TRANSITIONING TO A SUSTAINABLE ENERGY ECONOMY: THE CALL FOR NATIONAL COOPERATIVE WATERSHED PLANNING

BY

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Recent developments in the Middle East have underscored the national security concerns that arise from America's reliance on foreign fuels. While Americans stand enraptured by scenes broadcast from the epicenter of historic national uprisings, feelings of hope and support for the advancement of democratic principles are mingled with concerns about how this could impact us at the pump. Breaking America's dependence on foreign oil is but one driving factor leading policymakers to call for the transformation of the United States energy economy. Climate change is another—and both energy-based challenges are causing policymakers to chart a course toward a "sustainable energy economy," one that incorporates clean energy technology and the increased use of water-intensive domestic renewable fuels and nuclear power.

This Article explores what the transformation of the United States energy economy to a "sustainable energy economy" will mean for the nation's water resources. It begins by exploring the interdependency that exists between energy and water, often referred to as the "energy–water nexus," and specifically highlights the critical role that water plays in energy generation and fuel production. Next, it examines the current threats that forecasted population growth and climate change already pose for the very water resources expected to support this sustainable energy economy. The Article suggests that the path to achieving a sustainable energy economy starts with sustainable water resource management which, because of the energy–water nexus, requires the integration of energy and water-related policies. It goes on to explore the limited degree to which these policy areas have been integrated in existing regulatory regimes and policy initiatives.

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The Article concludes that achieving a "sustainable energy economy" will require a large-scale cooperative watershed planning effort—one that will ensure that water resources are available to support and sustain a transformation of the United States energy sector. After addressing some of the legal challenges that may face such a water-based planning effort, the Article identifies recent legislation that could provide a starting point by which to address some of the significant challenges associated with achieving a "sustainable energy economy."

I. INTRODUCTION

> Climate change looms as a defining issue of the 21st century, pitting the potential disruption of our global climate system against the future of a fossil fuel-based economy.[1]

The United States energy sector exists at the center of this defining issue. Because greenhouse gas emissions from the energy industry are a primary component in what is said to be anthropogenic-induced climate change-related impacts,[2] curbing greenhouse gas emissions from the energy sector has been and will continue to be the focus of the policy debate concerning effective mitigation and adaptation strategies. The United States energy sector also exists at the center of national efforts to break our addiction to foreign oil in order to achieve energy independence. Given that 51% of the 6.9 billion barrels of oil consumed in the United States in 2009 were imported from foreign countries,[3] achieving energy independence will be no small undertaking, particularly in the face of steady forecasted growth

1 J.B. RUHL ET AL., THE PRACTICE AND POLICY OF ENVIRONMENTAL LAW 1322 (2008).

2 *See infra* note 209 and accompanying text. According to U.S. Energy Information Administration (EIA) estimates, in 2008, United States' energy-related carbon dioxide emissions totaled 5,802 million metric tons. U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, UNITED STATES CARBON DIOXIDE EMISSIONS FROM ENERGY SOURCES, 2008 *FLASH* ESTIMATE 14 (2009), *available at* http://www.eia.doe.gov/oiaf/1605/flash/pdf/flash.pdf. When considered by itself, the electric power sector is the largest sector in terms of energy-related carbon dioxide emissions, making up 41% of total emissions. *Id.* at 6.

3 U.S. Energy Info. Admin., Independent Statistics and Analysis, Frequently Asked Questions: How Dependent is the United States on Foreign Oil?, http://tonto.eia.doe.gov/tools/faqs/faq.cfm?id=32&t=6 (last visited July 17, 2011); U.S. Energy Info. Admin., Independent Statistics and Analysis, Frequently Asked Questions: How Many Barrels of Oil Does the United States Consume Per Year?, http://tonto.eia.doe.gov/tools/faqs/faq.cfm?id=33&t=6 (last visited July 17, 2011).

in United States' energy demand.[4] In the context of both climate change and energy independence, developing a "more sustainable energy economy" has become the battle cry for today's policymakers.

But what does a more sustainable energy economy look like? As described in the current Administration's National Security Strategy released in May 2010, a more sustainable energy economy incorporates the development of clean energy technology, increases the use of renewable energy, and reinvigorates nuclear power.[5] For example, in response to the "real, urgent, and severe" dangers associated with climate change, the Administration targets actions that will "stimulate our energy economy at home, reinvigorate the United States domestic nuclear industry, increase our efficiency standards, invest in renewable energy, and provide the incentives that make clean energy the profitable kind of energy."[6]

Similarly, regarding our dependence on foreign oil which "undermine[s] our security and prosperity"[7] and "leave[s] us vulnerable to energy supply disruptions and manipulation and to changes in the environment on an unprecedented scale,"[8] this Administration calls for the transformation of our energy economy, the accelerated deployment of clean energy technologies, and the increased use of renewable and nuclear power.[9]

As well intentioned as policymakers may be to shore up national security, to devise effective climate change mitigation and adaptation strategies, and to lead in the development of clean energy technology—be it for the betterment of our economy or to promote more environmentally sustainable solutions—no single misstep will undermine their efforts to develop this "sustainable energy economy" more than the failure to consider one of the energy sector's most fundamental components—water. The interdependency between water and energy, often referred to as the "energy–water nexus,"[10] cannot be overstated. Nor can the significance that each plays in today's society. Our society is dependent on energy. Energy is a fundamental component of delivering clean water; cultivating food; operating industry; powering homes, offices, hospitals, and schools; and providing transportation.

By the same token, our society is dependent on water. Water is essential to life on earth. It is critical to continuing economic activity, to the

4 For example, according to EIA estimates, the United States industrial sector's natural gas demand is forecasted to increase at a rate of 1% per year from 2009 to 2035. *See* U.S. ENERGY INFO. ADMIN, U.S. DEP'T OF ENERGY, ANNUAL ENERGY OUTLOOK 2011: REFERENCE CASE 26 (2010), *available at* http://www.eia.gov/neic/speeches/newell_12162010.pdf.

5 *See* THE WHITE HOUSE, NATIONAL SECURITY STRATEGY 30 (May 2010), *available at* http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.

6 *Id.* at 47.

7 *Id.* at 30.

8 *Id.*

9 *Id.*

10 *See Trends and Policy Issues for the Nexus of Energy and Water: Hearing Before the S. Comm. on Energy and Natural Res.,* 112th Cong. 2–3, 7 (2011) (statement of Michael E. Webber, University of Texas at Austin), *available at* http://energy.senate.gov/public/_files/WebberTestimony2033111.pdf.

proper functioning of earth's environment, and to the maintenance of biodiversity.[11] It is also an essential component in energy generation and fuel production and, as such, will play a key role in whether we achieve energy independence, are successful in climate change-related strategies, or lead in the development of clean energy technology. In essence, water is a key component to developing a "sustainable energy economy."

Because water is an essential component in developing a sustainable energy economy, ensuring that the demand for water does not outpace the available supply is crucial to achieving these national energy-based goals. Water resource limitations have already interfered with attempts by the energy sector to expand energy production,[12] and the "green" energy sector is not immune from these challenges.[13]

Policymakers should be aware of recent studies that paint a troubling picture of the alarming rate at which our freshwater resources are being depleted.[14] Groundwater levels in some regions have dropped "as much as 300 to 900 feet over the past 50 years"[15] and the rate of aquifer pumping often outpaces the rate of recharge.[16] High demands to meet both human and industrial needs, drought conditions, and contamination contribute to water scarcity in many regions of the United States,[17] including, most recently, the

11 *See* United Nations Conference on Environment and Development, Rio de Janeiro, Braz., June 3–14, 1992, *Agenda 21*, ¶¶ 18.1–18.3, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. I), Annex II (Aug. 12, 1992).

12 For example, in 2006, an Idaho House committee approved a two-year moratorium on the construction of new coal-fired power plants on the basis of concerns regarding the environment and water supply. NAT'L ENERGY TECH. LAB., U.S. DEP'T OF ENERGY, ESTIMATING FRESHWATER NEEDS TO MEET FUTURE THERMOELECTRIC GENERATION REQUIREMENTS app. A-4 to A-5 (2010), *available at* http://www.netl.doe.gov/energy-analyses/pubs/2010_Water_Needs_Analysis.pdf. Similarly, concerns over the amount of water a proposed power plant would withdraw from a local aquifer caused Arizona to recently reject a permit request. *Id.* app. at A-5. Moreover, in February 2006, the Diné Power Authority agreed to pay the Navajo Nation $1,000 per acre-foot with a guaranteed minimum of $3 million for water to service a proposed energy project. *Id.*

13 An ethanol plant's petition to withdraw two million gallons per day from the local aquifer in the annual production of 100 million gallons of ethanol raised opposition from the citizens of Champaign and Urbana Illinois over concerns about water supply. Michael E. Webber, *Catch 22: Water vs. Energy*, SCI. AM. EARTH 3.0, Oct. 2008, at 34, 38.

14 For example, the annual rate of recharge for the more arid sections of the Ogallala aquifer (located in the Great Plains) is estimated at only 10% of its annual withdrawals. David A. Gabel, *Groundwater Vulnerability*, ENVTL. NEWS NETWORK, Mar. 25, 2010, http://www.enn.com/top_stories/article/41145 (last visited July 17, 2011).

15 U.S. DEP'T OF ENERGY, ENERGY DEMANDS ON WATER RESOURCES: REPORT TO CONGRESS ON THE INTERDEPENDENCY OF ENERGY AND WATER 10 (2006), *available at* http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf#63.
Approximately 17,000 square miles in forty-five states have been impacted by subsidence, "by far the single largest cause of which is" the compaction of aquifer systems accompanied by excessive groundwater pumping. U.S. GEOLOGICAL SURVEY, LAND SUBSIDENCE IN THE UNITED STATES 1 (2000), *available at* http://water.usgs.gov/ogw/pubs/fs00165/SubsidenceFS.v7.PDF.

16 U.S. DEP'T OF ENERGY, *supra* note 15, at 10.

17 *See* Robert W. Adler, *Freshwater: Sustaining Use by Protecting Ecosystems*, *in* AGENDA FOR A SUSTAINABLE AMERICA 205, 209 (John C. Dernbach ed., 2009); *see also* Heather Cooley, *Floods and Droughts*, *in* THE WORLD'S WATER 2006–2007: THE BIENNIAL REPORT ON FRESHWATER RESOURCES 91, 92 (Peter H. Gleick ed., 2007).

southeast region which historically has housed abundant supplies of freshwater resources.[18] Now, like the southwest, ecological systems in the southeast are starting to exhibit signs of stress as stakeholders scramble to secure their "fair share" of a resource once thought to be limitless.[19]

Recent drought conditions in the southeast region, which reduced water resources to exceedingly low levels and set off water wars between states,[20] provide some insight into the impact that water scarcity could have

18 *See* Patrick O'Driscoll & Larry Copeland, *Southeast Drought Hits Crisis Point*, USA TODAY, Oct. 21, 2007, http://www.usatoday.com/weather/news/2007-10-19-drought_N.htm (last visited July 17, 2011).

19 According to scientists at the Climate Prediction Center, almost 50% of the United States was involved in drought in 2007, and the southeast was experiencing the worst drought in more than a century. Doyle Rice, *United States' Drought Has 'Extraordinary Reversal,'* USA TODAY, Feb. 17, 2010, http://www.usatoday.com/weather/drought/2010-02-16-drought-us-reversal_N.htm?loc=interstitialskip (last visited July 17, 2011).

20 *See, e.g.*, Alabama v. U.S. Army Corps of Eng'rs, 441 F. Supp. 2d. 1123, 1124, 1128 (N.D. Ala. 2006) (involving the interstate battle between Georgia, Florida, and Alabama over waters of the Apalachicola-Chattahoochee-Flint (ACF) River Basin). Water from the ACF Basin serves as the primary source of drinking water for over 5 million residents of Atlanta and its suburbs, provides habitat for three federally-protected species, and supports Florida's $130 million shrimp and oyster industry, and serves the hundreds of towns, factories, farms, power plants, and recreational facilities located along its borders in all three states. Alyssa Lathrop, Comment, *A Tale of Three States: Equitable Apportionment of the Apalachicola-Chattahoochee-Flint River Basin*, 36 FLA. ST. U. L. REV. 865, 868–69, 877 (2009); *Regarding Drought Issues in the Southeast Before the Subcomm. on Water Res. and the Env't of the H. Comm. on Transp. and Infrastructure*, 110th Cong. 3–4 (2008) http://www.usgs.gov/congressional/hearings/docs/hamilton_weaver_11march08.doc (last visited July 17, 2011) (statement of Sam D. Hamilton, Regional Director, Southeast Region, U.S. Fish and Wildlife Service, Department of the Interior) (stating the lower ACF Rivers are home to four endangered mussels, two threatened mussels, and one threatened fish); Jefferson G. Edgens, *Thirst for Growth*, 14 FORUM FOR APPLIED RESEARCH AND PUBLIC POLICY, Spring 2001, at 14, 14, 16 *available at* http://forum.ra.utk.edu/Archives/PDF/16.1.pdf (stating that the ACF basin provides 70% of Atlanta's drinking water); Fl. Dep't of Envtl. Prot., Apalachicola-Chattahoochee-Flint River System, http://www.dep.state.fl.us/mainpage/acf/default.htm (last visited July 17, 2011) (stating oysters are the hallmark species of the Appalachia Bay and that the commercial fishing industry in the Apalachicola Bay is responsible for $134,000,000 in economic output). *See also* South Carolina v. North Carolina, 130 S.Ct. 854 (2010) (involving the interstate battle between North Carolina and South Carolina over the waters of the Catawba River). The future of the Catawba River, a river that supports a variety of uses with a diversity of interests, including public drinking water supply, hydroelectric and thermoelectric power generation, industrial uses, and irrigation, is currently in the hands of the United States. Supreme Court. *South Carolina*, 130 S. Ct. at 858–59 (describing the procedural posture of the case); Motion of the State of South Carolina for Leave to File Complaint, Complaint, and Brief in Support of its Motion for Leave to File Complaint at 4, South Carolina v. North Carolina, 130 S. Ct. 854 (2010) (No. 06-138), 2007 WL 2826231, at *4 (stating the uses of the Catawba River). Severe drought that existed between 1998 and 2002, and subsequent drought conditions led to the initiation of the lawsuit concerning North Carolina's upstream transfers of water that allegedly exceeded North Carolina's equitable share of the River. *See id.* at *1–2. The Supreme Court granted Duke Energy's motion to intervene in the case finding that it showed "unique and compelling interests" to warrant intervention in the equitable apportionment case. *South Carolina*, 130 S. Ct. at 867. Moreover, recognizing the relationship between water supply and energy production, the Court found it "likely that any equitable apportionment of the river will need to take into account the amount of water that Duke Energy needs to sustain its operations and provide electricity to the region." *Id.* at 866.

on energy generation. In water-stressed areas of the country, power plants will increasingly compete with other water users and tradeoffs will occur, raising increasing concerns over which use is more important: water to support domestic uses, food supply, or energy production.[21]

This Article advances the notion that creating a "sustainable energy economy" in support of the current Administration's energy policies cannot be achieved without first charting a course toward achieving sustainability of our nation's water resources. Because current energy policies make significant demands on water resources that are already stressed and are expected to undergo even greater assault from increased demands and climate change-related impacts, the path to a sustainable energy economy must involve the integration of two highly compartmentalized policy areas—energy policy and water policy. The integration of these policy areas will start policymakers down the path toward achieving sustainability of our water resources, a goal that this article maintains will require large-scale cooperative watershed-based management and planning that takes into account the dynamics of the energy–water nexus.

Part I of this Article details the energy–water nexus, a concept that describes the interdependency existing between energy and water. The energy–water nexus provides the framework for understanding how decisions made in energy policy could impact our nation's water resources and, in turn, how the diminished state of these resources could undermine energy-based policy initiatives. This Part details the "water footprint"[22] of various methods of electricity generation and fuel production and briefly addresses the reciprocal side of the energy–water nexus—how water supply is dependent on energy.

Part II provides an overview of the challenges already threatening the sustainability of our nation's water resources. These challenges include burgeoning population growth—including projected national population shifts—and the concomitant increase in energy and water demands, and climate change-related direct and indirect impacts. This Part provides the contextual framework under which policymakers currently operate when making energy-based policy decisions that could exacerbate challenges already faced by stressed water resources.

Part III explores the limited degree to which energy policy and water policy have been integrated in existing energy-based and water-based regulatory regimes. This Part concludes that, with the limited exception of power generation facilities that fall under the jurisdiction of the Federal Energy Regulatory Commission (FERC) and the Nuclear Regulatory Commission (NRC), we are far from achieving the integration of energy

21 NAT'L ENERGY TECH. LAB., *supra* note 12, app. at A-2.

22 A "water footprint," a "counterpart to the better known carbon footprint," is defined as the "total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business." Jeff B. Kray, *Climate Change and Water Resources*, *in* WATERS AND WATER RIGHTS §4A.01(b) (Robert E. Beck & Amy K. Kelley eds., 3d ed. 2010); *see also* A.Y. Hoekstra, *Human Appropriation of Natural Capital: A Comparison of Ecological Footprint and Water Footprint Analysis*, 68 ECOLOGICAL ECON. 1963, 1964 (2009).

policy and water policy necessary to achieve sustainability of our water resources in support of a more sustainable energy economy.

Part IV explores the current state of national energy policy and water policy and the degree to which recent policy initiatives are, or are not, signaling an integration, by policymakers, of these highly compartmentalized policy arenas. This Part concludes that despite the presence of ongoing dialogue concerning the integration of energy- and water-related issues, with the limited exception of the recently enacted Omnibus Public Land Management Act of 2009 (OPLMA),[23] the integration of energy and water policy necessary to achieve sustainability of our water resources is not taking place on the policy level.

Part V discusses roadblocks in our current legal structure that promise to interfere with legislative efforts to achieve a more sustainable energy economy through the regulation of water resources, including challenges relating to federalism and governance. Part V also proposes a cooperative national watershed planning effort that incorporates the dynamics of the energy–water nexus as one potential solution to the challenges outlined in this Article.

Our already stressed water resources are expected to undergo increasing assault by significant projected population increases, and the resulting demands made on the water and energy sectors, as well as climate change-related impacts and response measures designed to mitigate these impacts. Perhaps unintentionally, this Administration, through its energy policies, has now added developing clean energy technology, increasing the use of renewable energy, and reinvigorating nuclear power—i.e., creating a "sustainable energy economy"—to the burgeoning list of demands being placed on the nation's water resources. In order to avoid the catastrophic water shortages and significant ecological impacts that await us at the end of our current path, policymakers must develop a clear understanding of the role that water plays in the energy sector and this understanding must provide the framework by which future energy-based policies and decisions are made.

II. THE ENERGY–WATER NEXUS: HOW ENERGY AND WATER ARE LINKED

Much has been written on the subject of the energy–water nexus and the interdependency of these two vital resources.[24] With the advent of climate change and the current direction of the nation's energy policy, the dynamics of the energy–water nexus have increased in import. Because of the energy–water nexus, decisions made concerning energy generation, like increasing the use of nuclear power, as well as decisions made concerning increased use and production of renewable energy sources, can significantly

[23] Omnibus Public Land Management Act of 2009, Pub. L. No. 111-11, 123 Stat. 997 (codified as amended in scattered sections); U.S. Gov't Printing Office, Public Law 111-11 – Omnibus Public Land Management Act of 2009, http://www.gpo.gov/fdsys/pkg/PLAW-111publ11/content-detail.html (showing details of the location of its codification).

[24] *See, e.g.*, sources cited *infra* notes 30, 160, 167.

impact water resources.[25] For this reason, policymakers need to be keenly aware of the inextricable link between these two vital resources and the impact that decision-making in the energy policy arena can have on water resources, and vice versa.

For purposes of underscoring potential impacts that energy policy can have on water resources, it is important to understand, as detailed below, that energy generation and fuel production are dependent on water resources. This Part also details the flip side of the energy–water nexus—water production's dependency on energy. It is important to remember this half of the energy–water equation when considering the energy demand (and related water use) associated with accessing alternative sources of water supply as our nation's freshwater resources become further depleted.

A. Energy Supply and Fuel Production Are Water Dependent

Water is an integral component in energy production.[26] It plays a vital role in energy generation, including hydroelectric power generation, thermoelectric power plant cooling, and emissions scrubbing.[27] It also plays a vital role in energy resource development, including resource extraction, refining, processing, and transportation.[28]

1. Water Use in the Energy Generation Process

In the context of energy generation, the United States electric industry produced a reported 3,913,771 gigawatt-hours (GWh) of electricity in 2009.[29] In terms of water use, based on an average of twenty-five gallons of water used for every kilowatt-hour (kWh) generated,[30] in 2009 alone, the energy sector used approximately 98 trillion gallons of water in processes related to energy generation.[31]

Hydropower, the most obvious water-dependent energy source, remains an "important component" of United States electricity generation.[32]

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25 *See* U.S. DEP'T OF ENERGY, *supra* note 15, at 9–11 (discussing the interdependence of energy production and water usage, and stating that decisions about energy production can affect water usage rates).

26 *Id.* at 13.

27 *Technology Research and Development Efforts Related to the Energy and Water Linkage: Hearings Before the Subcomm. on Energy and Env't of the H. Comm. on Science and Tech.*, 111th Cong. 3 (2009) [hereinafter *Hearings*].

28 *Id.*

29 *Electric Output Down 3.7% in 2009; Economic Factors, Weather Cited*, ENERGY NEWS , Jan. 13, 2010, http://www.eei.org/newsroom/energynews/Pages/20100113.aspx (last visited Apr. 9, 2011). According to the Edison Electric Institute, this represents the lowest annual amount of GWhs produced since 2004 which the Institute associates with milder summer temperatures and the significant drop in Gross Domestic Product. *Id.*

30 Benjamin K. Sovacool, *Running on Empty: The Electricity–Water Nexus and the U.S. Electric Utility Sector*, 30 ENERGY L. J. 11, 13 (2009).

31 The exact calculation is 97,844,275,000,000 gallons of water.

32 U.S. DEP'T OF ENERGY, *supra* note 15, at 19.

In 2006, hydropower provided approximately 7% of the nation's electricity.[33] Water flow through hydroelectric turbines primarily consists of fresh surface water[34] and averages 3,160 billion gallons a day.[35] The United States Geological Survey (USGS) does not report the water used in hydropower generation as "withdrawn" from its source because it remains in-stream and is used repeatedly by successive dams.[36]

Thermoelectric-generating technologies, on the other hand, use steam rather than water flow to drive turbine generators.[37] These plants, which obtain heat from a variety of sources, including oil, coal, nuclear, natural gas, biomass, concentrated solar energy, and geothermal energy, require large amounts of water for plant cooling systems.[38] To operate these cooling systems, United States power plants withdraw water from a variety of sources, including surface water, ground water, fresh water, and saline water.[39] As compared to other water "use categories," water withdrawals in thermoelectric power generation account for an estimated 41% of all freshwater withdrawals, 61% of all surface water withdrawals, and 94% of all saline water withdrawals in the United States.[40] As much as 99% of

33 *See* U.S. Energy Info. Admin., Existing Net Summer Capacity by Energy Source and Producer Type, http://www.eia.doe.gov/cneaf/electricity/epa/epat1p1.html (last visited Apr. 9, 2011).

