# THIRSTY ENERGY

## Summary of the Initiative (2014-2018)

***The Water-Energy Challenge***

Significant amounts of water are needed in almost all energy generation processes, from generating hydropower, to cooling and other purposes in thermal power plants, to extracting and processing fuels. Conversely, the water sector needs energy to extract, treat, and transport water. Both energy and water are used in the production of crops, including those used to generate energy through biofuels. Population growth and rapidly expanding economies place additional demands on water and energy, while several regions around the world are already experiencing significant water and energy shortages.

Today, more than 780 million people lack access to potable water (WWAP, 2014), and over 1.3 billion people lack access to electricity (IEA, 2012). At the same time, estimates show that by 2035, global energy consumption will increase by 35%, while water consumption by the energy sector could increase by 85% (IEA, 2012). Climate change will further challenge water and energy management by causing more water variability and intensified weather events, such as severe floods and droughts. Despite these concerns, current energy planning and production is often made without taking into account existing and future water constraints.

***Thirsty Energy Initiative***

In order to address challenges presented by energy and water resource planning, the World Bank launched the Thirsty Energy initiative. The aim of the initiative was to help countries integrate water constraints into the energy sector and better address water and energy challenges, preparing them for an uncertain future by: 1) Identifying synergies and quantifying tradeoffs between energy development plans and water use; 2) Piloting a set of water-smart energy planning tools to promote a more sustainable development of energy resources; 3) Helping governments coordinate decision-making and enhance sustainable development; and 4) Raising awareness of the water-energy challenges, and promoting a dialogue between government, international organizations, and the private sector.

In order to achieve the abovementioned points, Thirsty Energy's activities were implemented at two different levels. At the global level, Thirsty Energy focused on a strong communication strategy, participating in international conferences, publishing material on the topic, and engaging in the international dialogue. At the country level, and through demand-based work, Thirsty Energy tailored approaches depending on the available resources, modeling experience, and institutional and political realities of the country. In order to ensure client ownership and successful integrated planning, Thirsty Energy focused on building the capacity of relevant stakeholders and leveraging existing efforts and knowledge.

***Funding and support***

Thirsty Energy was supported by the World Bank Water Global Practice and the Energy Global Practice. Funding for the initiative was provided by the World Bank's Water Partnership Program (WPP), the Energy Sector Management Assistance Program (ESMAP), and the Korean Green Growth Trust Fund (KGGTF).

***Lessons Learnt***

The water-energy nexus is context/regional specific, with variations in water resources due to geography, population, economic growth, demand, energy mix, and climate change. These factors can combine to create 'hot-spots' where the water-energy nexus is more challenging than elsewhere. It is therefore important to understand the regional challenges and devise context specific solutions to address the nexus in these critical hot-spots.

In the case studies undertaken by the initiative, the results show that accounting for the regional variability of water supply and the associated costs of water supply infrastructure can significantly impact energy planning, especially in a water-scarce country like South Africa. The case studies highlight the importance of the spatial component of energy and water resources—particularly in countries where water availability varies widely from region to region—and its potential impacts on the overall cost of different energy technologies. The case studies also show that specific energy sector policies can have significant implications for new investment in water supply infrastructure and, in some cases, can strand water supply investments (and vice versa). However, if decision makers plan in a more integrated manner they can ensure the robustness of water supply for energy and for other water users, thus maximizing the value of both energy and water infrastructure investments. Another conclusion from the case studies is that policies being pursued to mitigate climate change impacts could reduce both $CO_2$ emissions and water needs by the energy sector—with only modest increase in energy system cost.

**The importance of nexus solutions to achieve the SDGs.** Water availability is a necessary condition for reaching universal energy access and meeting the future energy needs both in developing and developed countries, as almost all energy generation processes require water. The water sector can benefit from universal energy access by improving access to reliable, affordable, and safe water supplies. However, if energy resources are developed without taking into account water needs and without monitoring pollution, energy access can have a negative impact on water resources. Water scarcity can threaten the long-term viability of energy projects and, conversely, energy processes can impact water resources and limit the water available for other users. Therefore, understanding the water–energy interrelationship is critical to building more resilient and sustainable energy systems. We need to foster initiatives that encourage cross-sectoral collaboration, given that decisions in one sector have many consequences in another. For example, increasing the share of biofuels in renewable energy generation may have a greater impact on water resources than other renewables. The nexus challenges cannot be addressed in isolation.

