge of environmental conditions both before and after drilling would improve understanding of the impact of development, enabling better regulation and improved company practices. And more rigorous measurement, funded by government, of the environmental performance of key drilling technologies would help too.

One particularly acute need is to improve transparency surrounding the chemical composition of the fluids that companies use to hydraulically fracture

wells, but do not always disclose. There have been no established cases of dangerous contamination where these fracking fluids have seeped from underground to contaminate water supplies, and there are solid geological reasons to doubt that the risks here are large, but incomplete disclosure—as well as other cases of serious water contamination resulting from poor handling of wastewater—has unquestionably sapped public confidence in development. There have also been cases where methane has leaked from gas production into water supplies, with companies sometimes resisting responsibility, further fanning suspicions.

More recently, evidence has emerged pointing to likely migration of trace quantities of fracking or drilling fluids from a poorly built Pennsylvania well into drinking water supplies. (This last incident might have been prevented by the sorts of stricter standards for well construction and integrity promoted by the International Energy Agency and the Center for Sustainable Shale Development.) Some states—notably, Colorado and Wyoming—require disclosure, and in other cases, companies do it voluntarily, but these efforts almost always have blind spots. Removing these gaps would help communities and would also reward those companies that operate with the highest standards, squeezing out less responsible competitors.

### Why Federal Standards Are Needed

In fact, it may be easier to agree on what the right rules ought to be than on who should set and enforce them. Industry has mostly pressed for state-level regulation and resisted federal rules. Companies have typically argued that large state-to-state variations in geological conditions and social attitudes toward development make state regulators best positioned to make the trade-

offs and design choices that any rule-making inevitably requires. Environmental groups have mostly pressed for federal regulation, seeing it as inevitably stronger, though some have concluded that states offer a better prospect for quick progress than the often sclerotic federal government does. The industry case for state-level regulation often makes sense: For example, rules for water disposal in Ohio might not work in another state where geological conditions are different. And if some Texans want to accept more local air pollution than Pennsylvanians do, it is unclear why federal regulators should overrule them. But companies' desire to be regulated by the states rather than by the EPA is often grounded in less principled motivations. Many states have fewer regulatory resources available than the federal government does, which can make enforcement of state regulations less stringent; some states may also impose smaller penalties than the EPA would.

Shale gas companies could actually benefit from some uniformity in rules. The industry can be highly mobile, shifting drilling rigs and pressure pumps from one state to another as opportunities variously emerge and recede; consistent regulations can make that process smoother. More importantly, when it comes to public acceptance, the states are far from independent. A major accident in Louisiana could sour Californians on shale gas development, even if the two states have different regulatory approaches; in the case of seismic activity, tremors in one state can be triggered by wastewater disposal in another. The fact that the ability to develop shale gas is important to delivering on national climate goals also argues for not allowing states to take excessive risks that would jeopardize that opportunity, just as states aren't allowed to reduce homeland security efforts at ports for parochial economic reasons. All this means that, where it is technically feasi-

ble and more effective than using state-only rules, federal standards for safe drilling should be set, with states free to outperform them.

The final piece in the policy puzzle goes beyond traditional environmental issues: Equally important to tackling threats to air and water is ensuring that shale gas development is intelligently integrated into state and local development plans. The downside of such projects can be felt immediately, as non-stop truck traffic rips up roads, police forces cope with increased crime, and hospitals see increased emergency room traffic—well before drillers turn a large profit and start boosting state income tax rolls. Here the federal government can play a facilitating role, convening state and local policy-makers to learn from each other and providing a repository of best practices. But ultimately, responsibility for developing and implementing such policies will need to be at the state and local levels.

### An Uneasy Alliance

No strategy for U.S. natural gas will or should be crafted with only the environment in mind. Shale gas has boosted the U.S. economy during an otherwise weak stretch, even if its economic benefits are often exaggerated and unevenly felt. It has also been a geopolitical windfall, sparing the United States from having to become a significant natural gas importer (even if its potential as a weapon against U.S. adversaries is regularly overblown). But, setting economic and geopolitical issues aside, from a purely environmental standpoint, putting shale gas on firm regulatory ground and using its abundance to transform U.S. climate policy is an opportunity that policy-makers, building on what the Obama Administration has already done, ought to seize.

Not that the politics are simple. There is no real prospect of returning to the days when the Sierra Club teamed up

with natural gas drillers to present a remarkably united front. Any future alliance between industry and people who care about the environment will inevitably be tentative, riven with suspicion, and punctuated by intense conflict. People who prioritize the environment reasonably fear that attempts to find common ground with industry will leave them with increased shale gas drilling but no more aggressive climate policy. And it may indeed turn out, when we look back in 20 years, that renewable energy makes such large and rapid gains that shale gas will have been relatively unimportant to meeting climate goals—after all, if there is one thing we’ve learned from the shale gas boom, it is that energy developments are unpredictable.