34 U.S. Geological Survey, Estimated Use of Water in the United States in 1990: Hydroelectric Power Water Use, http://water.usgs.gov/watuse/wuhy.html (last visited July 17, 2011).

35 U.S. DEP'T OF ENERGY, *supra* note 15, at 20.

36 *Id.* Although water supporting hydropower generation remains in stream, this form of power generation does impact the water resource and as such can affect water's usefulness for other purposes. These impacts can include, among other things, disruption of migrating fish patterns and wetlands habitats and changes in water quality and flow brought on by the use of dams. FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT 137 (Robert C. Clark et al. eds., 3d ed. 2010).

37 U.S. DEP'T OF ENERGY, *supra* note 15, at 18.

38 *See id.*

39 NANCY L. BARBER, U.S. GEOLOGICAL SURVEY, SUMMARY OF ESTIMATED WATER USE IN THE UNITED STATES IN 2005, at 2 (2009), *available at* http://pubs.usgs.gov/fs/2009/3098/pdf/2009-3098.pdf; JOAN F. KENNY ET AL., U.S. GEOLOGICAL SURVEY, ESTIMATED USE OF WATER IN THE UNITED STATES IN 2005, at 38 (2009), *available at* http://pubs.usgs.gov/circ/1344/pdf/c1344.pdf.

40 At a withdrawal rate of 410,000 million gallons of water per day, of which 80% are surface water withdrawals (328,000 million gallons per day), and a thermoelectric power withdrawal rate of 201,000 million gallons per day, of which 99% are surface water withdrawals (198,990 million gallons per day), thermoelectric power utilizes 61% of all withdrawals (198,990 million gallons per day, divided by 328,000 million gallons per day, equals 0.606). Similarly, 18% of the total surface water withdrawal was saline (0.18 multiplied by 328,000 million gallons per day equals 59,040 million gallons per day) and 28% of thermoelectric power was saline (0.28 multiplied by 198,990 million gallons per day equals 55,717.2 million gallons per day). Dividing 55,717.2 million gallons per day by 59,040 million gallons per day, equals 94% of all saline withdrawals. To compute the percentage of freshwater withdrawals, multiply 410,000 million gallons per day by 20% and then by 96% to get the amount of freshwater groundwater withdrawals, which is 78,720 million gallons per day. Add this to the amount of freshwater surface withdrawals (328,000 million gallons per day minus amount of saline withdrawals, 59,040 million gallons per day, which equals 268,960 million gallons per day) to get total freshwater withdrawal of 347,680 million gallons per day. Subtracting 55,717.2 million gallons per day from 198,990 million gallons per day equals the total freshwater withdrawal by thermoelectric power, which is 41% of the total freshwater withdrawals. *See* BARBER, *supra* note 39, at 2.

thermoelectric power plant cooling requirements are met using surface water withdrawals,[41] approximately 71% of which consist of fresh water.[42] When examined in the context of actual number of gallons used, according to the Department of Energy's (DOE) most recent statistics, in 2010 thermoelectric power plants are expected to use an estimated 145 billion gallons of the nation's freshwater resources per day in the electricity generating process.[43]

Thermoelectric power plants located in the southeast region of the United States also reveal demanding water utilization and consumption patterns. Currently, 84% of the nation's thermoelectric-power-related water withdrawals are occurring in eastern states, with thermoelectric power generally being the largest category of water withdrawal.[44] Power generating facilities located in the southeastern states[45] are responsible for approximately two-thirds of all freshwater withdrawals in that area,[46] drawing approximately 40 billion gallons of water a day.[47] Evaporation resulting from power plant cooling processes in this region causes the annual loss of nearly 140 billion gallons of water, an amount equivalent to the annual water use of more than one million homes.[48]

a. Water Use by Cooling Process

Water use in electricity generation primarily arises in connection with power plant cooling processes[49]—a thermoelectric power plant's need for water is due to the simple physical law that water can absorb 4,000 times as much heat as air for a given rise in temperature.[50] Fossil and nuclear power

41 KENNY ET AL., *supra* note 39, at 38.

42 *See id.* at 38–39 (dividing total thermoelectric withdrawal of 201,000 million gallons per day by freshwater withdrawal of 143,000 million gallons per day, which equals 0.7114, or, approximately 71%).

43 NAT'L ENERGY TECH. LAB, *supra* note 12, at 29.

44 KENNY ET AL., *supra* note 39, at 38. According to the USGS, this pattern of withdrawals exists due to the long established power production infrastructure along major rivers, the Great Lakes, and the coast. *Id.*

45 In calculating water use in the southeast, the following states were examined: West Virginia, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and Florida. *Id.* at 6, 39.

46 Jess Chandler et al., *Water and Watts*, SOUTHEAST ENERGY OPPORTUNITIES, Apr. 2009, at 1, *available at* http://pdf.wri.org/southeast_water_and_watts.pdf. Total freshwater withdrawals equaled 71,180 million gallons per day, 47,593 million gallons of which were used in thermoelectric power plants. *See* KENNY ET AL., *supra* note 39, at 6, 39.

47 Chandler et al., *supra* note 46, at 2.

48 *Id.*

49 *See* U.S. DEP'T OF ENERGY, *supra* note 15, at 17–18, 63. Water use at thermoelectric power plants is not limited to the cooling process. For example, at coal-fired energy production plants, water is used for flue gas scrubbing and ash handling. *See* World Nuclear Ass'n., Cooling Power Plants, http://www.world-nuclear.org/info/cooling_power_plants_inf121.html (last visited July 17, 2011).

50 Robert H. Abrams & Noah D. Hall, *Framing Water Policy in a Carbon Affected and Carbon Constrained Environment*, 50 NAT. RESOURCES J. 3, 40 (2010).

plants, accounting for approximately 80% of electric power generating capacity, "require cooling to condense the steam turbine exhaust."[51] Today's power plants primarily use water as the cooling medium,[52] withdrawing it mainly from large volume sources such as underground aquifers, lakes, rivers, and oceans.[53] The quantity of water required to cool the plant depends on both the generating and cooling technologies employed at a plant and the ambient meteorological conditions that exist at the plant's location.[54] Depending on the cooling process utilized, the water used in the cooling process is either consumed by evaporation in cooling towers or returned to its original source.[55] Although not all water used in thermoelectric power generation is "consumed," a recent DOE report indicates that thermoelectric generation does consume approximately 3.3 billion gallons of water per day.[56]

Conventional power plants, including oil, coal, natural gas, biomass, and nuclear powered facilities, use one of three cooling processes in the generation of electricity: closed-loop, open-loop, and dry-cooling systems.[57] Approximately 56% of conventional power plants use closed-loop cooling systems.[58] In closed-loop systems, the facility withdraws water from a source, cycles it through heat exchangers, allows it to cool in either ponds or towers, and then recirculates it.[59]

Power plants using closed-loop cooling systems withdraw less water initially—approximately 300 to 700 gallons per megawatt-hour (MWh),[60] (these plants account for only 8% of withdrawals by power plants[61])—but have a higher water consumption rate because of the evaporation that occurs during the cooling process.[62] The higher consumption rate requires the power plant to withdraw additional cooling water in order to replace

51 U.S. DEP'T OF ENERGY, *supra* note 15, app. B at 63.

52 NAT'L ENERGY TECH. LAB., *supra* note 12, at 8. Passing large quantities of cooling water through the condenser to absorb heat is the preferred method from both a cost and efficiency standpoint. U.S. DEP'T OF ENERGY, *supra* note 15, app. B at 63.

53 NAT'L ENERGY TECH. LAB., *supra* note 12, at 8.

54 U.S. DEP'T OF ENERGY, *supra* note 15, app. B at 63.

55 *Id.*

56 *Id.* at 9.

57 Chandler et al., *supra* note 46, at 2–3. Power plant cooling systems not only utilize large amounts of water, but also the cooling intake structures cause environmental damage to aquatic organisms from the water sources tapped to cool the plants by impingement and entrainment of the organisms. Entergy Corp. v. Riverkeeper, Inc., 129 S. Ct. 1498, 1502 (2009). A recent United States Supreme Court case found permissible EPA's reliance on a cost-benefit analysis in setting the national performance standards that reduced impingement mortality and entrainment at existing power plants, as well as in providing for cost-benefit variances from those standards as part of the regulations. *Id.* at 1504, 1510.

58 *Hearings*, *supra* note 27, at 15 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy).

59 KENNY ET AL., *supra* note 39, at 38.

60 *Hearings*, *supra* note 27, at 15 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy).

61 KENNY ET AL., *supra* note 39, at 38.

62 Chandler et al., *supra* note 46, at 3.

water lost during the cooling process.[63] Approximately 81% of electric generating facilities using closed-loop cooling systems reported consumptive use rates at or more than 50%.[64] These closed-loop cooling systems are more commonly found in the Western United States.[65]

Approximately 43% of power-generating plants use open-loop cooling systems.[66] In open-loop cooling systems, the facility withdraws water from a source and passes it through the condenser only once, then discharges it downstream to a receiving water body.[67] Plants employing the open-loop cooling system withdraw approximately 91% of all water used by power plants.[68] More than half of the nation's nuclear reactors use the open-loop cooling system.[69]

Although this cooling process requires more water withdrawals upfront than closed-loop cooling systems require (withdrawal rates range from approximately 20,000 to 60,000 gallons / MWh[70]), less water evaporates in the process (usually 200 to 400 gallons / MWh[71]), thereby reducing consumptive use rates as compared to closed-loop cooling systems.[72] However, impacts to water resources caused by the open-loop cooling process are not limited to water consumption. Because open-loop cooling systems often discharge process water at a higher temperature than the receiving water—sometimes by as much as twenty-five degrees Fahrenheit[73]—this practice may alter the temperature of the receiving water, thereby significantly altering the ecosystem[74] and causing increased evaporation from the receiving body of water.[75] Open-loop cooling systems are used in older power plants and are more commonly found in the Eastern United States.[76]

The dry-cooling process is "dependent entirely on air" and therefore uses less water than either the open- or closed-loop cooling systems.[77] However, because this cooling process is most cost efficient in cold, arid

63 KENNY ET AL., *supra* note 39, at 38.

64 *Id.*

65 Benjamin K. Sovacool & Kelly E. Sovacool, *Preventing National Electricity–Water Crisis Areas in the United States*, 34 COLUM. J. ENVTL. L. 333, 339 (2009).

66 *Hearings*, *supra* note 27, at 15 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy).

67 Sovacool, *supra* note 30, at 16–17.

68 *Id.* at 17; U.S. Geological Survey, Estimated Use of Water in the United States in 2000: Thermoelectric Power, http://pubs.usgs.gov/circ/2004/circ1268/htdocs/text-pt.html (last visited Julu 17, 2011).

69 Sovacool, *supra* note 30, at 17.

70 *Hearings*, *supra* note 27, at 15 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy).

71 *Id.*

72 Chandler et al., *supra* note 46, at 3.

73 Based on data collected by the U.S. Energy Information Administration at more than 150 open-loop units. Sovacool & Sovacool, *supra* note 65, at 352.

74 *Id.* at 353.

75 Sovacool, *supra* note 30, at 17.

76 *Hearings*, *supra* note 27, at 15 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy); Sovacool & Sovacool, *supra* note 65, at 338.

77 Sovacool, *supra* note 30, at 16–17; World Nuclear Ass'n., *supra* note 49.

environments,[78] only 1% of power generating systems employ dry cooling systems.[79]

A relatively recent Clean Water Act (CWA)[80] provision is likely to have considerable impact on the design of future power generation facilities[81] and, in turn, on the withdrawal and consumption patterns of these facilities. Section 316(b),[82] which is "[d]esigned to protect aquatic life from [] being killed by [cooling water] intake structures,"[83] strongly discourages the use of open-loop cooling systems.[84] This provision is expected to cause the energy sector to transition to a greater use of closed-loop and dry-cooling systems.[85] Because closed-loop cooling systems consume more water in the cooling process than open-loop cooling systems, water consumption levels by the energy sector are expected to increase.[86]

b. Water Use by Fuel Type

Water use at power plants also varies by the type of fuel used to generate the electricity. Understanding this dynamic of the energy–water nexus is particularly important in light of the current energy policies supporting increased use of nuclear power and renewable fuels. Power plants using natural gas, for example, use approximately fourteen gallons of water for every kWh generated.[87] By comparison, coal and waste-incineration plants use approximately thirty-six gallons of water per each kWh generated, and nuclear power plants use a striking forty-three gallons of water for every kWh generated.[88] Giving these numbers some context, in 2006, in the process of generating 877 billion kWh of electricity, natural gas plants used an estimated 12.3 trillion gallons of water.[89] During that same time period, coal-fired power plants, which generated 1,957 billion kWh of

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78 Sovacool, *supra* note 30, at 17.

79 *Hearings*, *supra* note 27, at 15 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy).

80 Federal Water Pollution Control Act, 33 U.S.C. §§ 1251–1387 (2006).

81 NAT'L ENERGY TECH. LAB., *supra* note 12, app. at A-2.

82 33 U.S.C. § 1326(b) (2006). To comply with Section 316(b), EPA must ensure that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." *Id.* Applicable regulations base cooling water intake structure performance standards on impingement mortality and entrainment (IM&E) impacts. NAT'L ENERGY TECH. LAB., *supra* note 12, app. at A-2. Open-loop cooling systems "are strongly discouraged unless the permit applicant can demonstrate that alternative IM&E measures can provide a reduction level comparable to that achieved through closed-loop cooling or that the compliance costs, air quality impacts, and/or energy generation impacts would outweigh the IM&E benefits and justify an open-loop system." *Id.* app. at A-3.

83 NAT'L ENERGY TECH. LAB., *supra* note 12, app at. A-2.

84 *Id.* app. at A-3.

85 *See id.*

86 *Id.*

87 Sovacool & Sovacool, *supra* note 65, at 340.

88 *Id.* at 340. Note that twenty-five gallons of water per kWh generated is industry average. *Id.*

89 *Id.*

electricity, used an estimated 52.8 trillion gallons of water.[90] Nuclear power plants, which generated an additional 787 billion kWh of electricity, used an estimated 33.8 trillion gallons of water,[91] a significant amount of water for a form of power generation that is increasing in popularity under current energy policy.[92]

Statistics on water withdrawals gathered from three nuclear power plants located in the southeast region also help to put these numbers into perspective. Georgia's Edwin Hatch Plant, for example, on a daily basis withdraws an average of 57 million gallons from the Altamaha River," but consumes (or loses to evaporation) 33 million gallons,[93] which is enough to service more than 196,000 homes.[94] Progress Energy's newest nuclear plant, the Harris Plant located in North Carolina, draws in 33 million gallons a day from Harris Lake, 17 million gallons of which is lost every day to evaporation.[95] Similarly, Duke Energy's McGuire Plant, also located in North Carolina, withdraws more than 2 billion gallons of water daily from Lake Norman.[96]

Water demands by "renewable" energy-fired power plants like solar thermal or biofuel powered plants do not differ conceptually from demands made by conventional fossil-fuel or nuclear power plants in that these plants still require significant amounts of water in the cooling processes.[97] Electricity production using renewable forms of energy may in fact be more water intensive given the "low energy return on energy investment"[98] ratio for a number of renewables. Corn-based ethanol's energy production ratio, for example, generates an energy return that varies between 1.2:1 and 1.6:1 (i.e., 1.2 units of energy returned for each unit of required energy input).[99] Compare this with petroleum's ratio of 15:1.[100] For its part, geothermal electricity production has a relatively low thermal efficiency, which is the ratio of electricity output to thermal energy input, as compared to other electricity generating technologies, meaning it also requires amounts of water similar to nuclear and coal generation.[101]

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90 *Id.*

91 *Id.*

92 *E.g.*, Kim Chipman, *Obama's Nuclear-Power Plan Set Back by Japan Quake Aftermath*, BLOOMBERG BUSINESSWEEK, Mar. 14, 2011, http://www.businessweek.com/news/2011-03-14/obama-s-nuclear-power-plan-set-back-by-japan-quake-aftermath.html (last visited July, 17, 2011).

93 SARA BARCZAK & RITA KILPATRICK, S. ALLIANCE FOR CLEAN ENERGY, ENERGY IMPACTS ON GEORGIA'S WATER RESOURCES 1 (2003), *available at* http://www.gwri.gatech.edu/uploads/proceedings/2003/Barczak%20and%20Kilpatrick.PDF.

94 Sovacool & Sovacool, *supra* note 65, at 341.

95 *Id.*

96 *Id.*

97 *Hearings*, *supra* note 27, at 31 (statement of Dr. Bryan J. Hannegan, Vice President, Environment and Generation, Electric Power Research Institute).

98 Mark D. Levine & Nathaniel T. Aden, *Sustainable and Unsustainable Developments in the U.S. Energy System*, *in* AGENDA FOR A SUSTAINABLE AMERICA 145, 155 (John C. Dernbach ed., 2009).

99 *Id.*

100 *Id.*

101 *Hearings*, *supra* note 27, at 36 (statement of Dr. Bryan Hannegan, Vice President, Environment and Generation, Electric Power Research Institute).

Policymakers need to be aware that water use in support of electricity generation extends beyond direct electricity generation activities. For example, an alarming amount of water is utilized at nuclear reactor power plants even in the absence of electricity generating activity.[102] Nuclear power plants require water to remove heat produced by the reactor core, to cool equipment and buildings associated with reducing the core's heat, and to lubricate oil coolers for the equipment, including the main turbine and chillers for air conditioning, responsible for cooling the reactor.[103] During the summer months, the Hope Creek plant in New Jersey uses 52,000 gallons of water per minute, even when not producing electricity.[104] Similarly, even when not producing electricity, the Milestone Unit 2 in Connecticut requires 30,000 gallons per minute and the Pilgrim plant in Massachusetts requires 13,500 gallons per minute.[105]

These statistics underscore the policymakers' need to be aware of the obvious tradeoffs associated with various fuel types in areas of carbon emissions and water use. For example, nuclear-fired power plants, which are increasing in popularity due to energy policies that promote reduced carbon emissions, use significantly more water than other forms of energy generation. Coal-fired power plants use a significant amount of water and emit high levels of carbon emissions, a seemingly bad choice for power generation in a climate change era. From a cost standpoint, however, coal is considered a cheap and abundant fuel source. Natural gas, on the other hand, uses less water and emits lower carbon emissions than other fuel sources. Perhaps for these reasons, DOE forecasts indicate that 90% of the next 1,000 power plants in the Unites States will use natural gas.[106] That notwithstanding, natural gas use does not come without its distinct set of water-related complications.[107]

The above statistics speak only to water use in the generation of electricity and in the cooling processes at electricity generation plants. Although the energy sector's demands on water resources during these processes are considerable, water use during energy generation activities only conveys part of the water-dependency dynamic. To understand the full extent of the energy sector's dependency on water resources, one must also consider the role that water plays in the production cycle of the various fuel

102 *See* Sovacool & Sovacool, *supra* note 65, at 355–56.

103 *Id.* (internal citations omitted).

104 *Id.* at 356.

105 *Id.*

106 U.S. Dep't of Energy, Natural Gas, http://www.energy.gov/energysources/naturalgas.htm (last visited Apr. 5, 2011).

107 Reports have linked repeated instances of groundwater and drinking well contamination to hydraulic fracturing processes. *See* Tom Gjelten, *Water Contamination Concerns Linger for Shale Gas*, NAT'L PUB. RADIO, Sept. 23, 2009, http://www.npr.org/templates/story/story.php?storyId=113142234 (last visited April 5, 2011); Jeff Brady, *Face-Off Over 'Fracking': Water Battle Brews on Hill*, NAT'L PUB. RADIO, May 27, 2009, http://www.npr.org/templates/story/story.php?storyId=104565793&ps=rs (last visited Apr. 5, 2011); *see also* discussion *infra* Part II.A.2(d) (water use in the natural gas drilling and fracturing process).

types. Policymakers should pay particular attention to the considerable role that water plays in the production of renewable resources—like biofuels—particularly in light of recent energy policies that promote increased production of these fuel sources.

2. Water Use in Fuel Production

In addition to playing an integral role in electricity generation, water is a vital player in the extraction, refining and processing, and transportation of fossil fuels (including oil, coal, and natural gas), nuclear power, and renewable resources (including hydropower, biomass, geothermal energy, wind, and solar).[108] For example, the United States energy sector consumes between one and two billion gallons of water per day solely in connection with petroleum refinement processes.[109] A brief survey of water use in the production cycle of various fuel types further highlights this dimension of the energy–water nexus.

a. Oil

Domestic petroleum is produced from underground locations where impervious rock forms prevent the petroleum from migrating to the surface.[110] While oil's initial extraction does not require significant amounts of water, enhanced oil recovery (EOR) techniques used to extract oil once deposits become depleted frequently involve the injection of water or steam into a well.[111] The quantity of water used in EOR can range from approximately eighty-one gallons per barrel of oil to 14,000 gallons of water per barrel of oil, depending on the age of the oil field and the method of EOR employed.[112] The refining process can also be water intensive. According to DOE estimates, petroleum refineries use one to two billion gallons of water

108 U.S. DEP'T OF ENERGY, *supra* note 15, at 9, 17, 41, 55–68. Management of the large quantities of process water derived from fuel extraction, refining, and processing presents its own set of problems. The oil and natural gas industry produces an estimated 840 billion gallons of "produced water" every year. *Hearings*, *supra* note 27, at 18 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy). The EPA found that "[a]t 23 percent of the sampled oil and gas extraction sites . . . the produced water contained 'one or more of the toxic constituents of concern at levels greater than 100 times the health-based standards.'" Hannah Wiseman, *Regulatory Adaptation in Fractured Appalachia*, 21 VILLANOVA ENVTL. L.J. 229, 245 (2010) (quoting Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,455 (July 6, 1988)). Moreover, "EPA estimates that approximately 10 to 70 percent of large-volume wastes [from oil and gas production] and 40 to 60 percent of associated wastes could potentially exhibit [Resource Conservation and Recovery Act of 1976] hazardous waste characteristics." 53 Fed. Reg. at 25,455.

109 U.S. DEP'T OF ENERGY, *supra* note 15, at 20.

110 BOSSELMAN ET AL., *supra* note 36, at 241.

111 *Hearings*, *supra* note 27, at 5.

112 U.S. DEP'T OF ENERGY, *supra* note 15, at 57. According to American Petroleum Institute estimates, oil and gas operations in 1995 generated eighteen billion barrels of produced water, 70% of which was recycled for EOR. *Hearings*, *supra* note 27, at 5.

per day[113] and consume between 1 and 2.5 gallons of water for each gallon of product.[114]

b. Oil Shale

Oil shale is carbonate rock that is rich in an organic sedimentary material called "kerogen," which, when heated, is converted to a synthetic crude-like oil called "shale oil."[115] According to the DOE, oil shale is emerging as a potential United States fuel source[116] with an estimated 2 trillion barrels of this "unconventional oil resource[]" contained in oil shale deposits located throughout Colorado, Utah, Wyoming, Kentucky, Ohio, and Indiana.[117]

The development of oil shale resources requires significant quantities of water.[118] Mining and aboveground processing (referred to as "retorting") together consume an estimated two and five gallons of water per gallon of refinery-ready oil (fifteen to thirty-eight gallons per million British thermal units (MMBtu)).[119] To meet water demands associated with processing this fuel source,[120] an oil shale industry that produces 2.5 million barrels of oil per day (MMBbl/d) is estimated to require between 105 and 315 million gallons of water per day.[121] Policymakers exploring this potential fuel source should be aware that the more arid conditions of portions of the region containing oil shale deposits may increase the challenges associated with obtaining the water resources necessary to support a sizeable oil shale industry.[122]

c. Coal

Coal, the primary source of energy production in the United States, contributed approximately 45% of the United States' power between January

113 Sovacool & Sovacool, *supra* note 65, at 346.

114 U.S. DEP'T OF ENERGY, *supra* note 15, at 20.

115 Institute for Energy Research, Oil Shale, http://www.instituteforenergyresearch.org/energy-overview/oil-shale/ (last visited July 3, 2011).

116 U.S. DEP'T OF ENERGY, *supra* note 15, at 20.

117 HARRY R. JOHNSON ET AL., AOC PETROLEUM SUPPORT SERVICES, LLC, STRATEGIC SIGNIFICANCE OF AMERICA'S OIL SHALE RESOURCE: VOLUME I: ASSESSMENT OF STRATEGIC ISSUES 2, 10 (2004), *available at* http://www.fossil.energy.gov/programs/reserves/npr/publications/npr_strategic_significancev1.pdf (prepared for the Office of Naval Petroleum and Oil Shale Reserves, U.S. Dep't of Energy).

118 OFFICE OF PETROLEUM RESERVES, U.S. DEP'T OF ENERGY, FACT SHEET: OIL SHALE WATER RESOURCES (2007), *available at* http://fossil.energy.gov/programs/reserves/npr/Oil_Shale_Water_Requirements.pdf.

119 U.S. DEP'T OF ENERGY, *supra* note 15, at 20, 43, 58.

120 Processing includes "in-situ heating processes, retorting, refining, reclamation, dust control and on-site worker demands." OFFICE OF PETROLEUM RESERVES, *supra* note 118.

121 *Id.*

122 The primary source of water in this region is the Colorado River Basin, the allocation of which is governed by the Colorado River Compact. *Id.*

2010 and July 2010.[123] Coal-fired generation, which increased 13.3% between July 2009 and July 2010, makes up over half of the 10.1% increase in net power generated in the United States over that same time period.[124] "[C]onversion of coal to energy requires . . . mining, processing, transportation, and combustion."[125] Depending on the source of the coal, estimates for water use in coal mining vary between 10 to 100 gallons per ton of coal mined (ranging from one to six gallons per MMBtu).[126]

Once extracted from surface or underground mines, much of the mined coal is cleaned or washed to increase heat content by removing noncombustible material, including approximately 80% of Eastern and interior coal.[127] Water requirements for coal washing range from twenty to forty gallons per ton of coal washed (one to two gallons per MMBtu).[128] When applied against 2003 coal industry production data, water use estimates in coal mining range from 70 to 260 million gallons per day.[129]

d. Natural Gas

Between January 2010 and July 2010, natural gas power plants contributed 22.9% of the power generated in the United States.[130] Natural gas has been identified as an important "bridge fuel"[131] in the effort to reduce our reliance on fossil fuels and transition to more "sustainable" energy resources.[132] "The production of natural gas from conventional domestic sources . . . peaked in 1973,"[133] and, companies now access unconventional sources of gas, like shale gas, through a procedure known as "hydraulic fracturing."[134] By 2035, the U.S. Energy Information Administration (EIA)

123 OFFICE OF COAL, NUCLEAR, ELEC. AND ALT. FUELS, U.S. DEP'T OF ENERGY, ELECTRIC POWER MONTHLY: OCTOBER 2010, at 1 (2010) *available at* http://www.eia.doe.gov/ftproot/electricity/epm/02261010.pdf. Additional power generated in the United States includes 22.9% by natural gas-fired plants and 19.5% by nuclear plants. *Id.*

124 *Id.*

125 BOSSELMAN ET AL., *supra* note 36, at 170.

126 U.S. DEP'T OF ENERGY, *supra* note 15, at 53.

127 *Id.*; *see also* U.S. Envtl. Prot. Agency, Clean Energy: Electricity from Coal, http://www.epa.gov/cleanenergy/energy-and-you/affect/coal.html (last visited Apr. 6, 2011).

128 U.S. DEP'T OF ENERGY, *supra* note 15, at 55.

129 *Id.*

130 OFFICE OF COAL, NUCLEAR, ELEC. AND ALT. FUELS, *supra* note 123, at 1.

131 Wiseman, *supra* note 108, at 231 (defining "bridge fuel" as a term used to describe "domestically-available, relatively clean resources upon which Americans can rely as we move toward a more sustainable energy base").

132 *Id.* at 232.

133 Jacqueline Lang Weaver, *The Traditional Petroleum-Based Economy: An "Eventful" Future*, 36 CUMB. L. REV. 505, 519 (2006).

134 Wiseman, *supra* note 108, at 233. Wiseman refers to the Marcellus Shale, which underlies the Appalachian region of the United States, as "the largest unconventional shale play in the world." *Id.* at 234. It is estimated to contain up to 500 trillion cubic feet of gas. *Id.* at 240.

predicts that shale gas will make up more than 35% of domestic natural gas production.[135]

Water is an essential component of both the drilling and deep shale fracturing process.[136] Shale fracturing requires operators to drill vertically thousands of feet underground at which point they deviate the drill bit and drill laterally through the shale—in some locations, more than 3,500 feet.[137] The wells are then "fractured" by pumping large volumes of "fracking fluid," the primary constituent of which is water, at high pressure, into the well boring.[138] The intent is to release trapped gas by fracturing the shale.

The volume of water needed in the hydraulic fracture operation can vary substantially based on local conditions.[139] According to the New York Department of Environmental Conservation, a single well requires between 2.4 million and 7.8 million gallons of water and a fractured well "may require up to 3 million gallons of water per treatment."[140] The DOE estimates that natural gas production uses approximately 400 million gallons of water per day.[141]

e. Nuclear

Nuclear power plants contributed 19.5% of the power generated in the United States between January 2010 and July 2010.[142] The nuclear fuel cycle involves uranium mining and processing (milling, conversion, enrichment, and fuel fabrication).[143] While nuclear power plants require more *cooling water* than any other electric power generating plant, when compared to other fuels, the water requirements for *mining and processing* uranium are minimal. "Water required for uranium mining varies from less than 1 gal[lon] per MMBtu for underground mining to 6 gal[lons] per MMBtu for surface mines."[144] Uranium processing consumes an additional estimated seven to eight gallons per MMBtu.[145] Because the majority of uranium process mining and enrichment facilities are located outside of the United States, United

135 J. DANIEL ARTHUR ET AL., WATER RESOURCES AND USE FOR HYDRAULIC FRACTURING IN THE MARCELLUS SHALE REGION 1, *available at* http://www.netl.doe.gov/technologies/oil-gas/publications/ENVreports/FE0000797_WaterResourceIssues.pdf.

136 *Id.* at 2.

137 Wiseman, *supra* note 108, at 237 & n.37.

138 *Id.* at 238.

139 *Id.* at 238 n.50.

140 *Id.* at 238–39 nn.50–51 (quoting DANIEL J. SOEDER & WILLIAM M. KAPPEL, U.S. GEOLOGICAL SURVEY, WATER RESOURCES AND NATURAL GAS PRODUCTION FROM THE MARCELLUS SHALE 4 (2009), *available at* http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf). Note that "wells may be re-fractured multiple times after producing for several years." *Id.* (quoting Railroad Comm'n of Tex., Water Use in the Barnett Shale, http://www.rrc.state.tx.us/barnettshale/wateruse_barnettshale.php (last visited July 3, 2011)).

141 Sovacool & Sovacool, *supra* note 65, at 346.

142 OFFICE OF COAL, NUCLEAR, ELEC. AND ALT. FUELS, *supra* note 123, at 1.

143 U.S. Energy Info. Admin., Introduction to Nuclear Power, http://www.eia.doe.gov/cneaf/nuclear/page/intro.html (last visited Apr. 6, 2011).

144 U.S. DEP'T OF ENERGY, *supra* note 15, at 56.

145 *Id.*

States' water resources are not implicated in much of the mining and processing activities.[146] With respect to domestic mining and processing activities, the DOE estimates that water use in domestic uranium mining and processing ranges from approximately 3 to 5 million gallons of water per day.[147]

f. Biomass

Because of its significant water demands, biomass production has come under significant scrutiny.[148] The term "biomass" includes a "wide variety of renewable plant materials that [are] converted to provide various sources of energy."[149] Although renewable energy resources[150] (including biomass, geothermal, solar, and wind) contributed only 4.2% of the power generated in the United States between January 2010 and July 2010,[151] this number is expected to increase significantly as a result of the nation's energy policies which call for the increased use and production of these energy sources.

Many renewable energy fuel sources make considerable demands on water resources, a dynamic of the energy–water nexus that policymakers should not overlook. Ethanol, for example, "the most commonly produced biofuel in the United States,"[152] incorporates water into its production cycle at two stages: in the growing of feedstock, which can be very water intensive, and in the refining process, which uses a modest amount of water by comparison to biofuel production.[153] Depending on where the corn is grown and whether it is irrigated, water requirements associated with ethanol production can range from 7 to 321 gallons of water per gallon of ethanol produced.[154] Water is introduced in the refining process through either the wet milling or dry milling processes.[155] A dry mill corn-ethanol

146 Sovacool & Sovacool, *supra* note 65, at 348.

147 *Id.*

148 *Hearings*, *supra* note 27, at 5.

149 BOSSELMAN ET AL., *supra* note 36, at 851.

150 Renewable energy resources are defined as "those that can be utilized without any discernable reduction in their future availability." *Id.* at 835.

151 OFFICE OF COAL, NUCLEAR, ELEC. AND ALT. FUELS, *supra* note 123, at 1.

152 *Hearings*, *supra* note 27, at 25 (statement of Anu K. Mittal, Director, Natural Resources and Environment at the U.S. Government Accountability Office).

153 U.S. DEP'T OF ENERGY, *supra* note 15, at 20; *Hearings*, *supra* note 27, at 5.

154 *Hearings*, *supra* note 27, at 26 (statement of Anu K. Mittal, Director, Natural Resources and Environment at the U.S. Government Accountability Office). Corn crops require fertilizer and pesticide applications, which some experts believe will result in an increase in the number of impaired streams and water bodies. *See* M. WU ET AL., CTR. FOR TRANSP. RESEARCH, ENERGY SYS. DIV., CONSUMPTIVE WATER USE IN THE PRODUCTION OF ETHANOL AND PETROLEUM GASOLINE 62 (2009).

155 *See* WU ET AL., *supra* note 154, at 25, 26; Kevin B. Hicks, *New Milling Methods Improve Corn Ethanol Production*, 52 AGRIC. RES. at 16, 16 (2004). In wet milling, the corn is soaked in water or dilute acid to separate the grain into its component parts before converting the starch to sugars that are then fermented to ethanol. In dry milling, the kernels are ground into a fine powder and processed without fractionating the grain into its component parts. *Id.*

facility, the most common ethanol refining process,[156] uses approximately four gallons of water per gallon of ethanol produced.[157]

In keeping with the national energy policy calling for increased use of and production of renewable resources, ethanol production rose to 9 billion gallons in January 2008, a 130% increase from January 2005.[158] Using 2008 ethanol production statistics to quantify the potential impact of ethanol production on water resources, water used to grow corn to produce ethanol ranged from 63 billion to 2.8 trillion gallons of water, while water used in the refinement process added another 36 billion gallons to ethanol's water price tag.[159]

B. The Reciprocal Side: Water Supply Is Energy Dependent

Additional evidence of the interdependency between water and energy can be found on the flip side of the energy–water nexus. Not only is energy production water dependent, but also water production is energy dependent.[160] Meeting "the Nation's water needs requires energy for supply, purification, distribution, and treatment."[161] According to a recent report to Congress on the interdependency of energy and water, approximately 4% of United States power generation nationwide is used to supply and treat water.[162] In fact, electricity represents an estimated 75% of the costs associated with municipal water processing and distribution.[163]

Of all energy-dependent activities associated with municipal water supply, pumping is by far the most energy-intensive.[164] The amount of energy required for pumping water depends on the accessibility of the water in terms of depth and in terms of location of the water source in relation to the consumer. For example, pumping water from a depth of 120 feet consumes approximately 540 kWh per million gallons of water.[165] By comparison, as much as 2,000 kWh per million gallons is consumed when pumping water from a depth of 400 feet.[166]

156 Hicks, *supra* note 155, at 16.

157 *Hearings*, *supra* note 27, at 5.

158 *See* Renewable Fuels Ass'n, Statistics, http://www.ethanolrfa.org/pages/statistics#C (last visited Apr. 4, 2011) (calculating the percent increase by subtracting the 2005 amount of 3,904 million gallons produced from the 2008 amount of 9,000 million gallons produced, which equals a difference of 5,096 million gallons, and then dividing that result by the 2005 amount, which equals a percent increase of 130.7%).

159 Seven to 321 gallons of water per gallon of refined ethanol multiplied by nine billion gallons of produced ethanol equals 63 billion to 2.8 trillion gallons of water. Four gallons of water per gallon of refined ethanol multiplied by nine billion gallons of refined ethanol equals 36 billion gallons of water that is required.

160 Robin Kundis Craig, *Water Supply, Desalination, Climate Change, and Energy Policy*, 22 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 225, 247 (2010).

161 U.S. DEP'T OF ENERGY, *supra* note 15, at 25.

162 *Id.*

163 *Id.*

164 Sovacool & Sovacool, *supra* note 65, at 365.

165 *Id.*

166 *Id.*

The State of California provides us with a clear case study in the vital role that energy plays in the distribution of domestic water supply. According to the California Energy Commission 2005 estimates, in 2001 the water sector in California was the biggest electricity consumer in the state,[167] responsible for 19% of the state's electricity use and 32% of the state's natural gas use.[168] Electricity consumption of this magnitude results in large part from the distance between the location of the municipal water resource, in northern California, and much of California's domestic water consumer base, located in southern California.[169] Providing domestic water supply to this consumer base requires California to convey water some 600 miles, a journey that traverses the Tehachapi Mountain range,[170] a costly proposition in terms of energy consumption.

Energy is expected to play an even bigger role in meeting our nation's water needs as our freshwater resources become increasingly depleted. Additional energy will be required to pump water greater distances, draw water from greater depths, and access alternative sources of municipal supply.[171] These alternative sources of supply oftentimes involve processes that in and of themselves are alarmingly energy intensive.[172] For example, delivering one million gallons of clean water from a lake or river requires approximately 1,400 kWh of energy.[173] Delivering this same amount of water from groundwater and wastewater requires 1,800 kWh and upwards of 2,350 kWh, respectively.[174] Delivering the same amount of water from seawater, on the other hand, demands as much as 16,500 kWh,[175] an extremely energy-intensive process by comparison.

Despite being labeled more energy intensive than any other source,[176] the United States government is increasingly focusing on desalination as a means by which to address growing concerns over water scarcity.[177]

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167 *See* GARY KLEIN ET AL., CAL. ENERGY COMM'N, CALIFORNIA'S WATER–ENERGY RELATIONSHIP 8 (2005).

168 Craig, *supra* note 160, at 229.

169 U.S. DEP'T OF ENERGY, *supra* note 15, at 26.

170 *See* Sovacool & Sovacool, *supra* note 65, at 365. In 2005, the California Energy Commission estimated energy requirements for the water supply and conveyance, treatment, and distribution as ranging as high as 18,700 kWh/million gallons. *See* U.S. DEP'T OF ENERGY, *supra* note 15, at 25.

171 U.S. DEP'T OF ENERGY, *supra* note 15, at 27.

172 *See* Webber, *supra* note 13, at 37 (explaining that "shipping in water over long distances . . . require[s] large amounts of energy").

173 *Id.* at 39.

174 *Id.*

175 *Id.*

176 Craig, *supra* note 160, at 248.

177 *See id.* at 228 (explaining that many countries are resorting to desalination as a solution). The Australian Government has dedicated more than AU$7.5 billion to desalination plants according to an October 2008 report of the Austria National Water Commission. *Id.* at 234. More than 2,000 desalination plants, with a total installed capacity of 1,600 million gallons per day, had been installed or contracted in the United States by January 2005. *Id.* at 245 (quoting HEATHER COOLEY ET AL., PAC. INST. FOR STUDIES IN DEV., ENV'T & SEC., DESALINATION, WITH A GRAIN OF SALT: A CALIFORNIA PERSPECTIVE 21 (Ian Hart ed., 2006), *available at* http://www.pacinst.org/reports/desalination/desalination_report.pdf); *see also* Water

Desalination, which most commonly involves the treatment of seawater through reverse osmosis, is a treatment process that consumes up to ten times more energy than traditional treatment of surface water.[178] In fact, energy has been identified as "the largest single variable cost for a desalination plant."[179]

Because of the energy–water nexus, energy production is implicated in every decision made that relates to alternative sources of water. For this reason, policymakers need to remain alert to the impact that such an increased energy requirement may have on the very water resources they are looking to supplement. Similarly, because of the energy–water nexus, water resources are implicated in every policy decision that relates to energy production.

Given the interdependency between these two vital resources, it is difficult to imagine that policymakers are not taking water resources into consideration when formulating energy policy. As discussed in Parts III and IV, however, United States' energy policy and water policy remain largely compartmentalized. Current energy policy and the resultant impacts that these policies may have on the nation's water resources, however, necessitate a shift in this compartmentalized manner of policymaking and a movement toward the integration of these inextricably linked resources in current policy. This is particularly necessary in light of existing stressors that already seek to undermine the sustainability of our water resources.

III. THE GATHERING STORM: CURRENT AND FUTURE THREATS TO THE NATION'S WATER RESOURCES

Our nation is already facing challenges in the energy and water sectors brought on by any number of factors, including drought conditions, poor planning, and unfettered patterns of resource utilization and consumption.[180] Water scarcity, in particular, is becoming an issue for many regions of the United States.[181] Even under normal climate conditions, most states predict

Desalination Act of 1966, Pub. L. No. 104-298, 110 Stat. 3622 (1996) (authorizing $30 million over a six-year period for desalination research and an additional $25 million to fund desalination demonstration projects); Craig, *supra* note 160, at 235.

178 Craig, *supra* note 160, at 247 (quoting NATIONAL RESEARCH COUNCIL, DESALINATION: A NATIONAL PERSPECTIVE 41–42 (2008)).

179 *Id.* at 249 (quoting COOLEY ET AL., *supra* note 177, at 41).

180 *See* WESTERN GOVERNOR'S ASS'N, WATER NEEDS AND STRATEGIES FOR A SUSTAINABLE FUTURE 3–4 (2006), *available at* http://www.westgov.org/wga/publicat/Water06.pdf. Almost 50% of the United States was involved in drought in 2007, and the southeast was experiencing "the worst drought in more than a century." Rice, *supra* note 19.

181 Adler, *supra* note 17, at 209. For example, according to the United States Global Change Research Program, the southeast region can expect future droughts to increase in "frequency, duration, and intensity." U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 112 (2009), *available at* http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

water shortages within the next ten years.[182] According to experts, however, we are no longer operating under "normal" climate conditions.[183] Predicted impacts from climate change along with increased demands on both the energy and the water sectors fueled by projected population growth threaten to exacerbate already stressed water resources, raising the specter of resource supply disruptions in both sectors and escalating concerns over national security.[184]

A. Potential Impacts from Projected Population Growth

"[R]ising demand for energy—fueled by both population growth and expanding uses of energy—may soon outstrip our ability to supply it with existing resources."[185] The EIA predicts the United States population to increase by approximately 70 million people by 2021,[186] with the Census Bureau projecting the population to reach as high as 420 million by 2050.[187] In the context of electricity production, the EIA projects that "259 gigawatts of new generating capacity—the equivalent of 259 large coal-fired power plants—will be needed between 2007 and 2030" to meet the needs of the growing population.[188]

At the same time, United States trends show unparalleled per capita use of water.[189] Compared to the global average water footprint of 1,243 cubic

182 U.S. GEN. ACCOUNTING OFFICE, GAO-03-514, FRESHWATER SUPPLY: STATES' VIEWS OF HOW FEDERAL AGENCIES COULD HELP THEM MEET THE CHALLENGES OF EXPECTED SHORTAGES 5 (2003), *available at* http://www.gao.gov/new.items/d03514.pdf.

183 *See* Robin Kundis Craig, *"Stationarity is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 15–16 (2010); *see also* U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 49 (explaining that the current system of evaluating water resources based on the assumption that baseline conditions will stay stationary is no longer valid in the face of climate change).

184 *See* Robin Kundis Craig, *Adapting Water Federalism to Climate Change Impacts: Energy Policy, Food Security, and the Allocation of Water Resources*, 5 ENVTL. & ENERGY L. & POL'Y J. 183, 216–18 (2010).

185 *Hearings*, *supra* note 27, at 24 (statement of Anu K. Mittal, Director, Natural Resources and Environment at the U.S. Government Accountability Office).

186 *See* U.S. DEP'T OF ENERGY, *supra* note 15, at 10.

187 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 48.

188 *Hearings*, *supra* note 27, at 24 (statement of Anu K. Mittal, Director, Natural Resources and Environment at the U.S. Government Accountability Office).