On the other side, industry leaders who might be friendly in principle fear ending up with climate policy that carves out so much special treatment for renewable energy and energy efficiency that gas sees no gains—and worry that, by supporting efforts to cut greenhouse gas emissions, they will alienate their traditional Republican supporters at the same time. Indeed, many politicians who support shale gas development are ideologically anti-regulation—so they will oppose stricter environmental rules along with policy efforts to harness shale gas as a climate tool, even if industry would benefit from both.

But betting entirely on renewables or nuclear power, or treating all fossil fuels as the enemy, is dangerous. These approaches could easily leave the country saddled with massive dependence on coal-fired electricity—with all the public health and climate damage that entails. This is the real alternative to the difficult work of making sure shale gas development is done right and harnessing it to help transform U.S. emissions. It is an alternative that no one should be willing to risk.

## News (FROM PAGE 5)

Building on July 21, 2015 in Washington, D.C. The forum followed the 2014 Congress on Adapting Food Production to a Changing Climate. Forum speakers discussed the effects of climate change on U.S. food production and examined federal funding for programs and research that support climate change resilience in agriculture.



*Charlie Walthall*

**Charlie Walthall**, National Program Leader for the United States Department of Agriculture (USDA) Agricultural Research Service Climate Change, Soils and Air Quality Research Program, opened the forum with a presentation of the effects of climate change on the agroecosystem. Changing climate conditions that affect agricultural production include temperature increases, precipitation changes, and increasing atmospheric CO<sub>2</sub> concentrations. Walthall stressed that water is the number one issue for agriculture in the 21st century. Drought, flooding, groundwater recharge and soil moisture are critical issues that must be addressed. Although individual farmers will likely be able to adjust to the effects of climate change in the near-term, the long-term

health of the U.S. agricultural system will depend on efforts from the entire farming community, including breeders, geneticists, industry, and NGOs.



*Bethany Johns*

**Bethany Johns**, Science Policy Manager for the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, concluded the forum with an examination of federal funding for USDA programs and research that support climate change adaptation in agriculture. A strategic goal of USDA is to “ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources.” Johns emphasized three takeaway messages in her presentation: 1) Climate science research, adaptation, and mitigation are intrinsic to the mission of USDA and the programs that the department funds, 2) Federal budget constraints are causing an innovation deficit in food and agriculture science, and 3) The United States is falling behind in investment for agricultural research and development.

## **American Geophysical Union**

*AGU Honors Journalists Andrew Revkin, Douglas Fox, and Sandi Doughton for Outstanding Science Reporting*

Three writers are being awarded top honors from the American Geophysical Union this year for their reporting on the Earth or space sciences. AGU recognizes veteran journalist and founder of The New York Times' Dot Earth blog Andrew Revkin with the 2015 Robert C. Cowen Award for Sustained Achievement in Science Journalism. The 2015 Walter Sullivan Award for Excellence in Science Journalism—Features goes to Douglas Fox for an in-depth story on how dust from a Chinese desert might hold the clues to drought in the Western United States. Sandi Doughton of The Seattle Times receives the 2015 David Perlman Award for Excellence in Science Journalism—News for her story in the wake of a tragic landslide on how lidar can reveal difficult-to-detect geohazard risks, but is underutilized.

The three AGU journalism awards will be formally presented during AGU's annual Honors Ceremony on Wednesday, 16 December 2015, as part of the 2015 AGU Fall Meeting in San Francisco.

For more information, contact AGU, 2000 Florida Avenue NW, Washington, DC 20009; (202) 462-6900, Website: [www.agu.org](http://www.agu.org).

## **American Meteorological Society**

*Broadcasters Gather in Raleigh, NC to Talk Weather, Warnings, and Communication*

The 43rd Conference on Broadcast Meteorology and the 3rd Conference on Weather Warnings and Communication took place in June at the Raleigh Convention Center.

Some of the AMS Communications Department staff sat down with presenters to talk about their research and presentations. Videos with experts can be viewed on the AMS YouTube channel.

Marking the 10th anniversary of Hurricane Katrina, a panel of experts took part in the conversation about the deadly storm and how we can learn from it going forward.

For more information, contact AMS, 45 Beacon Street, Boston, MA 02108; (617) 227-2425, [www.ametsoc.org](http://www.ametsoc.org)

## **American Society of Civil Engineers**

*ASCE Spotlights U.S. Infrastructure 'Game Changers' in Report, Website*

As the nation wrestles with how and where to best address current and future infrastructure needs, ASCE is highlighting "game changing" projects that prove that despite the challenges, innovative ideas and solutions in transportation, water, freight, and energy are thriving.