189 United States families use considerably more water than the estimated thirteen gallons per capita per day necessary for basic needs, including drinking, cooking, bathing, washing, and sanitation. John Leshy, *Notes on a Progressive National Water Policy*, 3 HARV. L. & POL'Y REV. 133, 136 (2009); *see also* Meena Palaniappan et al., *Environmental Justice and Water*, *in* THE WORLD'S WATER 2006–2007: THE BIENNIAL REPORT ON FRESHWATER RESOURCES 117, 124 (2006) (noting that the average human requires fifty liters, or about thirteen gallons, per capita, per day to sustain life). Water use in some cities in the United States reaches as high as 300 gallons per capita. U.S. Forest Serv. Pac. Sw. Region, U.S. Dep't of Agric., Water Use Facts, http://www.fs.fed.us/r5/publications/water_resources/html/water_use_facts.html (last visited Apr. 5, 2011) (highlighting that a person in some Central Valley cities in California may use more than 300 gallons of water per day). However, the average American uses 80 to 100 gallons of water per day. U.S. Geological Survey, Water Q&A: Water Use at Home, http://ga.water.usgs.gov/edu/qahome.html#HDR3 (last visited Apr. 10, 2011).

meters per year, the average United States citizen uses 2,483 cubic meters, the largest per capita water footprint of any country in the world.[190] Simultaneously, electricity use is increasing in connection with significant population shifts to the south, where air conditioning use is high,[191] and warming trends promise to make it higher.

Of equal concern is the projected population growth in areas of the United States that are already experiencing stressed water systems. Areas in the West, for example, have already been identified by the United States Bureau of Reclamation as "at risk for serious conflict over water, even in the absence of climate change."[192] Nevertheless, between the years 2000 and 2030, population is projected to increase 114.3% and 108.8% in Nevada and Arizona, respectively.[193] Similarly, even while Georgia, Alabama, and Florida battle over water for drinking, recreation, farming, hydropower, and environmental purposes,[194] interim projections indicate a 79.5% increase in Florida's population by 2030 and population growth for North Carolina and Georgia at 51.9% and 46.8%, respectively.[195]

The projected increase in population, coupled with a projected population shift to areas of the country where air conditioning use is high, is expected to increase energy demands for cooling requirements, a problem that is likely to be exacerbated by predicted climate change-related warming across the nation.[196] Corroborating this trend are climate change models, which "project continued warming in all seasons across the Southeast and an increase in the rate of warming through the end of this century."[197] Moreover, experts predict an increase in the number of "very hot days" in this region,[198] coupled with more dramatic temperature increases during those hot days.[199] Studies show that for every 1.8 degrees Farenheit increase in temperature, the demand for cooling increases 5% to 20%.[200] Because the majority of buildings are cooled using electricity, the energy industry should expect significant increases in electricity use and higher peak demands in

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190 WATERS AND WATER RIGHTS, *supra* note 22, § 4A.01(b).

191 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 53.

192 *Id.* at 47.

193 POPULATION DIV., U.S. CENSUS BUREAU, STATE INTERIM POPULATION PROJECTIONS 2005 tbl. 4 (2005), *available at* http://www.census.gov/population/www/projections/projectionsagesex.html (click on "Change in Total Population and Population 65 and Older by State: 2000 to 2030").

194 *See* sources cited *supra* note 20.

195 POPULATION DIV., *supra* note 193, tbl. 4.

196 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 48 (noting the projected increases in population expected in the United States); *id.* at 55 (discussing how population shifts to regions of high air-conditioning will likely increase energy demands for cooling and noting the impacts of these changes in terms of warming).

197 *Id.* at 111.

198 *Id.* at 111–12 (noting the expected increase in the number of hot days for the region, including an expected increase of 105 very hot days a year in North Florida, for a total of more than 165 days).

199 *See id.* at 112 (noting that for those very hot days in North Florida, the peak temperature will rise above ninety degrees Fahrenheit).

200 *Id.* at 54.

this region.[201] For purposes of impacts to water resources, these increased demands for electricity generation translate into increased demands on water resources servicing energy-generation power plants.

B. Predicted Impacts from Climate Change-Related Conditions

In addition to burgeoning population growth, climate change poses another threat to the sustainability of our nation's water resources. The existence of climate change is "unequivocal."[202] The global average temperature has risen 1.5 degrees Fahrenheit since 1900 and it is projected to rise another two degrees Fahrenheit to 11.5 degrees Fahrenheit by 2100.[203] The average temperature across the United States has risen approximately 2 degrees Fahrenheit over the last fifty years and it, too, is expected to increase.[204] Moreover, during the last thirty years, average winter temperatures in the Midwest and northern Great Plains have increased more than seven degrees Fahrenheit.[205] Giving consideration to climate change-related impacts in the context of the energy–water nexus is important for a number of reasons.

First, experts predict that climate change will significantly and directly impact the nation's water resources.[206] Because the production of energy from fossil fuels is inextricably linked to the availability of adequate water supplies, there is a high likelihood that these direct impacts to water resources will, in turn, directly impact power plant production in many regions of the United States.[207] In fact, constraints on electricity production in thermal power plants because of water shortages are already predicted for Arizona, Utah, Texas, Louisiana, Georgia, Alabama, Florida, California, Oregon, and Washington state by 2025.[208]

Second, experts link climate change primarily to "human-induced emission of heat-trapping gases" emitted from the burning of fossil fuels, including coal, oil, and gas.[209] In other words, climate change itself is intimately linked to energy production. In fact, 87% of greenhouse gas emissions come from energy production and use.[210] Because of the direct link between energy generation and the increase in temperature, policymakers are targeting the reduction of carbon dioxide emissions from the energy sector as a "primary focus" of climate change mitigation

201 *See id.* at 54–55 (emphasizing that this building cooling dynamic will lead to more general and peak energy demand).
202 *Id.* at 9.
203 *Id.*
204 *Id.* at 28.
205 *Id.* at 9.
206 *See id.* (noting current and future climate change-caused impacts related to water, including increased water temperatures, increased frequency and intensity of downpours, sea level rise, and reduced snow cover, glaciers, permafrost, and sea ice).
207 *Id.* at 56.
208 *Id.*
209 *Id.* at 9.
210 *Id.* at 53.

strategies.[211] Because of the energy–water nexus, however, these strategies, which include carbon sequestration and the shift to renewable forms of domestic energy, could pose additional threats to the sustainability of our nation's water resources.

1. Predicted Source Impacts

Scientists predict that climate change will have significant direct impacts on water resources in the United States.[212] Changes in the water cycle and overall patterns of precipitation,[213] along with increases in water temperatures and water vapor in the atmosphere, are expected to impact various regions of the United States differently.[214] Experts predict that certain regions of the United States, including much of the Midwest and Northeast, will experience an increase in frequency and intensity of heavy downpours,[215] while others, including much of the West, Southwest, and Southeast, will experience increased drought,[216] and still others will experience both.[217]

Experts also predict reduced frost days, reduced snow cover, and longer "ice-free periods" on lakes and rivers.[218] More precipitation is expected to fall as rain rather than snow, thereby decreasing mountain snowpack and related late summer stream flow from snowmelt.[219] This change in precipitation is expected to result in higher water temperatures, reduced water availability, and resultant competition among various water users, including the energy sector.[220] Higher water temperatures caused by increased air temperatures and reduced water flow also lead to increased

211 *See id.* at 11 (noting that key to these carbon dioxide mitigation strategies are measures such as the use of less carbon intensive fuels and carbon sequestration technology); *id.* at 53 (highlighting the direct link between energy production and climate warming). The two major responses that society can take in response to climate change are "mitigation" and "adaptation." Mitigation activities attempt to limit climate change by, for example, reducing heat-trapping emissions or removing some heat-trapping gases from the atmosphere. Adaptation, on the other hand, focuses on responding to new climatic or environmental conditions. *Id.* at 10–11.

212 *See* Neil Adger et al., *Summary for Policymakers*, *in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE: SUMMARY FOR POLICYMAKERS AND TECHNICAL SUMMARY 7, 14 (M.L. Parry et al. eds., 2007), *available at* http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm (click on "Summary for Policymakers") (noting expectations of decreased snowpack, increased flooding, and reduced summer flows in North America).

213 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 41.

214 *Id.* at 41–46 (providing various examples of these region-specific changes expected).

215 *Id.* at 44.

216 *Id.* at 44–45.

217 *Id.* at 44 (noting these dual effects may occur in the northeastern United States, among other areas).

218 *Id.* at 9.

219 Craig, *supra* note 184, at 209.

220 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 56.

evaporation and resultant changes in pollution levels and aquatic ecosystems.[221]

Coastal areas should expect more intense hurricanes and related wind, rain, and storm surges,[222] along with rising sea levels associated with expanding ocean water and melting glaciers, ice caps, and ice sheets.[223] Among other impacts, rising sea levels are expected to diminish the supply of fresh water resources, including shallow aquifers,[224] by "increas[ing] the salinity of both surface water and ground water through salt water intrusion."[225]

These climate change-related source impacts are already being felt by the energy sector. Experts expect these impacts to continue for some period of time despite society's attempts at mitigation.[226] For example, reduced snowpack and earlier peak runoff are changing the timing and amount of stream flows impacting hydropower production.[227] In the context of thermoelectric power generation, problems arising from climate change-related impacts include: scarcity of water resources resulting in increased competition among users;[228] increased energy demand associated with cooling requirements in southern regions;[229] and warmer temperatures that impact the availability and quality of power plant cooling water.[230]

These operational impacts were recently observed throughout much of the southeast region during its recent drought—one of the worst in recorded history[231]—which lasted approximately two years and drained municipal reservoirs, cost billions of dollars in destroyed crops, and set off water wars throughout the region.[232] Twenty-two of the twenty-four nuclear reactors located in regions suffering from the most severe levels of drought rely on submerged intake pipes to withdraw cooling water from the lakes and rivers that were suffering impacts from drought conditions.[233] Reduced water levels in lakes and rivers in the southeast came exceedingly close to dropping below minimum water levels set by the NRC, which would have led to the

221 Craig, *supra* note 184, at 209.

222 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 9.

223 U.S. Envtl. Prot. Agency, Coastal Zones and Sea Level Rise, http://www.epa.gov/climatechange/effects/coastal/#ref (last visited Apr. 3, 2011).

224 *Id.*

225 *Id.*

226 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 11.

227 *Id.* at 59 ("[E]very 1 percent decrease in precipitation results in a 2 to 3 percent drop in streamflow; every 1 percent decrease in streamflow in the Colorado River Basin results in a 3 percent drop in power generation.").

228 *Id.* at 56.

229 *See id.* at 53.

230 *See id.* at 56.

231 *See supra* notes 17–19 and accompanying text; Adler, *supra* note 17, at 209–13; *'Killer' Southeast U.S. Drought Low On Scale, Says Study*, SCIENCE DAILY, Oct. 2, 2009, http://www.sciencedaily.com/releases/2009/10/091001164104.htm (last visited Apr. 3, 2011).

232 *'Killer' Southeast U.S. Drought Low On Scale, Says Study*, *supra* note 231.

233 Mitch Weiss, *Drought Could Force Nuke-Plant Shutdowns*, USA TODAY, Jan. 25, 2008, http://www.usatoday.com/weather/drought/2008-01-24-drought-power_N.htm (last visited July 12, 2011).

mandatory shutdown of the nuclear plant.[234] For example, in January 2008, Progress Energy's Harris nuclear plant, which generates electricity for some 550,000 homes,[235] was 3.5 feet away from a mandatory shutdown because of reduced water levels in Harris Lake.[236] Similarly, Duke Energy's McGuire Nuclear Station, which provides electricity to half of its customer base in the Carolinas,[237] was less than one foot away from a mandatory shutdown.[238] Moreover, water shortages in the Catawba River Basin in 2002 required Duke Energy's hydroelectric plants to run at 40% of capacity.[239]

Drought-reduced water levels can also cause water temperatures to increase to levels that are too hot for power plants to use as a coolant or too warm to act as receiving waters for the discharge of heated process waters from power plants.[240] This increase in temperature may lead to increases in cooling water withdrawals because of an overall decrease in cooling capacity,[241] or, as in the case of the Browns Ferry Nuclear Reactor, it may result in a shutdown, as occurred in August 2007 when the water temperature in the Tennessee River exceeded ninety degrees Fahrenheit.[242]

Decreasing the capacity of cooling water efficiency can also reduce a power plant's power outputs,[243] thereby requiring increased power generation to meet power production demands. These impacts could have significant implications for national electric power supply, because even a reduction of 1% in electricity generated by power plants could result in a loss of 25 billion kWh per year—the amount consumed by two million Americans.[244]

Source impacts—i.e., predicted changes in the water cycle and patterns of precipitation, increased evaporation, drought conditions, the reduction in surface and groundwater levels, the salination of freshwater resources, and increased water temperatures and consequent changes in pollutant concentrations—are but one category of climate change-related impacts that threaten the sustainability of the nation's freshwater resources and, in turn, our attempts to achieve a more sustainable energy economy. Increased demand on these resources brought about by climate change-related conditions is another. For example, the energy sector itself is likely to

234 *Id.*

235 *See* Progress Energy, Harris Plant Information, http://progress-energy.com/aboutenergy/powerplants/nuclearplants/harris.asp (last visited Apr. 5, 2011).

236 *See* Weiss, *supra* note 233.

237 Duke Energy, McGuire Nuclear Station, http://www.duke-energy.com/power-plants/nuclear/mcguire.asp (last visited Apr. 5, 2011).

238 *See* Weiss, *supra* note 233.

239 Sovacool & Sovacool, *supra* note 65, at 360.

240 Weiss, *supra* note 233.

241 *See* GAËLLE THIVET, PLAN BLEU, STRATEGIES FOR INTEGRATED WATER AND ENERGY RESOURCES MANAGEMENT TO ADDRESS CLIMATE CHANGE 2 (2008), *available at* http://www.planbleu.org/publications/4p_eau_energieUK.pdf.

242 Weiss, *supra* note 233; Eric Fleischauer, *TVA OKs Cooling Tower Expansion*, THE TIMESDAILY, Nov. 5, 2010, http://www.timesdaily.com/article/20101105/NEWS/101109870?Title=TVA-OKs-cooling-tower-expansion (last visited June 18, 2011).

243 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 56.

244 *Id.*

increase its water use in response to increased cooling demands brought on by higher temperatures in the south.[245] The increased demand for water by the agricultural sector resulting from warmer temperatures and longer growing seasons is also expected.[246]

Increased demand on water resources by other users impacts the energy sector in two ways. First, it increases the likelihood that energy production will be constrained by limited water supplies. Second, it has the potential to increase energy demands associated with pumping water from greater depths and moving water greater distances. Moreover, it may increase energy demand associated with the production of alternative sources of water supply.[247] As discussed in Part I, these alternative sources of water supply, like desalination, can be more energy-intensive than any other existing source of supply.[248]

2. Impacts from Mitigation Measures

The role that the energy–water nexus should play in climate change policymaking decisions that target the energy sector is clearly illustrated in the potential impact that climate change-related mitigation measures could have on water resources. Because energy is at the heart of climate change,[249] and because of the significant climate change-related impacts that experts predict for our water resources,[250] it may now be more accurately described as the "climate change–energy–water nexus." "Climate affects water, water affects energy. The way we use energy affects climate . . . ,"[251] and the way we address climate change affects both.

Responses to climate change generally fall into two categories: mitigation and adaptation.[252] Mitigation focuses on prevention strategies. It is an attempt to limit climate change by addressing its underlying cause—for

245 *Id.* at 54–55.

246 Climate change related impacts are affecting the agricultural sector in a number of ways. Plants need water to maintain temperatures that are within optimal range to prevent crop failure and reduced yields. *Id.* at 72. The irrigation sector may demand increased water to "cool" plants in response to longer growing seasons, increased daytime and nighttime temperatures, and increased periods of reduced precipitation and drought. *Id.* at 72–75. Increased demand in water by the agricultural sector is also the likely outcome of the increased interest in the production of biofuels and biodiesel as a domestic renewable energy source. Abrams & Hall, *supra* note 50, at 57.

247 U.S. DEP'T OF ENERGY, *supra* note 15, at 27.

248 *See supra* notes 176–79 and accompanying text.

249 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 53.

250 Among the impacts identified in the National Water Program Strategy Response to Climate Change are increases in water pollution, more extreme water-related events, changes in the availability of drinking water supplies, water body boundary movement and displacement, changing aquatic biology, and collective impacts on coastal areas. OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, NATIONAL WATER PROGRAM STRATEGY: RESPONSE TO CLIMATE CHANGE, at ii (Sept. 2008), *available at* http://water.epa.gov/scitech/climatechange/upload/20081016_nwpsresponse_to_climate_change_revised.pdf.

251 *Hearings*, *supra* note 27, at 10 (statement of Dr. Kristina M. Johnson, Under Secretary of Energy, U.S. Department of Energy).

252 BOSSELMAN ET AL., *supra* note 36, at 724.

example, by reducing emissions of greenhouse gases. Adaptation, on the other hand, involves strategies designed to reduce the adverse effects of climate change. Because experts link climate change primarily to greenhouse gas emissions, the large percentage of which come from energy production and use,[253] mitigation strategies in the context of energy generation tend to focus on the reduction of greenhouse gas emissions from the energy production process.[254] Two mitigation strategies that could exacerbate existing water resource concerns include reducing the use of fossil fuels in the energy generation process and replacing them with fuels that emit lower levels of CO_2, including nuclear power and biofuels, and the deployment of carbon sequestration technologies.

At present, renewable resources other than hydropower account for less than 4% of the nation's electricity production.[255] Under the current Administration, this number is slated to increase significantly. The increase in domestic renewable energy sources appears to serve two distinct purposes: (1) to reduce greenhouse gas emissions as a mitigation strategy for climate change; and (2) to increase energy security by decreasing the nation's reliance on foreign oil.[256]

Because of the Administration's policies concerning energy independence, this shift to "renewable" forms of energy has gained momentum. The focus in the short term appears to be on increased use of nuclear power and biofuels. President Obama recently committed to expanding the nation's use of nuclear energy "[t]o meet our growing energy needs and prevent the worst consequences of climate change."[257] On February 16, 2010, President Obama announced $8.3 billion in federal loan guarantees to finance nuclear power plant construction, a move he declared "is only the beginning."[258]

Moreover, the American Recovery and Reinvestment Act of 2009 (ARRA)[259] provides a number of incentives for renewable energy development and deployment, and President Obama's 2010 budget called for doubling the country's renewable energy capacity in three years.[260] Furthermore, under the Energy Independence and Security Act of 2007

253 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 181, at 9.

254 *Id.* at 11.

255 BOSSELMAN ET AL., *supra* note 36, at 834.

256 In 2009, the United States consumed approximately 6.9 billion barrels of oil, 51% of which were imported from foreign countries. U.S. Energy Info. Admin., *supra* note 3.

257 Daniel Stone, *Flirting With Disaster*, NEWSWEEK, Jan. 10 & 17, 2011, at 38.

258 *Obama Moves to Back Nuclear Power*, CBC NEWS, Feb. 16, 2010, http://www.cbc.ca/world/story/2010/02/16/obama-nuclear-loan.html#ixzz0kpDJUOsF (last visited June 18, 2011).

259 Pub. L. 111-5, 123 Stat. 115 (codified as amended in scattered sections); U.S. Gov't Printing Office, Public Law 111-5 – American Recovery and Reinvestment Act of 2009, http://www.gpo.gov/fdsys/pkg/PLAW-111publ5/content-detail.html (showing details of the location of its codification).

260 BOSSELMAN ET AL., *supra* note 36, at 834. Biodiesel, a "diesel fuel derived from fermenting waste vegetable oils or animal fats for use in vehicles," is also experiencing a growth in production. Several federal programs, including tax credits, promote biodiesel production. *Id.* at 853.

(EISA),[261] Congress mandated a renewable fuels standard that requires "36 billion gallons of renewable fuel to be blended into the nation's fuel supply by 2022, with an allowance for fifteen billion gallons of corn-based ethanol by 2015."[262] Recent statistics by the Renewable Fuels Association revealed a 130% increase in ethanol production from January 2005 to January 2008,[263] indicating that this shift to renewable energy fuels is already underway.

Policymakers must be aware that choices about emission reductions not only will have consequences for climate change-related impacts, but also may have far-reaching effects on the sustainability of our nation's water resources. As in the case of nuclear power, for example, these more "carbon-friendly" forms of energy production pose significant trade-offs for water resources.[264] As previously discussed, nuclear power plants require an average of forty-three gallons of water for every kWh generated,[265] can withdraw more than 2 billion gallons of water a day from water sources, and some are responsible for consuming approximately 33 million gallons a day.[266] Even when not producing electricity, nuclear power plants can require up to 52,000 gallons of water per minute in cooling water.[267]

Similarly, studies paint biomass life-cycle production as a highly water-intensive activity that could seriously exacerbate water supply problems in regions of the United States where water is already scarce. Although water demands in biomass production vary greatly based on agricultural production systems and climate conditions,[268] recent studies by Argonne National Laboratory indicate that the water demand in ethanol production is "substantially in excess" of the water required in gasoline production.[269] One 2008 study concluded that the life-cycle water footprint for biofuel[270] ranges

261 Energy Independence and Security Act of 2007, 42 U.S.C. §§ 17001–17386 (Supp. III 2006).

262 Abrams & Hall, *supra* note 50, at 58; Energy Independence and Security Act of 2007, Pub. L. No. 110-140, §§ 201–202, 121 Stat. 1492, 1519–22 (2007) (defining "advanced biofuel" as "renewable fuel, other than ethanol derived from corn starch" and "renewable fuel" as "fuel that is produced from renewable biomass" and subsequently requiring the use of 20.5 billions of gallons of renewable fuel by 2015, and requiring 5.5 billion of these gallons to come from advanced biofuel).

263 Renewable Fuels Ass'n, *supra* note 158 (calculating the percent increase by subtracting the 2005 amount, 3,904 million gallons produced, from the 2008 amount of 9,000 million gallons produced, which equals a difference of 5,096 million gallons, and then dividing that result by the 2005 amount, which equals a percent increase of 130.7%).

264 Leshy, *supra* note 189, at 153.

265 Sovacool & Sovacool, *supra* note 65, at 340. Note that the industry average is twenty-five gallons of water per kWh generated. *Id.*

266 *See id.* at 341–42 (noting water withdrawal and consumption totals at several nuclear power plants in the United States).

267 *Id.* at 356 (noting the water requirements of the Hope Creek nuclear power plant in New Jersey).

268 Winnie Gerbens-Leenes et al., *The Water Footprint of Bioenergy*, PROCEEDINGS NAT'L ACAD. SCI. U.S.A. 10219, 10220 (2009), *available at* www.pnas.org/cgi/doi/10.1073/pnas.0812619106.