At a July event on Capitol Hill in Washington, ASCE debuted Infrastructure #GameChangers, a new report and associated website at [ASCEgamechangers.org](http://ASCEgamechangers.org) that shows how communities across the country have developed solutions to challenges that could prove to be game changers nationwide.

For more information, contact ASCE, 1801 Alexander Bell Drive, Reston, VA 20191; (800) 548-2723, [www.asce.org](http://www.asce.org).

## **American Society of Landscape Architecture**

*ASLA Elevates 37 to Fellowship for Outstanding Achievement*

The American Society of Landscape Architects has elevated 37 members to the ASLA Council of Fellows for 2015. Fellowship is among the highest honors ASLA bestows on members and recognizes the contributions of these individ-

uals to their profession and society at large based on their works, leadership and management, knowledge and service. The new class of Fellows will be recognized at the 2015 ASLA Annual Meeting and EXPO, November 6-9, in Chicago.

Individuals considered for this distinction must be members of ASLA in good standing for at least 10 years and must be recommended to the Council of Fellows by the Executive Committee of their local chapter, the Executive Committee of ASLA or the Executive Committee of the Council of Fellows.

For more information contact ASLA, 636 Eye Street, NW, Washington, DC 20001; (202) 898-2444. Website: [www.asla.org](http://www.asla.org)

## **American Water Resources Association**

*2016 AWRA Summer Specialty Conference: GIS and Water Resources IX*

AWRA's 2016 Summer Specialty Conference on GIS and Water Resources will take place in Sacramento, CA on July 11-13, 2016. Management of water resources requires many decisions, both long-term and short-term. Geographic Information Systems (GIS) as a technology has been used in the water resources domain since its inception. GIS is more and more used not only for data acquisition and processing, but also to directly support water resources decisions.

The conference will focus on the role of GIS to support better decisions across broad spectrum of water resources. Decisions related to floods, droughts, water quality, and policy aspects of water resources will be covered.

For more information, contact AWRA, P.O. Box 1626, Middleburg, VA 20118; (540) 687-8390. Website: [www.awra.org](http://www.awra.org).



## **Geological Society of America**

*Baltimore Hosts Earth Scientists, 1-4  
November 2015*

Registration is open for The Geological Society of America's Annual Meeting & Exposition, to be held November 1-4 2015 at the Baltimore Convention Center in Baltimore, Maryland. Geoscientists from around the world, representing 37 disciplines, will present new findings that enlarge the body of geoscience knowledge and define directions for future study.

There are currently 219 topical sessions submitted, as well as a special session on the recent Nepal earthquakes. In addition, GSA is hosting the Geological Society of China as part of the "Bridging Two Continents" meeting being held within the GSA Annual Meeting. Dr. James Hansen, renowned climate scientist at Columbia University in New York City, will speak at this meeting during a ticketed luncheon on Monday that is open to all GSA attendees. Numerous field trips, short courses, and special events round out the meeting.

For more information, contact GSA, P.O. Box 9140, Boulder, CO 80301; (303) 357-1806. Website: [www.geosociety.org](http://www.geosociety.org).

## **Society of Environmental Toxicology and Chemistry**

*Register for SETAC Salt Lake City*

Register today for five days of cutting-edge science in environmental toxicology and chemistry at the SETAC North America 36th Annual Meeting from November 1-5 in Salt Lake City, Utah. The meeting draws more than 1,900 scientists, assessors, regulators and managers from academia, business and government representing more than 40 countries.

For more information, contact SETAC, 229 S. Baylen Street, Pensacola, FL 32502; (850) 469-1500, [www.setac.org](http://www.setac.org).

## **Society of Wood Science and Technology**

*2015 International Convention*

The 2015 SWST International Convention at Grand Teton National Park in Wyoming concluded on June 7. The theme of this year's meeting was renewable materials and the bio-economy. Jerold E. Winandy received the Distinguished Service Award for his outstanding contribution to the field and to SWST; James Funck was awarded the Fellow Award for the society; Lech Muszynski received the first ever Distinguished Educator Award from the society; and Jan Oscarsson accepted the first place award for the George Marra Excellence in Writing award.

For more information, contact SWST, P.O. Box 6155, Monona, WI 53716; (608) 577-1342. Website: [www.swst.org](http://www.swst.org)

## **International News: United Nations Environment Programme**

*UN's Top Climate Official  
Welcomes Scientists'  
Affirmation of Need for  
Long-Term Emissions Goal*

Scientists meeting at a major international gathering in Paris have said that humanity must achieve a state of zero greenhouse gas emissions by the end of this century in order to hold the global average temperature rise to a maximum 2° Celsius.