269 BOSSELMAN ET AL., *supra* note 36, at 1101.

270 Note that biofuel contains both bioethanol and biodiesel. *See* Gerbens-Leenes et al., *supra* note 268, at 10219–20.

from 1,388 to 19,924 liters of water per liter of biofuel.[271] Another study found that ethanol production requires 1,700 gallons of water per gallon of ethanol produced.[272] Still another analysis concluded that biofuels "can consume 20 or more times as much water for every mile traveled than the production of gasoline."[273] These numbers clearly illustrate how energy policy must account for life-cycle water costs.[274]

Other attempts to reduce greenhouse gas emissions as mitigation for climate change may also have significant impacts on the nation's water resources. Carbon capture and storage (CCS), for example, could increase water demand at traditional power plants by between 20% and 33%.[275] In the CCS process, carbon dioxide is captured from flue gas, compressed to convert it from a gaseous state to a "supercritical fluid," and transported to a sequestration site, usually by pipeline, where it is injected into deep subsurface rock formations through one or more wells to a depth where the pressure and temperature are sufficient to keep the CO_2 in a "supercritical state."[276] Additional water is required in the process because of the additional energy required in CO_2 capture, transportation, and injection.[277] Moreover, the large majority of commercial approaches to CO_2 capture currently result in a significant energy penalty which, at a coal-fired power plant, can approach 30% because of parasitic steam loads.[278] Finally, tougher air pollution laws have led to the installation of scrubbers at many coal-generated power plants. Using scrubbers to reduce air emissions has created "vast new sources" of wastewater that contain chemicals from the scrubbing process.[279]

Our nation's water resources are already exhibiting strain from a wide range of factors, including historic drought levels and unfettered use and consumption. Experts predict anticipated climate change-related impacts to compound these challenges which will only be further exacerbated by increased demand associated with significant population growth. This is the "water resource framework" under which policymakers currently operate. Despite the already strained state of much of the nation's water resources, however, and despite the absence of comprehensive energy and climate

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271 *Id.* at 10222. According to the study, the water footprint for bioethanol appears to be smaller than biodiesel. *Id.*

272 David Pimental & Tad Patzek, *Green Plants, Fossil Fuels, and Now Biofuels*, 56 BIOSCIENCE 875, 875 (2006).

273 Webber, *supra* note 13, at 37–39.

274 Leshy, *supra* note 189, at 154.

275 Abrams & Hall, *supra* note 50, at 61.

276 *Id.* at 60–61 (quoting OFFICE OF WATER, ENVIRONMENTAL PROTECTION AGENCY, EPA PROPOSES NEW REQUIREMENTS FOR GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE 1 (2008), *available at* http://www.epa.gov/safewater/uic/pdfs/fs_uic_co2_proposedrule.pdf).

277 *Id.* at 61.

278 MELANIE D. JENSEN ET AL., CARBON SEPARATION AND CAPTURE, PLAINS CO_2 REDUCTION (PCOR) PARTNERSHIP 2 (2005), *available at* http://www.netl.doe.gov/technologies/carbon_seq/partnerships/phase1/pdfs/CarbonSeparationCapture.pdf.

279 Charles Duhigg, *Cleansing the Air at the Expense of Waterways*, N.Y. TIMES, Oct. 13, 2009, at A22.

change legislation,[280] aggressive policy initiatives that promote renewable energy production and deployment and establish renewable fuel standards[281] are causing a shift in the nation's energy portfolio towards increased use of water-intensive renewable energy resources. This apparent disconnect may be due in large part to the highly compartmentalized handling of energy- and water-related issues. Historically, decisions concerning energy production have been made without consideration of water resource maintenance.[282] A cursory review of our current regulatory regimes indicates that with the limited exception of power generating facilities that fall under the jurisdiction of FERC or the NRC—and even within those regulatory regimes—compartmentalization of energy- and water-related issues remains the general rule.

IV. COMPARTMENTALIZATION OF ENERGY POLICY AND WATER POLICY UNDER CURRENT REGULATORY REGIMES

A. Energy-Based Regulation that Integrates Water-Related Issues

United States' energy regulation consists of a "patchwork quilt of federal, state, and local agencies, many of which have jurisdiction over a discrete segment of the energy industry and none of which regulates an entire industry."[283] On the federal level, the FERC and the NRC regulate the siting and operation of distinct modes of electric power generation—hydropower and nuclear power—which together, in 2009, produced only 27% of the nation's electricity (6.8% and 20.2%, respectively).[284]

In each instance, to varying degrees, consideration is given to water resource utilization. Aside from this limited federal regulatory coverage, however, regulations governing the remaining 73% of power generation plant siting and operation, and the manner in which these power plants utilize and impact water resources, are often left entirely to state and local regulatory authorities.[285] These regulatory gaps, while consistent with the federal government's historic deference to state regulation of water resources, may require reconsideration in light of the heightened concerns surrounding water resource scarcity, concerns which are only magnified by expert predictions concerning climate change-related impacts.

280 Carl Hulse & David M. Herszenhorn, *Democrats Call Off Effort for Climate Bill in Senate*, N. Y. TIMES, July 23, 2010, at A15.

281 *See supra* notes 257–62 and accompanying text; RANDY SCHNEPF & BRENT D. YACOBUCCI, CONG. RESEARCH SERV., R40155, RENEWABLE FUEL STANDARD (RFS): OVERVIEW AND ISSUES 3 (2010).

282 Webber, *supra* note 13, at 34–35.

283 James H. McGrew, *FERC's Green Agenda*, TRENDS: ABA SECTION OF ENVIRONMENT, ENERGY AND RESOURCES, Mar.–Apr. 2010, at 1.

284 U.S. Energy Info. Admin., Electric Power Industry 2009: Year in Review, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html (last visited July 2, 2011); Federal Energy Regulatory Comm'n, Hydropower, http://www.ferc.gov/industries/hydropower.asp (last visited Jul. 2, 2011); U.S. Nuclear Regulatory Comm'n, New Reactors: What We Regulate, http://www.nrc.gov/reactors/new-reactors.html (last visited July 2, 2011).

285 BOSSELMAN ET AL., *supra* note 36, at 13.

1. FERC Hydropower Licensing

The hydropower licensing process represents one of the few instances in which a federal regulating authority is called on to specifically consider the impact that demands generated by electrical power generation will have on water resources and to incorporate those impacts into its decision-making process.[286] FERC, originally known as the Federal Power Commission, was created under the Federal Water Power Act of 1920, which was later incorporated into the Federal Power Act (FPA),[287] to oversee the construction of hydroelectric dams on interstate rivers.[288] Under the FPA, FERC is charged with licensing and regulating non-federal (i.e., private, municipal, and state) hydroelectric projects that affect navigable waters, occupy United States public lands, use water or water power at a government dam, or affect the interests of interstate commerce.[289]

In its capacity as a licensing authority, FERC has developed three distinct licensing processes referred to as the "integrated," "traditional," and "alternative" licensing processes, all of which have varying degrees of FERC staff involvement at different stages of the licensing process.[290] Today,

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286 18 C.F.R. § 5.6 (2010) (describing the required contents of the pre-application document, which includes environmental considerations such as existing uses of water, wetland habitat, and other fish and aquatic resources); FED. ENERGY REGULATORY COMM'N, HANDBOOK FOR HYDROELECTRIC PROJECT LICENSING AND 5 MW EXEMPTIONS FROM LICENSING 2-3 to 2-5 (2004), *available at* http://www.ferc.gov/industries/hydropower/geninfo/handbooks/licensing_handbook.pdf (detailing the process and requirements for applying for a license). Under the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. §§ 4321–4347 (2006), a federal agency would also be called on to consider environmental impacts before undertaking or approving "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C) (2006). In the case of NEPA, however, such consideration is to inform the decision-making process. The agency need only consider the impacts and alternative actions. It is not required to avoid the impacts. J.B. RUHL ET AL., *supra* note 1, at 436. *See also* Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 350–51 (1989).

287 Federal Power Act, 16 U.S.C. §§ 791–828c (2006).

288 When Congress passed the Federal Power Act, the Commission's name was changed to the Federal Energy Regulatory Commission, or FERC. BOSSELMAN ET AL., *supra* note 36, at 575 n.1.

289 FERC licensing is required for any project that is: (1) located on a navigable water of the United States; (2) occupies land of the United States; (3) utilizes surplus water or water power from a government dam; or (4) is located on a body of water over which Congress has Commerce Clause jurisdiction and the project affects interstate commerce. 16 U.S.C. § 817(1) (2006). FERC also has jurisdiction over segments of the electricity and oil and gas industries, which include "some (but not all) aspects of the sale for resale and the transmission of electric energy in interstate commerce; the transportation of natural gas in interstate commerce; and the rates, terms and conditions of the interstate transportation of oil by pipeline." McGrew, *supra* note 283, at 1; 16 U.S.C. § 824(a)–(d) (2006) (defining FERC jurisdiction of sale and transmission of electric energy); 15 U.S.C. § 3371(a)(1) (2006) (authorizing FERC oversight of interstate natural gas transportation); 49 U.S.C. § 60502 (2006) (granting FERC authority to establish rates for transport of oil by pipeline); Fed. Energy Regulatory Comm'n, What FERC Does, http://www.ferc.gov/about/ferc-does.asp (last visited Apr. 4, 2011).

290 For example, under the traditional licensing process, there is little FERC involvement during the project scoping process that occurs during the pre-application stage. In the alternative licensing process, FERC involvement at this stage is limited to an advisory role. By comparison, in the integrated licensing process, FERC staff involvement "begins during the pre-

pursuant to a rule issued in July 2003, the integrated licensing process is the default process for both the licensing and relicensing of hydroelectric projects.[291] FERC incorporates water-related concerns and impacts into its decision-making throughout the licensing process. This integration of energy and water-related issues can first be seen in the "pre-application process," which lays the groundwork for environmental studies through data gathering and interagency consultation. The integration of energy- and water-related issues can also be seen in FERC's licensing decision-making process, as discussed below.

a. The Pre-Application Process

The FERC pre-application process requires applicants to consider, in some depth, environmental issues associated with a project, prior to filing license applications.[292] Because hydroelectric generation uses water flow through hydroelectric turbines to generate electricity, such environmental review would certainly implicate water resources. As part of the "pre-application process," a potential applicant is required to file a notice of intent to file a license application and a pre-application document (PAD).[293] As a practical matter, "[t]he PAD serves as the foundation for issue identification, study plan development, and [FERC's] environmental analysis" under NEPA,[294] all of which take water resource conditions into consideration.

Among other things, the PAD must include a description of the project location, facilities, and operations, including detailed maps showing lands and waters located within the project boundary. It must also include a description of existing environment and resource impacts on the following resources: geology and soils; fish and aquatic resources; wildlife and botanical resources; wetlands, riparian, and littoral habitat; rare, threatened, and endangered species; recreation and land use; aesthetic resources; and the river basin, among others.[295] Specifically, with respect to water resources, the PAD must describe the proposed project's water resources and water resources in the surrounding area, and must address the quantity and quality of those water resources affected by the project through the discussion of several items, including:

1. Drainage area;

filing consultation process and is sustained throughout the licensing process." FED. ENERGY REGULATORY COMM'N, *supra* note 286, at 1-2.

291 *See* Hydroelectric Licensing Under the Federal Power Act, 68 Fed. Reg. 51,070, 51,070 (Aug. 25, 2003) (to be codified at 18 C.F.R. pts. 2, 4, 5, 9, 16, 375, and 385).

292 BOSSELMAN ET AL., *supra* note 36, at 145.

293 National Environmental Policy Act of 1969, 18 C.F.R. § 5.1(d)(1) (2010).

294 FED. ENERGY REGULATORY COMM'N, *supra* note 286, at 2-4; *see* 18 C.F.R. § 5.6(d) (2010) (describing the content requirements for the PAD).

295 FED. ENERGY REGULATORY COMM'N, *supra* note 286, at 2-5; 18 C.F.R. § 5.6(d) (2010) (listing the required resource impact descriptions in a PAD).

2. The monthly minimum, mean, and maximum recorded flows in cubic feet per second of the stream or other body of water at the power plant intake or point of diversion . . . ;
3. A monthly flow duration curve . . . ;
4. Existing and proposed uses of project waters for irrigation, domestic water supply, industrial and other purposes, including any upstream or downstream requirements or constraints to accommodate those purposes;
5. Existing instream flow uses of streams in the project area that would be affected by project construction and operation . . . ;
6. Any federally-approved water quality standards applicable to project waters;
7. Seasonal variation of existing water quality data for any stream, lake, or reservoir that would be affected by the proposed project . . . ;
8. The following data with respect to any existing or proposed lake or reservoir associated with the proposed project; surface area, volume, maximum depth, mean depth, flushing rate, shoreline length, substrate composition; and
9. Gradient for downstream reaches directly affected by the proposed project.[296]

Notice and circulation of the PAD starts "a process of give and take between the applicant, the FERC staff, and the commenting agencies."[297] As part of the pre-application process, the applicant is required to consult with "relevant Federal, state, and interstate resource agencies, including as appropriate the National Marine Fisheries Service, the United States Fish and Wildlife Service, . . . the United States Environmental Protection Agency, the Federal agency administering any United States lands utilized or occupied by the project, the appropriate state fish and wildlife agencies, the appropriate state water resource management agencies, [and] the certifying agency or Indian tribe under Section 401(a)(1) of the [CWA]."[298] The applicant must integrate the responses of agencies expressing concerns into project proposals.[299] Agency comments are used by FERC to initiate the review process under NEPA and by the applicant to construct a "study plan" by which it will provide more detailed environmental impact information, all of which will ultimately result in a "preliminary licensing proposal" that, if satisfactory, will conclude in the submission of the license application.[300]

b. Factors Considered by FERC in Its Licensing Decisions

Once FERC receives the application for a license or relicense, it evaluates the project within the NEPA framework and according to a set of

296 18 C.F.R. § 5.6(d)(3)(iii)(A)–(I) (2010).
297 BOSSELMAN ET AL., *supra* note 36, at 147.
298 18 C.F.R. § 5.1(d)(1) (2010).
299 BOSSELMAN ET AL., *supra* note 36, at 145.
300 *Id.* at 147; *see* 18 C.F.R. § 5.11 (2010) (discussing what a "Potential Applicant's proposed study plan" must include).

nine factors to determine whether the license is "best adapted to serve the public interest."[301] This "public interest" analysis is another example of the way in which FERC considers water resources in its hydropower licensing process. In addition to nine public interest factors, FERC must determine the terms of the license with consideration given to the extent to which the proposed project is consistent with federal or state comprehensive plans for improving, developing or conserving waterways impacted by the project.[302] Specifically, under FPA Section 10(a):

> [T]he project adopted . . . shall be . . . [the] best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of water-power development, for the adequate protection, mitigation, and enhancement of fish and wildlife . . . and for other beneficial public uses, including irrigation, flood control, water supply, and recreation[] . . . .[303]

In order to ensure that the project "will be best adapted to the comprehensive plan"[304] FERC is required to consider, among other things, the extent to which the project is consistent with a filed comprehensive plan as well as any recommendations by agencies exercising authority over fish and wildlife, flood control, navigation, irrigation, recreation, cultural, and other relevant resources of the State in which the project is located.[305]

301 18 C.F.R. § 16.13 (2010).

302 Federal Power Act, 16 U.S.C. § 803(2)(A) (2006). The nine factors include: the plans and ability of the applicant to comply with the term and conditions of a license; the plans of the applicant to manage and operate and maintain the project safely; the plans and abilities of the applicant to operate and maintain the project in a manner most likely to provide efficient and reliable electric service; the need of the applicant for the electricity generated by the project or projects to serve its customers; the existing and planned transmission services of the applicant; whether the plans of the applicant will be achieved, to the greatest extent possible, in a cost effective manner; and such other factors as the Commission may deem relevant. 16 U.S.C. § 808(a)(2)(A)–(G) (2006). In the case of relicensing, FERC will also consider the licensee's record of compliance with the terms and conditions of the existing license and the actions taken by the licensee related to the project that affect the public. *Id.* § 808(a)(3)(A)–(B).

303 16 U.S.C. § 803(a)(1) (2006).

304 A comprehensive plan consists of a comprehensive study of one or more of the beneficial uses of a waterway or waterways which is filed with FERC and which describes significant resources of the waterways (including navigation, power development, energy conservation, fish and wildlife, recreation, irrigation, flood control, and water supply); various existing and planned uses for those resources; as well as a discussion of goals, objectives, and recommendations for improving developing or conserving the waterways. *See* Fed. Energy Regulatory Comm'n, Hydropower General Information: Comprehensive Plans, http://www.ferc.gov/industries/hydropower/gen-info/comp-plans.asp (last visited June 18, 2011).

305 16 U.S.C. § 803(a)(2) (2006). In the case of a state or municipal applicant, or an applicant which is primarily engaged in the generation or sale of electric power (other than electric power solely from cogeneration facilities or small power production facilities), FERC shall also consider "the electricity consumption efficiency improvement program of the applicant, including its plans, performance and capabilities for encouraging or assisting its customers to conserve electricity cost-effectively, taking into account the published policies, restrictions, and requirements of relevant State regulatory authorities applicable to such applicant." *Id.* § 803(a)(2)(C).

At a minimum, the FPA Section 10(a) review appears to integrate energy- and water-related issues in each of FERC's licensing decisions. One of the most obvious limitations associated with FERC's hydropower licensing process, however, is the limited scope of its jurisdiction. As previously mentioned, FERC's licensing process only applies to a small percentage of electricity generating power plants. Moreover, there are no doubt challenges associated with reaching a consensus of many agencies with divergent interests concerning the parameters of a specific project. To further underscore the shortcomings that may be associated with FERC's regulations, this last challenge is overcome in FERC's licensing scheme, perhaps by necessity, by leaving the "best interest"[306] determination solely in the hands of FERC,[307] a party whose mission it is to "assist customers in obtaining reliable, efficient and sustainable energy services."[308]

Nevertheless, FPA Section 10(a) could serve as a framework for the analysis to further integrate energy and water-related concerns and to advance the goal of achieving sustainability of our water resources. Contemplating, at the outset of the licensing or relicensing of an energy project, a plan to adapt an energy project to an overall comprehensive plan for water resources would certainly advance national efforts to achieve sustainability of our water resources. Among other things, contemplating such a plan benefits commerce, utilizes energy production, protects, mitigates, and enhances ecosystems, and provides for other beneficial public uses like irrigation, flood control, water supply, and recreation and would further promote efforts to create a more sustainable energy economy in support of our nation's current energy and national security goals.

2. NRC Nuclear Power Plant Licensing

Licensing of nuclear power plants under the Atomic Energy Act of 1954 (AEA)[309] represents the second instance in which a federal energy-based regulatory regime contemplates the integration of energy and water-related issues. Similar to the limitations seen under the FERC licensing regime, licensing by the NRC is limited to nuclear power plants, only one segment—albeit a growing segment—of power generating facilities. Although the NRC review process appears, on its face, to be comprehensive in its integration of energy- and water-related issues, a significant limitation exists in that, with the exception of a NEPA review, the integration of energy- and water-related issues occurs only in connection with safety-related issues. Although, in the case of a nuclear reactor, safety is of vital importance, it far from covers the

306 *See id.* § 797(a) (authorizing FERC to investigate whether a proposed project "can be advantageously used by the United States for its public purposes"); *id.* § 797(e) (directing FERC to determine whether a proposed project is "in the judgment of the Commission, desirable and justified in the public interest"); *see also* 18 C.F.R. § 16.13 (2010).

307 BOSSELMAN ET AL., *supra* note 36, at 130–31.

308 FED. ENERGY REGULATORY COMM'N, THE STRATEGIC PLAN: FY 2009–2014, at 2 (2009), *available at* http://www.ferc.gov/about/strat-docs/FY-09-14-strat-plan-print.pdf.

309 Atomic Energy Act of 1954, 42 U.S.C. §§ 2011–2297 (2006).

scope of water- and energy-related issues that require integration in the pursuit of sustainability of the nation's water resources.

As a general overview, constructing a nuclear facility requires compliance with NEPA and the AEA's licensing provisions.[310] Most, if not all, presently operating nuclear power plants are licensed under Part 50 of the Code of Federal Regulations,[311] a licensing process that involves two distinct chronological steps: 1) obtaining a construction permit; and 2) obtaining a license to operate.[312] In 1989, in an attempt to standardize the licensing process and avoid the duplicative efforts that plagued the Part 50 process, the NRC[313] adopted a new reactor licensing process—the Part 52 process.[314]

Part 52 divides the licensing process into three separate standardized licenses: the Early Site Permit (ESP); the Design Certification (DC); and the Combined Operating License (COL).[315] The ESP process is a site permitting process that allows a permit applicant to resolve issues relating to a chosen site—in particular, issues relating to site safety, environmental concerns, and emergency preparedness—before having to commit to a particular nuclear reactor design.[316] Once issued, the siting permit allows the permit holder to "bank" the approved site for a period of up to forty years before commencing construction of the proposed nuclear facility.[317]

The DC process was designed "to streamline new reactor licensing without sacrificing security and safety."[318] Under Part 52, applicants may seek "certification" of a standard nuclear reactor design, which may, in turn, be purchased by a company for construction on an approved nuclear reactor site—for example, a site with an ESP.[319] Because the facility design would have already undergone the design scrutiny associated with the DC process, the applicant seeking to construct the nuclear facility would not be required to undergo facility design review again.[320]

Finally, the COL process combines construction and operating licensing into a one-step process. The procedures for obtaining approvals are similar to the processes involved in Part 50, the primary difference being that an applicant who previously availed himself of the ESP and DC processes

310 *See id.* § 2131 (requiring "any person within the United States to transfer or receive in interstate commerce, manufacture, produce, transfer, acquire, possess, use, import, or export any [atomic energy] utilization or production facility" to obtain a license from the NRC).

311 10 C.F.R. § 50 (2010).

312 BOSSELMAN ET AL., *supra* note 36, at 1018.

313 The NRC administers the AEA and was established by the Energy Reorganization Act of 1974. 42 U.S.C. §§ 5801–5891 (2006).

314 *See* 10 C.F.R. § 52 (2010); BOSSELMAN ET AL., *supra* note 36, at 1018. Note that an applicant may still proceed with licensing under Part 50's traditional two-step process. *Id.* at 1019.

315 *See* 10 C.F.R. § 52 (2010).

316 U.S. NUCLEAR REGULATORY COMM'N, FREQUENTLY ASKED QUESTIONS ABOUT LICENSE APPLICATIONS FOR NEW NUCLEAR POWER REACTORS 14 (2009), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0468/br0468.pdf.

317 The ESP is "valid for not less than 10, nor more than 20 years." 10 C.F.R. § 52.26(a) (2010). It may be renewed for up to twenty additional years. *Id.* § 52.33.

318 BOSSELMAN ET AL., *supra* note 36, at 1023.

319 *Id.*

320 *Id.*

would only need refer to them in the COL application, and as such, would not be made to revisit issues (such as environmental issues related to site approval) already "addressed" in the previous processes.[321]

The NRC permitting process integrates energy and water-related issues through several different mechanisms. In the case of an ESP application, for example, the NRC staff evaluates issues related to site safety, emergency planning, and environmental protection. The NRC documents findings related to site safety and emergency planning in a safety evaluation report and documents findings relating to environmental protection issues in an environmental impact statement (EIS).[322] Issues existing at the energy–water interface are addressed in both the environmental report and safety report, as discussed below.

a. The Environmental Report

The environmental report section of the ESP application serves as the starting point for the NRC's EIS.[323] Among other things, the applicant's environmental report is required to contain:

> a description of the proposed action, a statement of its purposes, a description of the environment affected, . . . [a discussion of t]he impact of the proposed action on the environment[,] . . . [a]ny adverse environmental effects which cannot be avoided should the proposal be implemented[,] [a]lternatives to the proposed action[,] . . . [t]he relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity[,] and [a]ny irreversible and irretrievable commitments of resources which would be involved."[324]

The report also requires an analysis that "considers and balances the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects."[325]

A guidance document intended to assist NRC staffers responsible for nuclear power plant environmental reviews provides guidance to applicants concerning the degree to which the applicant's environmental review and

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321 *Id.* at 1026.

322 U.S. NUCLEAR REGULATORY COMM'N, *supra* note 316, at 12. 10 C.F.R. § 52.18 requires the NRC to prepare an EIS in accordance with applicable provisions of 10 C.F.R. pt. 51 in connection with review of the ESP application. *See* 10 C.F.R. § 52.18 (2010).

323 U.S. NUCLEAR REGULATORY COMM'N, *supra* note 316, at 30; 10 C.F.R. § 50.30(f) (2010) ("An application for a[n] . . . early site permit . . . for a nuclear power reactor . . . whose construction or operation may be determined by the Commission to have a significant impact on the environment, shall be accompanied by an Environmental Report . . . ."); *see also* 10 C.F.R. § 51.41 (2010).

324 10 C.F.R. § 51.45(b) (2010).

325 *Id.* § 51.45(c).

the NRC's EIS should examine water-related issues.[326] Environmental Review Plan (ERP) Section 2.3, for example, is devoted entirely to hydrological and water quality issues. Among the many subsections of ERP Section 2.3, is the Environmental Standard Review Plan (ESRP) 2.3.1, titled "Hydrology," which "directs the staff's description of the surface-water bodies and groundwater aquifers that could affect the plant-water supply and effluent disposal or that could be affected by plant construction or operation of the proposed project."[327] ESRP 2.3.1 further provides that:

> The scope of review directed by this plan includes consideration of site-specific and regional data on the physical and hydrological characteristics of ground and surface water in sufficient detail to provide the basic data for other reviews addressing the evaluation impacts on water bodies, aquifers, aquatic ecosystems, and social and economic structures of the area.[328]

Related surface and groundwater "data and information needs" identified in this section include:

- Regarding freshwater streams within the watershed:
  - A list of major streams, including the size of the drainage area and gradient;
  - Maximum, average maximum, average minimum, and minimum monthly flow;
  - Flood frequency distribution; and
  - Historical drought stages and discharges by month, and the seven-day once-in-ten years low flow.
- Regarding lakes and impoundments:
  - A general description;
  - Influential intake or discharge structures, as well as the size, location, and elevation of outlets;
  - Variations in inflows, outflows, and water surface elevations; and
  - Storage volumes and retention times.
- Regarding groundwater:
  - Areal extent of aquifers, recharge, and discharge areas, elevation and depth, and geologic formations;
  - Interactions between site surface and groundwaters;
  - Recharge rates; and

326 U.S. NUCLEAR REGULATORY COMM'N, ENVIRONMENTAL STANDARD REVIEW PLAN: STANDARD REVIEW PLANS FOR ENVIRONMENTAL REVIEWS FOR NUCLEAR POWER PLANTS 1 (1999), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1555/sr1555.pdf.

327 *Id.* at 2.3.1-1.

328 *Id.*

- Designations or proposals for designation of "sole source aquifers."[329]

Similarly, the scope of review under ESRP 2.3.2, titled "Water Use," includes: "(1) consideration of such water uses as domestic, municipal, agricultural, industrial, mining, recreation, navigation, and hydroelectric power, (2) identification of their locations, and (3) quantification of water diversions, consumption, and returns."[330]

Similar ESRPs exist for water quality[331] and water treatment,[332] among others. The scope of review under ESRP 3.3.1, entitled "Water Consumption," calls for consideration of the "quantity of water required for plant operation, the amount of water consumed by the plant water systems, and the amount of water discharged to a water body." The analysis is based on the rationale that "[a] detailed and thorough description of the plant water consumption is essential *for the evaluation of potential impacts to the environment* that may result from plant, construction, or operation."[333]

This last statement raises an important limitation to the integration of energy- and water-related issues in the context of the environmental report. That is, the analysis, although an apparently thorough one, is only performed with an eye toward "environmental impacts." Considerations supporting the integration of energy and water-related issues in the context of power plant siting extend far beyond environmental impacts to include water scarcity, potential competition among various uses, and national security concerns. Moreover, issues identified in the NEPA analysis are identified in order to ensure that the NRC's decision to grant a permit is an informed one.[334] NEPA does not require the NRC to choose an alternative that is the "right alternative."[335] It merely requires the agency to comply with a decision-making process that forces them to consider environmental impacts of the proposed action (in this case granting a permit) along with comparative impacts associated with reasonable alternative actions.[336]

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329 *Id.* at 2.3.1-2 to 1-5.

330 *Id.* at 2.3.2-1.

331 *Id.* at 2.3.3-1 (calling for consideration of physical, chemical, and biological water quality characteristics of ground and surface water).

332 *Id.* at 3.3.2-1 (calling for consideration of treatment needed for plant water streams).

333 *Id.* at 3.3.1-1, 3.3.1-3 (emphasis added).

334 *See* Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 349 (1989) ("The statutory requirement that a federal agency contemplating a major action prepare such an environmental impact statement serves NEPA's 'action-forcing' purpose in two important respects. It ensures that the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts; it also guarantees that the relevant information will be made available to the larger audience that may also play a role in both the decisionmaking process and the implementation of that decision.") (citation omitted).

335 *See id.* at 350 ("Although these procedures are almost certain to affect the agency's substantive decision, it is now well settled that NEPA itself does not mandate particular results, but simply prescribes the necessary process. If the adverse environmental effects of the proposed action are adequately identified and evaluated, the agency is not constrained by NEPA from deciding that other values outweigh the environmental costs.") (citation omitted).

336 *See, e.g.*, *supra* text accompanying notes 329–33.

b. The Site Safety Analysis Report

In addition to submitting an environmental report as part of its application, the applicant is required to submit a site safety analysis report, which contains detailed information concerning the design of structures, systems, and components at a proposed nuclear facility.[337] The NRC reviews the applicant's report and summarizes its findings in a safety evaluation report. Like the environmental report, the applicant must integrate energy- and water-related issues, only in this context, the integration is limited in scope to operational safety issues. The site safety analysis report is required to include:

- The specific power level of the facilities and anticipated maximum levels of radiological and thermal effluents each facility will produce;
- The type of cooling systems, intakes, and outflows that may be associated with each facility;
- The boundaries of the site and general location of each facility on the site;
- The seismic, meteorological, hydrologic, and geologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated;
- The existing and projected future population profile of the site's surroundings;
- A description and safety assessment of the facility's proposed site;
- Information demonstrating that site characteristics allow for development of adequate security plans; and
- An evaluation of the site against applicable sections of the Standard Review Plan (SRP).[338]

The *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*[339] is considered "the most definitive basis available for specifying the NRC's interpretation of an acceptable level of safety for light-water reactor facilities."[340] Because cooling water availability is a key factor in nuclear reactor safety, the integration of energy- and water-related issues occurs in connection with the applicant's safety evaluation report. In that regard, the above-referenced Standard Review Plan contains a number of

337 U.S. NUCLEAR REGULATORY COMM'N, *supra* note 316, at 69.
338 10 C.F.R. § 52.17(a)(1) (2010).
339 U.S. NUCLEAR REGULATORY COMM'N, STANDARD REVIEW PLAN FOR THE REVIEW OF SAFETY ANALYSIS REPORTS FOR NUCLEAR POWER PLANTS 1 (1987), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/.
340 U.S. NUCLEAR REGULATORY COMM'N, *supra* note 316, at 68.

comprehensive SRPs that deal specifically with issues identified at the energy–water interface. These include, among others, SRP 2.4.1 titled *Hydrologic Description*, SRP 2.4.2 titled *Floods*, SRP 2.4.11 titled *Low Water Considerations*, and SRP 2.4.12 titled *Groundwater*.[341]

In each of the report's "areas of review," the applicant is required to gather *historical data* relating to the proposed site to determine whether the design, structures, systems, and components of the proposed facility meet the NRC's regulatory requirements. For example, SRP 2.4.11 is included in the site safety analysis because "[l]ow water conditions could adversely affect sources of water required for cooling the proposed plant. Accordingly . . . [regulatory] requirements are imposed to ensure that components and structures associated with the ultimate heat sink will continue to function, thereby keeping the plant in safe condition."[342] Under SRP 2.4.11, when assessing whether the proposed nuclear plant can safely operate under the "low water conditions" unique to the proposed site, the NRC considers, among other things:

- Historical data concerning drought-related low water conditions at and in the vicinity of the site, including initiating phenomena, locations, and durations, and data related to the "worst drought considered reasonably possible in the region;"
- Data concerning non-drought related low-water levels caused by other phenomena, including other hydrometeorological events and the blockage of intakes by sediment, debris, littoral drift, and ice, including locations and durations of the events;
- The potential for "other anthropogenic water uses [that] could exacerbate the natural causes of low water" including "use limitations imposed or under discussion by Federal, State, or local agencies authorizing the use of water," or institutional restraints on water use such as limitations on use and discharge permits;
- A description of all safety-related water supply requirements at or in the vicinity of the site, including the design basis of the plant's intake system; and
- Applicant's "assessment of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated worst-case low-flow scenario for the proposed plant site."[343]

If the assessment reveals safety concerns, modifications to the proposed facility plan or site selection may be required.[344]

As of January 2010, twenty-six applications for newly-built reactors had been filed with the NRC.[345] While there is some comfort in knowing that issues relating to the energy–water nexus are being considered in connection with the upsurge of licensing applications for this extremely

341 *See* U.S. NUCLEAR REGULATORY COMM'N, *supra* note 339, at 2.4.1, 2.4.2, 2.4.11, 2.4.12.
342 *Id.* at 2.4.11-5.
343 *Id.* at 2.4.11-4 to 11-8, 2.4.11-11.
344 U.S. NUCLEAR REGULATORY COMM'N, *supra* note 316, at 2–3.
345 BOSSELMAN ET AL., *supra* note 36, at 1012.

water-intensive form of power generation, it is important to keep in mind the limitations of the analyses being performed. As previously discussed, integration of energy and water-related issues performed in the context of the environmental review are limited in scope to environmental impacts.[346]

Similarly, in the context of conducting a safety evaluation, integration of energy- and water-related issues takes place for the limited purpose of safety review, which although important in the context of nuclear power, fails to consider the many dimensions of energy- and water-related issues that require integration in order to achieve sustainability of our water resources. Moreover, included among these additional considerations, are potential climate change-related impacts which may require adaptation strategies. Such consideration appears to be missing from the NRC's current licensing regime.

For example, when assessing whether a proposed plant can operate safely under low water conditions, NRC guidance calls for an examination of water use limitations "imposed or under discussion by Federal, State, or local agencies authorizing the use of water."[347] This may be an accurate depiction of water resource availability and the capacity of the plant's safety features to respond to today's low water conditions, but whether this is an accurate depiction of water resource availability and the capacity of the plant's safety features to respond to conditions forty years from now, when the license term expires,[348] is questionable, particularly with the dawn of climate change-related impacts.

An even more fundamental question arises in connection with the NRC's reliance on *historical* data, like drought conditions and flood events, in determining whether the safety-related plant features can effectively withstand like conditions. As in the case of flooding, for purposes of an ESP, an applicant considers:

> [T]he most severe natural phenomena that have been historically reported for the site and surrounding area and reasonable combination of these phenomena in establishing design-basis information pertaining to the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.[349]

Will the built in "margin" be significant enough to accommodate climate change-related precipitation events, the severity of which is still unknown? Increasingly, scholars are concluding that historical data cannot be relied on to predict conditions impacted by climate change: "Accurate prediction of climate change effects on local ecological conditions is, for now (and perhaps always will be), beyond the capacity of ecological models."[350]

346 *See supra* text accompanying notes 333–36.

347 *See* U.S. NUCLEAR REGULATORY COMM'N, *supra* note 339, at 2.4.11-2.

348 A license may be issued for up to a forty-year period. 10 C.F.R § 50.51(a) (2010).

349 U.S. NUCLEAR REGULATORY COMM'N, *supra* note 339, at 2.4.2-14.

350 J.B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 B.U.L. REV. 1, 23 (2008).

Further, "the effects of climate change will themselves be complex—ever-changing, often unpredictable, and subject to feedback mechanisms that may not be completely understood and that may change over time."[351]

This further begs the question of whether, in the era of climate change, public health and safety concerns are adequately addressed by a licensing process that relies on historical data to grant site approvals that may be "banked" for up to forty years. The NRC's new permitting regime is meant to provide "predictability" in the licensing process by offering finality on issues assessed during the ESP phase of permitting, before an applicant commits resources to construction. In that regard, with limited exception, the NRC staff is precluded from imposing new site characteristics, design parameters or terms and conditions on an ESP at the COL permitting stage.[352] We may find that, for public health and safety reasons, in this climate change-created "world of triage, best guesses, and shifting sands,"[353] a COL application that relies on an ESP granted decades earlier, the terms of which are based on historic data from that time may, by definition, call for the reassessment of the environmental and technical assumptions upon which the ESP was based.

Outside of the limited analyses performed by the FERC and the NRC, on the limited segment of energy production generation facilities that fall within their discrete jurisdictions, there is no federal mandate arising from energy-based regulation that requires decision-making authorities at the federal or state level to consider water resource management in connection with decisions concerning siting and operation of the remaining 77% of energy production power plants facilities. Although the analysis performed in connection with FERC and NRC licensing exhibit some degree of energy and water policy integration, each instance is limited in scope and, for the reasons outlined above, fails to address vital issues relating to the sustainability of our nation's water resources. As will be discussed in the next section, dialogue among policymakers concerning the interdependency between water and energy is beginning. Based on the roles that the federal and state governments have historically played in the areas of water policy and energy policy, however, the likelihood of such a federal mandate in the near future appears slim.

B. Water-Based Regulation that Integrates Energy-Related Issues

A cursory examination of the degree to which water-based regulatory regimes integrate energy-related issues reveals two CWA provisions that

351 Craig, *supra* note 183, at 29.

352 Modifications to site conditions, design parameters or ESP terms and conditions will be permitted when: the applicant requests a variance from such conditions; when necessary to bring the ESP into compliance with regulations that existed at the time of its issuance; when necessary to adequately protect public health and safety; or upon determining that such modification is necessary based on updated information filed by the applicant concerning emergency preparedness or as a result of a contested COL application. 10 C.F.R. § 52.39(a)(1) (2010).

353 *See* Craig, *supra* note 183, at 16.

deserve note. These include CWA Section 316(b), which is designed to prevent entrainment of aquatic life at cooling water intake structures;[354] and CWA Section 303(d), which requires states to identify impaired waters and Total Maximum Daily Loads (TMDLs) for those waters,[355] which are, in turn, incorporated into National Pollution Discharge Elimination System, or NPDES, permits.[356] In that these two provisions, for different reasons, promote closed-loop cooling systems, a more water consumptive cooling process, they symbolize the complexity associated with issues that exist at the energy–water nexus.

As previously discussed, CWA Section 316(b) targets cooling water intake structures. Compliance with this provision requires U.S. Environmental Protection Agency (EPA) to ensure that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."[357] Because entrainment is associated more often with the open-loop cooling process that withdraws greater quantities of water from the water resource, the best technology available for minimizing entrainment is likely to involve the closed-loop or air-cooling process.[358]

CWA Section 303(d) may promote increased use of closed-loop cooling systems for a different reason. CWA Section 303(d) requires states to identify a list of impaired waters that are not meeting established state water quality standards and establish TMDLs for those water bodies.[359] A TMDL establishes the maximum amount of a pollutant that can be discharged to a water body in order for it to meet established water quality standards.[360] The TMDL allocates pollutant loads among pollutant sources and provides a basis for states to establish water quality-based controls that provide the pollution reduction necessary for a water body to meet established water quality standards.[361] TMDL requirements could constrain a power plant's discharge of cooling water if it contained certain levels of pollutants and if the receiving waters were impaired.[362] A closed-loop cooling system avoids problems associated with discharging water containing pollutants into an impaired water body.

Because closed-loop cooling systems consume more water in the cooling process than open-loop cooling systems, water consumption levels

354 *See* Federal Water Pollution Control Act, 33 U.S.C. § 1326(b) (2006); U.S. ENVTL. PROT. AGENCY, CLEAN WATER ACT SECTION 316(b) EXISTING FACILITIES PROPOSED RULE QS AND AS (2011), *available at* http://water.epa.gov/lawsregs/lawsguidance/cwa/316b/upload/qa_proposed.pdf (discussing the changes regulated entities could anticipate, including requirements for facilities with large withdrawals to conduct studies specifically to determine entrainment mortality controls and requiring low flows at intake for new facilities).

355 33 U.S.C. § 1313(d) (2006).

356 *Id.* § 1342(a).

357 *Id.* § 1326(b).

358 NAT'L ENERGY TECH. LAB., *supra* note 12, at A-3.

359 33 U.S.C. §§ 1313(d)(1)(A), (C) (2006).

360 *Id.* § 1313(d)(1)(C).

361 NAT'L ENERGY TECH. LAB., *supra* note 12, at A-3.

362 *Id.*

by the energy sector in response to these CWA provisions are expected to increase.[363] While addressing issues relating to entrainment and pollution is clearly in support of achieving sustainability of our nation's water resources, promoting the use of a more consumptive form of the cooling process seems contrary to these goals.

V. ENERGY AND WATER POLICY: DOES IT HELP OR HINDER?

With the exception of facilities governed under the limited jurisdiction of the FERC and the NRC, state public utility commissions are traditionally responsible for regulating energy-generating facilities located in their state.[364] As noted, historically, decisions concerning energy production have been made without consideration paid to water resource maintenance and vice versa.[365] The increasing occurrences of water shortages in various regions coupled with the promise of increased demand and climate change-related impacts lead policymakers to rethink these historical assumptions. The prospect of energy disruption, the realization that our current path leads to increased competition and prioritization among various water users, and the concomitant threat to energy independence, renewable resource development, and national security that accompanies conditions of water scarcity and energy interruption all point to the need to create a "more sustainable energy economy."

A. Energy Policy

A review of the current Administration's agenda items, recent energy-related legislative activity, and activities by various federal agencies that play an important role in the energy sector reveals a national "energy policy" that focuses on three primary issues: climate change,[366] energy independence

363 *Id.*

364 *See* BOSSELMAN ET AL., *supra* note 36, at 13.

365 *See* Webber, *supra* note 13, at 35 ("Woefully underappreciated, however, is the reality that each of these precious commodities [water and energy] might soon cripple our use of the other. . . . A few are voicing concerns about peak water. But almost no one is addressing the tension between the two . . . .").

366 On June 26, 2009, the House of Representatives passed the American Clean Energy and Security Act of 2009, also referred to as the Waxman-Markey Bill. H.R. 2454, 111th Cong. (2009); GovTrack.us, H.R. 2454: American Clean Energy and Security Act of 2009, http://www.govtrack.us/congress/bill.xpd?bill=h111-2454 (last visited Jul. 2, 2011). The Senate chose not to consider the legislation before the end of the legislative term. *See* Carl Hulse & David Herszenhorn, *supra* note 280, at A15 (noting that political reality drove the Senate's refusal to take up climate change legislation in the face of more pressing needs, such as legislation to address the oil spill in the Gulf of Mexico). Although Congress has yet to pass climate change legislation, greenhouse gas regulation remains "at the forefront of Washington's environmental agenda." Roger R. Martella, Jr., *Climate Change Along the Northeast Corridor: How Washington and New York Are Approaching and Preparing for Greenhouse Gas Controls*, 18 N.Y.U. ENVTL. L.J. 14, 15 (2010). The EPA also continues to pursue multiple regulatory initiatives designed to regulate greenhouse gases under the Clean Air Act. Some of these regulatory initiatives are in response to the United States Supreme Court's decision in

and security, and renewable resources. Although these issues are central to the problems arising at the energy–water nexus, recent legislation and activities by the various agencies are still failing to consider the impact that these policy-driven activities will have on the already stressed state of our nation's water supply as recently seen in the policy initiatives calling for an increased production and use of water-intensive renewable resources.

Some of the more significant energy-related legislation includes the 2005 Energy Policy Act (EPAct),[367] EISA, and ARRA, each of which calls for an increase in water-intensive domestic renewable fuels production. EPAct, for example, established a DOE loan guarantee program to support development of renewable energy and other clean energy technologies,[368] as well as authorized $800 million of new clean renewable energy bonds to finance facilities generating electricity from renewable sources.[369] EPAct also created a Renewable Fuel Standard program, whereby Congress required an increasing volume of renewable fuel, including ethanol, biodiesel, and all motor vehicle fuels derived from biomass, be used in gasoline in the United States starting in 2006 and increasing annually through 2012.[370]

EISA continued the effort to increase production of renewable energy by increasing the annual statutory renewable fuel volumes established in EPAct, extending the Renewable Fuel Standards Program through 2022[371] and mandating the production of renewable fuels from "renewable

Massachusetts v. EPA, 549 U.S. 497 (2007). For example, in December of 2009, the EPA Administrator found that "greenhouse gases from new motor vehicles . . . contribute to the greenhouse gas air pollution that endangers public health and welfare under [Clean Air Act] section 202(a)." *See* Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496 (Dec. 15, 2009) (to be codified at 40 C.F.R. § 1). For a summary of EPA's climate change regulatory initiatives, see U.S. Envt'l Prot. Agency, Climate Change: Regulatory Initiatives, http://www.epa.gov/climatechange/initiatives/index.html (last visited Apr. 6, 2011). There appears to be a concerted effort by some members of Congress, however, to prevent EPA from moving forward with regulation of stationary sources. *See* JAMES E. MCCARTHY & LARRY PARKER, EPA REGULATION OF GREENHOUSE GASES: CONGRESSIONAL RESPONSES AND OPTIONS 2–3 (2010), *available at* http://www.fas.org/sgp/crs/misc/R41212.pdf (describing legislation introduced by some members of Congress in response to EPA attempting to regulate greenhouse gas emissions).