In a joint statement at the end of the "Our Common Future Under Climate

Change" conference, scientists said the world needed to reach a long-term vision of climate neutrality and seize the obvious benefits of clean energy and sustainable development in order to stay below this 2° defense line against the worst impacts of climate change.

The leading scientists' call comes less than five months before the UN climate change conference in Paris, at which governments will conclude a new universal climate change agreement which aims to put the world on a firm pathway towards an early peaking of global emissions, followed by a very rapid decline towards a net zero goal.

Laurence Tubiana, French Ambassador for the UN Climate Change Conference in Paris (COP 21) said: "Scientists are working, with many partners, to develop long-term pathways at the scale of cities, economic sectors like agriculture and national economies, with strong focus on making solutions operational. We need COP 21 to be the political answer to that work, and show that the transition to a decarbonized and climate-resilient economy is not just necessary, but also that it is feasible (politically, economically and technologically); and even beyond that, that it is inevitable, and underway."

Earlier in the conference, International Energy Agency Chief Economist Fatih Birol noted that not only visions, but specific targets will be critical to send the signal for greenhouse gas emitters like the energy sector to meet ambitious goals, including an emissions peak in 2020.

Around 200 scientists from almost 100 countries attended the Paris science conference, which showcased evidence-based ways to both reduce emissions and build resilient economies.

For more information, visit <http://www.unep.org/newscentre/Default.aspx?DocumentID=26830&ArticleID=35229&l=en>

# Meetings

See <http://www.rnrf.org> for additional meetings

*Submit Meeting Notices to: [info@rnrf.org](mailto:info@rnrf.org)*

## August 2015

**American Fisheries Society Annual Conference.** August 15-20, 2015. Portland, OR. <http://2015.fisheries.org>

**Society for Ecological Restoration, 2015 World Conference on Ecological Restoration.** August 23-27, 2015. Manchester, UK. <http://ser2015.org>

## September 2015

**Coastal Structures and Solutions to Coastal Disasters Joint Conference.** September 9-11 2015. Boston, MA. <http://www.copricoastalconference.org>

**Energy Policy and Research Conference.** September 10-11, 2015. Denver, CO. <http://epi.boisestate.edu/conference/welcome.aspx>

**Association of Fish & Wildlife Agencies Annual Meeting.** September 13-17, 2015. Tucson, AZ. <http://www.AFWAAnnualMeeting.org/>

**World Forestry Institute 11th Who Will Own the Forest? Meeting.** September 15-17, 2015. Portland, OR. <http://wwotf.worldforestry.org/wwotf11/>

**ACEEE National Conference on Energy Efficiency as a Resource.** September 20-22, 2015. Little Rock, AR. <http://www.aceee.org/conferences/2015/eeer>

**Water Environment Federation Technical Exhibition and Conference.** September 26-30, 2015. Chicago, IL. [http://www.weftec.org/about\\_weftec/default.aspx](http://www.weftec.org/about_weftec/default.aspx)

## October 2015

**The First International Symposium on Sustainable Human-Building Ecosystems.** October 5-7, 2015. Pittsburgh, PA. <http://www.shbe.org/symposium>

**Healthy Forests, Vibrant Economy.** October 7-8, 2015. Scottsdale, AZ. <http://www.srpnet.com/water/forest/conference.aspx>

**Society of Environmental Journalists Annual Conference. Weather, Water, Energy: News in Every Neighborhood.** October 7-11, 2015. Norman, OK. <http://www.sej.org/initiatives/sej-annual-conferences/AC2015-main>

**American Society of Civil Engineers 2015 Convention.** October 11-14, 2015. New York, NY. <http://www.asceconvention.org/>

**The Wildlife Society 22nd Annual Conference.** October 17-21, 2015. Winnipeg, Manitoba, Canada. <http://wildlife.org/2015conference/>

**Urban Land Institute Fall Meeting.** October 21-23, 2015. New York, NY. <http://fall.uli.org/>

## November 2015

**Geological Society of America 2015 Annual Meeting.** November 1-4, 2015. Baltimore, MD. <http://www.geosociety.org/meetings/2015>

**SETAC North America Annual Meeting: Cross-Pollination for Environmental Progress.** November 1-5, 2015. Salt Lake City, UT. <http://slc.setac.org/>

**Natural Areas Conference.** November 3-5, 2015. Little Rock, AR. <http://www.naturalareasconference.org/>

**2015 Society of American Foresters National Convention.** November 3-7, 2015. Baton Rouge, LA. <http://www.xcdsystem.com/saf/site14/>

**American Society of Landscape Architects Annual Meeting.** November 6-9, 2015. Chicago, IL. <http://www.asla.org/annualmeetingandexpo.aspx>

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