367 Energy Policy Act of 2005, Pub. L. 109-58, 119 Stat. 594 (codified as amended in scattered sections); U.S. Gov't Printing Office, Public Law 109-58 – Energy Policy Act of 2005, http://www.gpo.gov/fdsys/pkg/PLAW-109publ58/content-detail.html (showing details of the location of its codification).

368 Pub. L. 109-58, § 1701–04, 119 Stat. 594, 1117–22 (2005) (codified at 42 U.S.C. §§ 16511–14 (2006)).

369 Pub. L. 109-58, § 54, 119 Stat. 594, 992–94 (2005) (codified at 26 U.S.C. § 54 (2006)).

370 Pub. L. 109-58, 119 Stat. 594 (2005) (codified at 42 U.S.C. § 7545(o) (Supp. III 2006)); *see also* Jay P. Kesan & Christopher J. Miller, *The Renewable Fuel Standard: Mandating Renewable Fuel Production in the United States*, TRENDS: ABA SECTION OF ENVIRONMENT, ENERGY AND RESOURCES, Sept.–Oct. 2010, at 4.

371 *See* Energy Independence and Security Act of 2007, Pub. L. 110-140, § 202, 121 Stat. 1492, 1521–23 (codified as amended at 42 U.S.C. § 7545(o) (Supp. III 2006)). Congress also gave EPA the authority to mandate production of certain volumes of renewable fuel beyond 2023 through rulemaking.Pub. L. 109-58, § 202, 119 Stat. 594, 1523 (codified as amended at 42 U.S.C. § 7545(o)(2)(B)(II) (Supp. III 2006).

biomass."[372] Finally, ARRA allocated some $6 billion in new funds to support the DOE loan guarantee program originally established under EPAct,[373] extended and modified the tax incentives made available to businesses and individuals involved in development and production of renewable energy sources under EISA,[374] and authorized an additional $1.6 billion in clean renewable energy bonds.[375]

Although certainly in advance of the current Administration's energy agenda, these recent energy-based policy initiatives fail to integrate water-related issues into policies that clearly promote more water-intensive forms of energy production. Instead, these policies signal the ongoing lack of integration, by policymakers, of energy- and water-related issues in the context of national energy policy.

B. Water Policy

In contrast to the failure by policymakers to integrate water resource considerations into energy-based legislation, policymakers recently experienced a measurable degree of success in integrating energy-related activities into a water-based national assessment program. In what has been touted as a move toward national water planning,[376] in March 2009, Congress enacted the OPLMA, in which it created a National Water Availability and Use Assessment Program (NWAUAP) in the Department of the Interior.[377] Using energy production as a prominent justification,[378] this program directs the Secretary of the Interior to create and maintain "a comprehensive national water use inventory" and "conduct an ongoing assessment of water availability."[379] The goals of this program are:

> (1) [T]o provide a more accurate assessment of the status of the water resources of the United States;
>
> (2) [T]o assist in the determination of the quantity of water that is available for beneficial uses;
>
> (3) [T]o assist in the determination of the quality of the water resources of the United States;
>
> (4) [T]o identify long-term trends in water availability;
>
> (5) [T]o use each long-term trend described in paragraph (4) to provide a more accurate assessment of the change in the availability of water in the United States; and

372 Pub. L. 109-58, § 202, 119 Stat. 594, 1523 (codified as amended at 42 U.S.C. § 7545(o)(2)(B)(II) (Supp. III 2006) (mandating the use of "renewable fuel," which is defined as "fuel that is produced from renewable biomass."); *see also* Kesan & Miller, *supra* note 370, at 4.

373 Pub. L. 111-5, § 4, 123 Stat. 115, 140.

374 Pub. L. 111-5, sec. 1101–03, § 45(d), 123 Stat. 115, 319–21.

375 Pub. L. 111-5, sec. 1111, § 54C(c), 123 Stat. 115, 322.

376 Craig, *supra* note 184, at 226–29.

377 Omnibus Public Land Management Act of 2009 § 9508; 42 U.S.C. § 10368 (Supp. III 2006)).

378 Craig, *supra* note 184, at 227.

379 42 U.S.C. § 10368(b)(1)(A), (b)(2) (Supp. III 2006).

(6) [T]o develop the basis for an improved ability to forecast the availability of water for future economic, *energy production*, and environmental uses.[380]

The Secretary is required to incorporate its findings in a report to Congress by December 31, 2012, and every five years thereafter.[381] The required data will help to shed light on a number of key issues that exist at the intersection of energy and water. Specifically, OPLMA Section 9508(d) requires the Secretary to provide a detailed assessment of:

(1) the current availability of water resources in the United States, including—

(A) historic trends and annual updates of river basin inflows and outflows;

(B) surface water storage;

(C) groundwater reserves; and

(D) estimates of undeveloped potential resources (including saline and brackish water and wastewater);

(2) significant trends affecting water availability, including each documented or projected impact to the availability of water as a result of global climate change;

(3) the withdrawal and use of surface water and groundwater by various sectors, including—

(A) the agricultural sector;

(B) municipalities;

(C) the industrial sector;

(D) thermoelectric power generators; and

(E) hydroelectric power generators;

(4) significant trends relating to each water use sector, including significant changes in water use due to the development of *new energy supplies*;

(5) significant water use conflicts or shortages that have occurred or are occurring; and

(6) each factor that has caused, or is causing, a conflict or shortage described in paragraph (5).[382]

Although limited in scope to federal water projects, OPLMA integrates energy and water-based issues, as well as climate change-related impacts by requiring the Secretary to "assess each effect of, and risk resulting from, global climate change with respect to water supplies that are required for the generation of hydroelectric power at each Federal water project that is

380 *Id.* § 10368(a) (emphasis added).
381 *Id.* § 10368(d).
382 *Id.* (emphasis added).

applicable to a Federal Power Marketing Administration."[383] Moreover, OPLMA Section 9503 goes so far as to "establish a climate change adaptation program,"[384] although the scope of the program is specifically limited to "area[s] that encompass[] a watershed that contains a federally authorized reclamation project."[385] Provisions of this program require the Secretary:

> (1) to coordinate with . . . other appropriate agencies to assess each effect of, and risk resulting from, global climate change with respect to the quantity of water resources located in a [reclamation project] service area; and
>
> (2) to ensure, to the maximum extent possible, that strategies are developed at watershed and aquifer system scales to address potential water shortages, conflicts, and other impacts to water users located at, and the environment of, each service area.[386]

With respect to each major reclamation river basin, the Secretary is also required to analyze, among other things, "the extent to which changes in the water supply of the United States will impact . . . hydroelectric power generation facilities."[387] Additionally, "[i]n consultation with appropriate non-Federal participants," the Secretary must "consider and develop appropriate strategies to mitigate" any such impact to hydroelectric generation facilities including strategies relating to "the modification of any reservoir storage or operating guideline in existence as of [the date of OPLMA's enactment]; the development of new water management, operating, or habitat restoration plans; water conservation; improved hydrologic models and other decision support systems; and groundwater and surface water storage needs."[388]

Also falling under the heading of water policy, the EPA Administrator "has identified 'clean energy and climate change' as a top Agency priority, and EPA national and Regional offices are working to define strategies and actions in th[e] area."[389] In an effort to "describe climate change impacts on water programs, define goals and objectives for responding to climate change, and to identify a comprehensive package of specific response actions," EPA released its *National Water Program Strategy: Response to Climate Change* in 2008, in which EPA outlines its plans to work cooperatively with national, state, and local governments and public and private stakeholders to "understand the science, develop tools, and implement actions to address the impacts of climate change on water resources."[390]

383 *Id.* § 10365(a).

384 *Id.* § 10363(a).

385 *See id.*; *id.* § 10362(17) (defining the term "service area").

386 *Id.* § 10363(a).

387 *Id.* § 10363(b)(3)(B).

388 *Id.* § 10363(b)(4).

389 OFFICE OF WATER, U.S. ENVTL. PROT. AGENCY, NATIONAL WATER PROGRAM STRATEGY: RESPONSE TO CLIMATE CHANGE, at i (2008), *available at* http://www.epa.gov/ow/climatechange/docs/TO5_DRAFT_CCR_Revised_10-16.pdf.

390 *Id.* at iii. EPA breaks down its efforts into five separate "goals" that provide a framework for the specific adaptation and mitigation strategies that EPA intends to take in response to climate change. These goals include mitigation of greenhouse gases, adaptation to climate

On a positive note, dialogue concerning the interdependency between water and energy is starting to take place as policymakers begin to recognize that this nexus holds an important key to developing a more sustainable energy economy. For example, in response to a December 2004 letter[391] to the Secretary of Energy from the chairman and ranking members of the House and Senate Subcommittees on Energy and Water Development Appropriations, the DOE issued a December 2006 report entitled *Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water*,[392] cited throughout this Article, which focuses on the "interdependency of energy and water" and the "threats to national energy production resulting from limited water supplies."[393]

More recently, the DOE, in conjunction with the National Energy Technology Laboratory, issued a report entitled *Estimating Freshwater Needs to Meet Future Thermoelectric Generation Requirements*,[394] also cited throughout this Article. In this report, the DOE recognized the need to reconcile "[g]rowing concerns about freshwater availability . . . with growing demand for power if the United States is to maintain economic growth and current standards of living."[395]

A selection of bills introduced in the House and Senate offers further evidence that the message is being heard. For example, HR 3598, entitled the *Energy and Water Research Integration Act*,[396] recently passed by the House, is designed "to ensure consideration of water intensity in the DOE's energy research, development, and demonstration programs to help guarantee efficient, reliable, and sustainable delivery of energy and water resources."[397] Similarly, a bipartisan bill recently introduced to the Senate, the *Energy and Water Integration Act of 2009*,[398] calls for three major new studies detailing different dimensions of the energy–water interface.[399] The first study targets the impact of energy development and production on United States' water resources, broken down by three distinct sectors, one of which is the

change, climate change research related to water, education of water program professionals on climate change impacts to water resources and water programs, and establishing capability to manage climate change challenges on a sustained basis. *Id.* at iii–iv.

391 U.S. DEP'T. OF ENERGY, *supra* note 15, at 3.

392 *Id.*

393 *Id.*

394 NAT'L ENERGY TECH. LAB., *supra* note 12.

395 *Id.* at 1.

396 The Energy and Water Research Integration Act, H.R. 3598, 111th Cong. § 2 (2009), passed the House of Representatives on December 1, 2009, directed the Secretary of Energy to advance energy technologies and practices that would "minimize freshwater withdrawal and consumption; increase water use efficiency; and utilize nontraditional water sources . . . ; consider the effects climate variability and change may have on water supplies and quality for energy generation and fuel production;" and improve understanding of the interdependencies between energy and water production and use. It further requires the Secretary to establish technical milestones for technologies designed to improve efficiencies in energy generation, fuel production, and traditional and non-traditional water use, recovery, and treatment. *Id.*

397 *Id.* pmbl.

398 Energy and Water Integration Act of 2009, S. 531, 111th Cong. (2009). The bill was introduced to the Senate on March 5, 2009, but never made it out of committee.

399 *Id.* §§ 2–4; *see also* Kray, *supra* note 22, § 4A.02.

electricity sector.[400] This study would also analyze water impact associated with specific fuel sources, including any impacts resulting from extraction or mining practices.[401] The second study targets electrical power plant water and energy efficiency.[402] And the third study targets energy use by the Bureau of Reclamation's water storage and delivery operations.[403] The future of this bill and others like it remains unknown, particularly in light of the recent turnover of the House of Representatives, where "many . . . dismiss strong scientific evidence of human-caused warming."[404]

Despite the growing dialogue, ongoing assessments, and legislative initiatives, for the most part, energy and water policy still operate in separate spheres and lack the integration required to trigger the coordinated effort necessary to make any meaningful and timely impact on the crisis developing in our energy and water sectors.

VI. CHALLENGES AND SOLUTIONS: STEPS TOWARD ACHIEVING A "MORE SUSTAINABLE ENERGY" ECONOMY

Creating a more sustainable energy economy is a complex undertaking which necessitates a bilateral approach to managing the issues identified in this Article. First, in order to avoid compounding problems that already exist at the energy–water interface, and to further the goals associated with creating and maintaining a sustainable energy economy, all future energy-based policy initiatives must be examined through the lens of, and influenced by, the dynamics of the energy–water nexus. In today's world, this analysis should certainly be influenced by current and anticipated climate change-related impacts.

Second, laying the groundwork necessary to create and maintain the sustainable energy economy vital to the success of our nation's energy policies requires us to undertake a massive national planning effort. Developing the policy framework by which to manage this large-scale planning effort is a formidable task. Policymakers who are versed in the interdependency between water and energy would no doubt agree that our nation's waters lie at the center of this planning effort. This Article goes a step further to suggest that the path to achieving a sustainable energy economy starts with achieving sustainability of our nation's water resources. In that regard, this Article suggests that the policy framework by which to achieve sustainability of our nation's water resources which, in turn, will support national efforts to create a more sustainable energy economy,

400 S. 531, § 2(b) (describing sector assessments within the "scope of study").

401 *Id.* § 2(b)(4).

402 The study would identify and evaluate strategies to maximize water and energy efficiency in the production of electricity, including the assessment of energy production efficiency by type of generation facility (e.g., coal, oil, natural gas, hydropower, thermal, solar, and nuclear). *Id.* § 3(a)–(b).

403 *Id.* § 4(b)(1).

404 Charles Hanley, *As World Warms, Negotiators Give Talks Another Try*, MINN. PUB. RADIO, Nov 20, 2010, http://minnesota.publicradio.org/display/web/2010/11/20/climate-change-conference/ (last visited July 3, 2011).

requires *participation by federal and state stakeholders and integration of federal and state planning efforts in a large-scale watershed planning and management program that incorporates the dynamics of the energy–water nexus.*

The idea of watershed planning is not a new one.[405] The watershed planning process, as described by EPA, is a process which identifies a series of "cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary."[406] Although watershed management and planning is often discussed in the context of restoring impaired water bodies,[407] a large-scale national planning effort could lay the groundwork necessary to achieve sustainability of the nation's water resources. Even states like Florida, which are at the forefront of watershed planning,[408] could benefit from this larger national effort.[409] Before turning to the task of detailing the framework for this large-scale planning effort, however, several significant challenges that are implicated in any discussion concerning the federal government's role in water planning deserve consideration—these involve the concept of

405 *See* J.B. Ruhl et al., *Proposal for a Model State Watershed Management Act*, 33 ENVTL. L. 929, 931 (2003) (identifying "watershed-based problems" that could benefit from "watershed-based solutions" including "river fragmentation . . . , the loss of riverine wetlands, and the separation of river channels from floodplains through levees").

406 NONPOINT SOURCE CONTROL BRANCH, U.S. ENVT'L PROT. AGENCY, HANDBOOK FOR DEVELOPING WATERSHED PLANS TO RESTORE AND PROTECT OUR WATERS 2-2 (2008), *available at* http://www.epa.gov/owow/nps/watershed_handbook.

407 *See id.* ("Using a watershed approach to restore impaired waterbodies is beneficial because it addresses the problems in a holistic manner and the stakeholders in the watershed are actively involved in selecting the management strategies that will be implemented to solve the problems.").

408 A handful of states, including Florida, "have adopted multi-tiered approaches" to watershed planning that attempt to integrate land use planning and resource allocation. Ruhl et al., *supra* note 405, at 939. Florida's watershed-based management program is designed around five state Water Management Districts (WMDs) drawn on watershed boundaries rather than political boundaries. Florida Water Resources Act of 1972, FLA. STAT. §§ 373.013–373.71, 373.069 (2010). Each WMD is required to produce a district water management plan based on a 20-year planning cycle that "addresses water supply, water quality, flood protection and floodplain management, and natural systems." *Id.* § 373.036(2)(a). As part of its planning effort, each WMD conducts a Water Supply Assessment that compares existing and reasonably anticipated future needs against existing and reasonably anticipated water sources to determine whether supply is adequate to meet the demands of that district. *Id.* § 373.036(2)(b)(4). The Florida Department of Environmental Protection (FDEP) reviews the WMDs' Water Management Plans to ensure consistency with the Florida Water Plan, the "principal planning tool for long-term protection of Florida's water resources." ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, DISTRICT WATER MANAGEMENT PLAN 3 (2005), *available at* http://www.sjrwmd.com/dwmp/pdfs/DWMP_2005_final.pdf; *see id.* § 373.026(7) (describing FDEP's "general supervisory authority over all water management districts"). For a suggested model for a multi-tiered approach to state watershed management, *see* Ruhl et al., *supra* note 405, at 942–45.

409 For example, under the Florida Water Resource Act, a Consumptive Use Permit is required for power plants seeking to withdraw water for cleaning, cooling, and other activities. FLA. STAT. § 373.223 (2010). That notwithstanding, water resource planning is not mandated under the criteria considered by the Florida Public Service Commission when making decisions concerning power plant siting. *Id.* § 403.519 (requiring only the consideration of need and reliability).

"federalism" and identifying the appropriate governance structure by which to achieve these lofty goals.

A. Challenges Associated with Pursuing National Watershed Planning: The Concept of Federalism

"Federalism" has been described as the interaction between the two layers of government in the United States—the federal government and the state government.[410] The passing of the OPLMA supports the proposition that federal policymakers are making progress in acknowledging the impacts that climate change generally, and energy production specifically, are having and will continue to have on the nation's water resources for years to come. Despite this progress, however, political and legal mechanisms that are currently in place concerning the states' authoritative role in managing water resources within state boundaries will pose significant barriers to any policymaker using federal water-based regulation and policymaking as the sole means by which to create and maintain a sustainable energy economy.[411]

Throughout federal water-related legislation, Congress has made it clear that the state reigns supreme in the allocation and administration of water within its boundaries.[412] An example of Congress's deference to the authority of the states in this regard is clearly articulated in the Clean Water Act, which provides:

> It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this chapter. It is the further policy of Congress that nothing in this chapter shall be construed to supersede or abrogate rights to quantities of water which have been established by any State.[413]

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410 WILLIAM FUNK, INTRODUCTION TO AMERICAN CONSTITUTIONAL STRUCTURE 302 (2008); *see also* Craig, *supra* note 184, at 185, 192–93 (describing state law control over water allocation as a "quintessential example of states' rights or decentralized federalism").

411 For an overview of the federal-state relationship regarding water and the historical federal deference to state water law and policy, see Robert W. Adler, *Climate Change and the Hegemony of State Water Law*, 29 STAN. ENVTL. L.J. 1 (2010). *See also* Craig, *supra* note 184, at 192–97.

412 *See, e.g.*, Federal Power Act of 1935 §27, 16 U.S.C. § 821 (2006) (savings clause stating that the Federal Power Act does not "affect or in any way [] interfere with the laws of the respective States relating to the control, appropriation, use, or distribution of water"); *see also* Adler, *supra* note 411, at 4 n.10 (citing the savings clause in the FPA for Professor Adler's proposition that "state water law has reigned supreme as the primary authority governing the allocation and use of water resources, as proclaimed by Congress"); Federal Water Pollution Control Act, 33 U.S.C. § 1251(g) (2006) (recognizing the primary responsibilities and rights of states over water resources); Desert Lands Act of 1877, 43 U.S.C. § 321 (2006) (requiring recipients of desert land patents to acquire "the right to the use of water by . . . bona fide prior appropriation," which is governed by the states); Reclamation Act of 1902 § 8, 43 U.S.C. § 383 (2006) (nothing in the Reclamation Act shall "be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use, or distribution of water used in irrigation, or any vested right").

413 33. U.S.C. § 1251(g) (2006).

Even the seemingly groundbreaking OPLMA, which toys with the notion of national water planning, ardently reiterates that the "States bear the primary responsibility and authority for managing the water resources of the United States, [and] the Federal Government should support the States, as well as regional, local, and tribal governments," in their efforts.[414]

"Past federal deference to state water law and policy has been based largely on the notion that states and localities are better qualified to make decisions that are influenced by variable local physical and economic conditions."[415] Although the federal government has "influenced state water law and policy through financial investments in infrastructure and technology," through regulations designed to address issues like environmental protection, and through the resolution of interstate disputes, "only rarely [has the federal government] disturbed the core authority of the states to allocate water resources among competing users—what might be viewed as the heart of water law and policy."[416]

As illustrated by recent energy-based policy initiatives, an attempt by policymakers to avoid triggering the federalism-related challenges often associated with water-based initiatives by using energy-based regulatory schemes to create a sustainable energy economy is likely to prove ineffective for several reasons. First, because of the energy–water nexus, policy initiatives that fail to take water resources into consideration only exacerbate existing problems which, in turn, only undermines the very energy-based policies being pursued. Second, federalism-related challenges are not altogether avoided by legislating in the energy policy arena. Similar to the degree of federal deference afforded states in their role as water resource managers, the federal government has often deferred to the states in energy facility siting decisions and in regulating the operation of energy production facilities.[417]

Even in the context of regulating nuclear power, Congress has made it clear that excepting issues relating to nuclear power plant *safety*, state regulatory schemes govern. As articulated in Section 274(k) of the AEA, "[n]othing in this section shall be construed to affect the authority of any State or local agency to regulate activities for purposes other than protection against radiation hazards."[418] Moreover, the Supreme Court has identified the AEA as an example of Congress legislating "in a field which the States have traditionally occupied."[419] Specifically,

> Congress, in passing the 1954 Act and in subsequently amending it, intended that the Federal Government should regulate the radiological safety aspects involved in the construction and operation of a nuclear plant, but that the

414 Omnibus Public Lands Management Act of 2009, 42 U.S.C. § 10361(4) (Supp. III 2006).

415 Adler, *supra* note 411, at 31.

416 *Id.* at 60.

417 *See* BOSSELMAN ET AL., *supra* note 36, at 13 (noting that "state systems . . . have not been replaced by the new federal regulatory programs"); *infra* text accompanying note 410–11.

418 Atomic Energy Act of 1954, 42 U.S.C. § 2021(k) (2006).

419 Pac. Gas & Elec. Co. v. State Energy Res. Conservation & Dev. Comm'n, 461 U.S. 190, 206 (1983) (quoting Rice v. Santa Fe Elevator Corp., 331 U.S. 218, 230 (1947)).

> States retain their traditional responsibility in the field of regulating electrical utilities for determining questions of need, reliability, cost, and other related state concerns.[420]

As further articulated by the NRC Atomic Safety and Licensing Appeal Board, "[s]tates . . . retain the right, even in the face of the issuance of an NRC construction permit, to preclude construction on such bases as a lack of need for additional generating capacity or the environmental unacceptability of the proposed facility or site."[421]

Because of the historic roles that states have played in decisions relating to water resource management and energy production, under the political and legal mechanisms currently in place, any legislative initiative targeted at creating and maintaining a sustainable energy economy by way of water resource management will implicate federalism concerns. As such, in any responsive legislation, policymakers will be called upon to strike the "proper" balance between federal and state governmental authority.

B. Challenges Associated with Pursuing National Watershed Planning: Identifying the Appropriate Governance Structure

In addition to federalism-related concerns, policymakers striving to lay the groundwork for creating a more sustainable energy economy will also be required to contend with the related and equally challenging issue of determining the most effective governance structure. On the issue of governance, the national, international, and global nature of climate change-related issues have prompted many policy analysts to call for a "fundamental reassessment" of existing governance structures—one that shifts the balance of federalism and incorporates considerations relating to the "character of different environmental problems and the appropriate contributions that different levels of government can make in solving them."[422] Similar governance issues arise in the context of achieving sustainability of our water resources.

Because states have historically played a primary decision-making role in the areas of water law and policy, current regulatory regimes arguably place the burden of developing a "more sustainable energy economy" squarely on the shoulders of the states. Given the national, international, and global scale of the issues policymakers are looking to address, however, placing this obligation or this power in the hands of states operating in furtherance of state interests results in a mismatch of both "natural and political scales."[423] This mismatch of scales arguably imposes significant constraints on any attempt to develop effective regional, national,

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420 *Id.* at 205.

421 *Consol. Edison Co. of N.Y. Inc.*, 7 N.R.C. 31, 34 (1978).

422 DAVID SCHOENBROD ET AL., BREAKING THE LOGJAM: ENVIRONMENTAL PROTECTION THAT WILL WORK 45 (2010).

423 *See* RUHL, *supra* note 1, at 21.

international, and global solutions to the problems policymakers are hoping to address.

Proffered approaches to address governance-related challenges have ranged from encouraging an "enhanced federal role in water resource law and policy"[424] to implementing a "national water policy"[425] to the suggestion that Congress must "undertake wholesale change in the statutes."[426] Another theory views the issue as one involving a "trade-off: deference to states in water matters comes at a cost of protecting national interests."[427] In the end, how, and whether, federalism will be rebalanced and the governance structure that will be identified by policymakers as most effective in addressing challenges relating to sustainability of water resources and responding to dilemmas that exist at the energy–water nexus remain to be seen. The final framework will surely remain a subject of political and scholarly debate for years to come.

That notwithstanding, in the context of today's regulatory regime, one thing remains clear—because of the historical role that states have played in water management and energy production, and because of the national, international, and global interests at stake, the policy framework designed to address issues arising at the intersection of energy and water will require the active participation of, and commitment by, both federal and state governments. The challenge lies in designing a framework that capitalizes on the "comparative advantage[s] in dealing with various environmental issues,"[428] while remaining true to historic state and federal roles in water resource management and energy-based decisions.

C. Taking Steps Toward Achieving a More Sustainable Energy Economy: Cooperative National Watershed Planning and Management

A cooperative large-scale watershed planning and management effort requires integrated planning on a number of levels. First, because of the dynamics of the energy–water nexus, this planning effort requires the integration of two historically highly compartmentalized policy areas—energy policy and water policy. The integration of these policy arenas must take place on both federal and state governance levels, throughout decision-making concerning energy siting and water resource management and allocation.

Additionally, a successful watershed planning effort will require participation by both federal and state stakeholders. Existing and future federal hydroelectric projects as well as the national, international, and global-level implications associated with decisions made in this arena, particularly in the context of national security and climate change, calls for

424 Adler, *supra* note 411, at 7–8.
425 Leshy, *supra* note 189, at 144.
426 *See* SCHOENBROD ET AL., *supra* note 422, at 29.
427 Reed D. Benson, *Deflating the Deference Myth: National Interests vs. State Authority Under Federal Laws Affecting Water Use*, 2006 UTAH L. REV. 241, 316 (2006).
428 SCHOENBROD ET AL., *supra* note 422, at 47.

federal involvement in the watershed planning efforts. By the same token, for federalism-related concerns, and because states have played a primary role in water management and allocation, and in energy production and siting, states are well positioned from a governance perspective to play a primary role in achieving sustainability of our water resources. Provisions of the recently enacted OPLMA represent the beginning of the integration of energy and water policy on a federal level. With some limitation, OPLMA may also provide the means by which to achieve the integration of federal and state efforts in cooperative watershed planning.

1. OPLMA: The Integration of Energy and Water Policy on the Federal Level

As detailed in Part IV of this Article, OPLMA integrates water planning and energy production in the context of its NWAUAP and in the context of federal hydroelectric power generating facilities, the segment of energy production over which the federal government exercises primary jurisdiction.[429] In connection with maintaining its national water use inventory and conducting the ongoing assessment of water availability under the NWAUAP, OPLMA charges the Department of Interior (DOI) with improving the ability to forecast water availability for energy production.[430] Moreover, DOI must identify water use trends associated with the energy sector generally,[431] and specifically, with development of new energy supplies.[432]

Further integration of energy and water policy on the federal level can be seen in OPLMA's "climate change adaptation program" designed to identify the risks and effects of climate change-related impacts to watersheds that support federally authorized reclamation projects.[433] Under this program, DOI is charged with developing strategies, "at watershed and aquifer system scales," to address potential water shortages, conflicts, and other potential impacts to water users.[434] To the extent that changes in water supplies are expected to impact hydroelectric power generation facilities, DOI is further called on to develop strategies, in consultation with non-Federal participants, that will mitigate any impact to these facilities.[435]

Inasmuch as the integration of energy and water policy is beginning on the federal level, two "integration components" that make up the recommended policy framework by which to create a more sustainable energy economy remain largely unaddressed—these include the integration of energy and water policy on the state level and the vertical integration of federal and state watershed planning efforts. With some limitation, Title VI

429 *See supra* Part V.B.

430 Omnibus Public Land Management Act of 2009, 42 U.S.C. § 10368(a)(6) (Supp. III 2006).

431 *Id.* § 10368(d).

432 *Id.*

433 *See id.* § 10363(a).

434 *Id.* § 10363(a)(2).

435 *Id.* § 10363(b)(3)–(4).

of OPLMA provides a starting point by which to address both of these remaining components.

2. OPLMA Title VI: The Integration of Federal and State Watershed Planning Efforts

OPLMA Title VI Subtitle A entitled "Cooperative Watershed Management Program"[436] (the "Watershed Program") appears to provide a preliminary policy framework by which to structure the large-scale watershed planning initiative contemplated by this Article with one major exception—it fails to ensure the participation of state stakeholders in the watershed management and planning process. For those stakeholders choosing to participate in OPLMA's Watershed Program, however, Title VI provides the means by which to expand and integrate the watershed planning efforts already underway on every level of governance.

The Watershed Program authorizes DOI to establish a grant program by which DOI shall provide grants to form or enlarge a watershed group and to conduct one or more projects "in accordance with the goals of a watershed group."[437] Title VI defines "watershed group" as a "self-sustaining, cooperative watershed-wide group" that is comprised of and incorporates the perspectives of a wide array of affected stakeholders including, among others, *hydroelectric production*, irrigated agricultural production, the environment, potable water purveyors and industrial water users, private property owners within a watershed, and federal, state, and local agencies that have authority with respect to the watershed.[438] The watershed group addresses water availability and quality issues, makes decisions on a consensus basis, and is "*capable of promoting the sustainable use of the water resources of the relevant watershed and improving the functioning condition of rivers and streams* through—water conservation; improved water quality; ecological resiliency; and the reduction of water conflicts."[439]

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436 Pub. L. No. 111-11, § 6001, 123 Stat. 1165 (2009) (codified at 16 U.S.C. § 1015 (Supp. III 2006)).

437 Omnibus Public Lands Act of 2009, 16 U.S.C. § 1015a(a) (Supp. III 2006).

438 *Id.* § 1015(5).

439 *Id.* § 1015(5)(D) (emphasis added). Specifically, "watershed group" is defined as a "self-sustaining, cooperative watershed-wide group that—

> (A) is comprised of representatives of the affected stakeholders of the relevant watershed;
>
> (B) incorporates the perspectives of a diverse array of stakeholders, including, to the maximum extent practicable—
>
> (i) representatives of—
>
> (I) hydroelectric production;
>
> (II) livestock grazing;
>
> (III) timber production;
>
> (IV) land development;

Under the grant program, the DOI may award a grant recipient three "phases" of grants. First phase grants of up to $100,000 per year for up to a three-year period[440] are awarded to eligible recipients "to establish or enlarge a watershed group; to develop a mission statement for the watershed group; to develop project concepts; and to develop a restoration plan."[441] The second phase grants of up to $1 million per year for up to a four-year period[442] are awarded to "plan and carry out watershed management projects."[443] And third phase grants of up to $5 million per year for up to a

(V) recreation or tourism;

(VI) irrigated agricultural production;

(VII) the environment;

(VIII) potable water purveyors and industrial water users; and

(IX) private property owners within the watershed;

(ii) any Federal agency that has authority with respect to the watershed;

(iii) any State agency that has authority with respect to the watershed;

(iv) any local agency that has authority with respect to the watershed; and

(v) any Indian tribe that —

(I) owns land within the watershed; or

(II) has land in the watershed that is held in trust;

(C) is a grassroots, non-regulatory entity that addresses water availability and quality issues within the relevant watershed;

(D) is capable of promoting the sustainable use of the water resources of the relevant watershed and improving the functioning condition of rivers and streams through—

(i) water conservation;

(ii) improved water quality;

(iii) ecological resiliency; and

(iv) the reduction of water conflicts; and

(E) makes decisions on a consensus basis, as defined in the bylaws of the watershed group." *Id.* § 1015(5).

440 *Id.* § 1015a(c)(2)(A)(i).

441 *Id.* § 1015a(c)(2)(A)(ii).

442 *Id.* § 1015a(c)(2)(B)(i).

443 *Id.* § 1015a(c)(2)(B)(ii). Section 1015(6) defines the term "Watershed Management Project" as "any project (including a demonstration project) that—

(A) enhances water conservation, including alternative water uses;

(B) improves water quality;

(C) improves ecological resiliency of a river or stream;

(D) reduces the potential for water conflicts; or five-year period[444] are awarded to "plan and carry out at least 1 watershed management project."[445]

Insofar as OPLMA's Watershed Program specifically incorporates issues relating to hydroelectric production, it promotes the integration of energy and water policy on the federal level. However, promoting the sustainable use of water resources, by definition, also requires consideration of impacts on the watershed caused by other forms of energy production, most of which are managed on the state-level, including nuclear power generation and renewable energy production. Because a watershed group is meant to be comprised of all affected stakeholders, consideration of energy–water issues relating to thermoelectric and renewable energy production would presumably be incorporated into any cooperative watershed planning and management effort. To ensure consideration of these issues, however, and to promote the integration of energy and water policy on a state-level, it is necessary to consider all forms of energy production in the context of watershed planning and management.

Insofar as the Watershed Program calls for participation by all affected stakeholders, including federal and state agencies with authority over the watershed, it appears to promote the integration of federal and state-based planning efforts. While participation in this large-scale planning effort is likely to undermine the historic control that states have exercised over water policy decisions, it remains unclear whether OPLMA's Watershed Program provides the incentive necessary to ensure participation by all "affected stakeholders." With crises looming in many areas of our water sector and in the shadow of additional climate change-related impacts, achieving sustainability of our nation's water resources may be impossible without state buy-in to the planning effort. Consequently, this Article suggests that the proposed national watershed planning initiative be structured to increase the likelihood of state participation either through cooperative federalism or by creating meaningful incentives.

3. Cooperative Watershed Planning: Ensuring Participation by the States

Federally structured cooperative federalism has already been effectively used to achieve national goals relating to the quality of the nation's waters. Under the framework of cooperative federalism, "federal and state governments work together in structured, overlapping, and synergistic ways to achieve mutual goals,"[446] as exemplified by the CWA, which involved improved water quality.[447] In that instance, the cooperative

(E) advances any other goals associated with water quality or quantity that the Secretary determines to be appropriate." *Id.* § 1015(6).

444 *Id.* § 1015a(c)(2)(C)(i)(I).

445 *Id.* § 1015a(c)(2)(C)(ii). The grant program is structured as a cost share which requires watershed groups performing projects under second and third phase grants to contribute at least 50% of the total cost of the watershed management activities. *Id.* § 1015a(d).

446 Craig, *supra* note 184, at 202.

447 *Id.*

federalism approach came only after Congress determined that national interests were at stake and the states' efforts were inadequately advancing these national interests.[448]

Achieving energy independence, developing effective climate change-related mitigation and adaptation strategies, and becoming a global leader in renewable energy production are currently a few of the more significant national policy interests. Whether policymakers perceive these interests as being threatened by state action (or inaction) may determine whether Congress makes a "conscious and deliberate federal intervention"[449] into an area of law historically belonging to the states.

A second, less federally invasive approach, and one that is recommended here, takes the form of an "Economic Incentive Program"—a program designed to "tap into basic economic interests, using constructed market frameworks or direct incentives, to induce desired behavior or otherwise make it more likely to occur."[450] In other words, "[t]ying meaningful strings to federal aid."[451] Conditioning federal aid on state water law or policy reform is an approach that has been utilized in the past and could be an effective means by which to obtain state buy-in to national watershed planning under an overarching federal framework.

The CWA presents an example of an incentive-based regulatory program.[452] In an effort to control the amount of sewage being discharged into navigable waters, Congress provided infrastructure grants that greatly increased the amount and effectiveness of sewage treatment in the United States.[453] Ironically enough, this infrastructure, which is now breaking down, may provide the very avenue by which incentive legislation could be designed.

States are facing significant costs associated with addressing the growing problem of inadequate and aging water infrastructure.[454] These escalating costs could provide the incentive necessary to induce states to take part in this national watershed planning effort. In return for participation in watershed planning, the federal government could offer grants to assist states in tackling this growing problem—and it is a problem. The nation's 1 million miles of water mains are aging.[455] The age of some

448 *Id.* at 206.

449 *Id.* at 207.

450 J.B. Ruhl, *Endangered Species Act Innovations in the Post-Babbittonian Era—Are There Any?*, 14 DUKE ENVTL. L. & POL'Y F. 419, 429 (2004).

451 Leshy, *supra* note 189, at 152.

452 *See* Clinton W. Shinn, *The Federal Grant Program to Aid Construction of Municipal Sewage Treatment Plants: A Survey of the 1972 FWPCA Amendments*, 48 TUL. L. REV. 85, 87–88 (1974).

453 *Id.* at 86–88.

454 Michael Cooper, *In Aging Water Systems, Bigger Threats Are Seen*, N.Y. TIMES, Apr. 19, 2009, at A14.

455 *See* NAT'L INST. OF STANDARDS AND TECH., ADVANCED SENSING TECHNOLOGIES FOR THE INFRASTRUCTURE: ROADS, HIGHWAYS, BRIDGES AND WATER 2 (2008), *available at* http://www.nist.gov/tip/prev_competitions/upload/cnn_white_paperfinal.pdf.

system components surpasses the 100-year mark[456] raising serious public health concerns and causing an estimated loss of approximately 1.7 trillion gallons of water per year at an annual national cost of $2.6 billion.[457] And "[some] experts fear that the problem is getting worse."[458]

Evidence of failing water systems exists nationwide:[459] "Each day, one can find news reports that a half-dozen or more communities are affected by 'boil water' alerts due to water main breaks or other failures within their water-delivery system."[460] In one Colorado community, water storage tanks with leaking rivets were the suspected cause of drinking water contamination leading to 389 cases of illness and resulting in a boil order for approximately 8,500 residents.[461] Washington D.C. averages a pipe break every day and intense rains have reportedly overwhelmed the city's systems causing untreated sewage to flow into the Potomac and Anacostia Rivers.[462] According to an EPA report some 240,000 water mains break per year.[463] Moreover, USGS estimates indicate a resulting loss of up to 6 billion gallons of drinking water each day.[464]

Although an economic incentive program will certainly raise budgetary concerns given the state of the current federal budgetary crisis, policymakers can rest assured in knowing that, as is also the case in the context of issues existing at the energy–water interface, the costs associated with dealing with infrastructure problems later will certainly exceed the costs associated with dealing with them today particularly as portions of infrastructure approach the end of operational life spans. Deferred maintenance or a "run to failure" will inevitably increase long-term costs and damage the environment, will result in a loss of scarce natural resources, and will lead to service disruptions that harm customers.[465] Unfortunately,

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456 OFFICE OF RESEARCH AND DEV., U.S. ENVT'L PROT. AGENCY, AGING WATER INFRASTRUCTURE RESEARCH PROGRAM: ADDRESSING THE CHALLENGE THROUGH INNOVATION 3 (2007), *available at* http://www.epa.gov/nrmrl/pubs/600f07015/600f07015.pdf.

457 *Id.* at 2.

458 Cooper, *supra* note 454.

459 *See* Susan Thornton, *A Quiet Crisis Below Ground*, THE DENVER POST, Sept. 18, 2008, *available at* http://www.denverpost.com/thornton/ci_10492095 (noting EPA nationwide estimates of "a $540 billion gap between what communities are spending on water infrastructure and the actual investments needed").

460 NAT'L INST. OF STANDARDS AND TECH., *supra* note 455, at 2.

461 Thornton, *supra* note 459; NAT'L INST OF STANDARDS AND TECH., *supra* note 455, at 2 ("Drops in water system pressure, resulting from water main breaks, lead to microbial contamination of drinking water.").

462 Charles Duhigg, *Repair Costs Daunting as Water Lines Crumble*, N.Y. TIMES, Mar. 15, 2010, at A1, A15.

463 OFFICE OF RESEARCH AND DEV., *supra* note 456, at 2.

464 NAT'L INST. OF STANDARDS AND TECH., *supra* note 455, at 2; *see also* G. KUNKEL, PHILA. WATER DEP'T., DEVELOPMENTS IN WATER LOSS CONTROL POLICY AND REGULATION IN THE UNITED STATES 3 (2005) *available at* http://waterloss2007.com/Leakage2005.com/pdf/Developments (describing the 1995 USGS estimate of "public use and loss" in water withdrawals).

465 CLEAN WATER COUNCIL OF N. J., DRAFT RECOMMENDATIONS FOR WATER INFRASTRUCTURE MANAGEMENT AND FINANCING: WHITE PAPER FOR PUBLIC HEARING AND COMMENT, OCTOBER 12, 2010, at 1 (2010) *available at* http://www.nj.gov/dep/cleanwatercouncil/pdf/2010_recommendations_water_infrastructure_financing_draft_public_release_1.pdf.

deferred maintenance has been the approach taken by many municipalities and states for decades[466] and operation, maintenance, and capital investment in these failing systems have been seriously underfunded.[467] According to EPA's Aging Infrastructure Research program, "if operation, maintenance, and capital investment remain at [2007] levels, the potential funding shortage for drinking water and wastewater infrastructure could exceed $500 billion by 2020."[468]

Incentives for infrastructure improvements on the energy front are also available. The electric grid, for one thing, is in serious need of upgrade with the expansion and improvement of the electric grid already having been the focus of legislative initiatives.[469] Moreover, in order to meet our renewable energy goals, thousands of miles of transmission lines are needed to bring power from renewable resources, which are often located far from load centers, to customers.[470] Additional power lines are also needed to connect renewable resources to the grid.[471]

Building the infrastructure necessary to access power generated by renewable resources is fundamental to achieving a "more sustainable energy economy." ARRA, for example, appropriated $4.5 billion to DOE to be used for "electricity delivery and energy reliability activities to modernize the electric grid," which includes "implementation of [the] Smart Grid programs created in [EISA]."[472] ARRA further provides ratemaking incentives for investor-owned utilities that propose to build transmission facilities that will improve reliability or reduce congestion.[473] Under an economic incentive program, funding by the federal government to assist the states in paying for the necessary development, repair, and replacement of energy and water-based infrastructure, like the appropriations or incentives seen in ARRA, could be used as a "carrot" to secure commitment by receiving states to participate in the national water planning and management effort outlined above.

VII. CONCLUSION

Perhaps without realizing, recent energy-based policy decisions have charted a course for the energy sector that threatens the viability of one of our most vital natural resources—water. To avoid the potential catastrophe that awaits us if we stay true to this course, policymakers must become well versed in the energy–water nexus, and this knowledge must provide the

466 Duhigg, *supra* note 462, at A15.

467 *See* OFFICE OF RESEARCH AND DEV., *supra* note 456, at 3.

468 *Id.*

469 *See, e.g.*, American Recovery & Reinvestment Act of 2009, Pub. L. No. 111-5, § 3(a)(4), 123 Stat. 115 (establishing one of the Act's purposes as "[t]o invest in transportation, environmental protection, and other infrastructure that will provide long-term economic benefits").

470 McGrew, *supra* note 283, at 1.

471 *Id.* at 14.

472 Kenneth B. Driver, *Annual Report: VI. Electricity*, 2009 PUB. UTIL. COMM. & TRANSP. L. 79, 82 (2009).

473 *Id.*

framework by which future energy-based policy decisions are made. In addition to the survival of our economy and our way of life, achieving sustainability of our nation's water resources is vital to creating the more sustainable energy economy necessary to support energy-independence, renewable energy, and climate change-related goals.

Creating a sustainable energy economy calls for achieving sustainability of our nation's water resources—a task that requires a large-scale national watershed planning effort. The enormity of the task before us is enough to give pause to even the most ardent protectors of water resources. Recent legislation, however, may provide the starting point by which to address many of these vital issues. Success lies in ensuring the necessary participation by all affected stakeholders and in incorporating the dynamics of the energy–water nexus. In short, "[w]hether proponents realize it or not, any plan to switch from gasoline to electricity or biofuels is a strategic decision to switch our dependence from foreign oil to domestic water."[474] A policy framework must be put in place to ensure that our nation's water resources can withstand the growing demands that are sure to arise from the transformation of the United States energy economy to a "sustainable energy economy."

474 Webber, *supra* note 13, at 38.