**Infrastructure investments made today are critical.** Choices and decisions about which extraction facilities to develop and where, which power plants to build, which to retire, and which energy or

cooling technologies to deploy and develop matter. Energy infrastructure is designed to last for decades and thus, decisions should be made taking into account future water availability including climate change impacts and increasing future competing water demands across sectors. Energy projects need to assess if their water supply is sustainable now and into the future and it is imperative to take into account and anticipate any future tradeoffs across different water users.

***Outcomes***

The initiative has improved collaboration between the water and energy practices, leveraging the skills from both units in the World Bank. The initiative has also enabled the World Bank to be involved in the water-energy nexus discussions around the world, and improved collaboration with other international organizations such as the International Energy Agency, the United Nations, GIZ, the US Energy Department, the Stockholm International Water Institute, etc.

The initiative has carried 3 case studies in South Africa, China, and Morocco. Through these case studies, Thirsty Energy has developed and piloted water-smart energy planning tools to promote a more sustainable development of energy resources. The case studies have been documented and shared, so countries facing similar challenges can address the water-energy issues and enhance sustainable development. The case studies summarize the analysis and demonstrate the process and type of tools that can be employed to examine the water-energy nexus and the insights that can be gained from water-smart energy planning.

**Increased awareness on the water-energy nexus.** Thirsty Energy has presented at a number of international events, including the SE4All Forum, United Nations Water Conference, African Utility Week, and World Water Week, raising awareness of the water-energy challenges and promoting dialogue among government, international organizations, and the private sector. Several communication materials have been prepared, including two sets of infographics in several languages, which have proven to be very successful to raise awareness of the topic, feature stories, blogs, etc. The messages have been picked up by the media and the general public, especially during events on water and energy. All the material (reports, brochures, infographics, presentations, interviews, blogs, etc.) can be found in the Initiative's website: http://www.worldbank.org/thirstyenergy

## Activities at a Global Level:

***Launch of the initiative and global reach:***

Thirsty Energy was officially launched on January 2014 at the joint closing session of the World Future Energy Summit (WFES) and the International Water Summit (IWS) in Abu Dhabi. The conference had over 25,000 attendees from over 130 countries, including political, corporate, and non-governmental leaders in energy from around the world. The launch also comprised a high-level panel discussion with Rachel Kyte (World Bank Group Vice President) introducing the initiative. The panel included H.E. Dr. Thani Ahmed Al Zeyoudi (Head of Directorate, Energy and Climate Change, Ministry of Foreign Affairs, UAE), Maria van der Hoeven (Executive Director, International Energy Agency), Torgny

Holmgren (Executive Director, SIWI), William Rex (Acting Manager, TWIWA), Vivien Foster (Sector Manager, Energy Unit), Guillermo Bravo (VP, Abengoa), and Loic Douillet (VP, Alstom).

Extensive communications materials were prepared and distributed during the events, including infographics and a brochure, to ensure the key messages of the initiative were being communicated effectively. There were several interviews and exchanges with media, and the Bank also prepared a blog titled "4 Ways Water Shortages are Harming Energy Production;" a feature story and press release; and updated the Thirsty Energy website with additional material. During the launch, over 70 media sites and blogs had articles highlighting the initiative, including an article in the Guardian Sustainable Business and a blog in Forbes Magazine. On Twitter, among many others, Fareed Zakaria of CNN with 429,287 followers tweeted about Thirsty Energy; Green Energy News with 78,200 followers; the Guardian Sustainable Business with 64,700 followers, Environmental Defense Fund with 62,600 followers; IEA with 33,651 followers; McKinsey on Society with 22,072; and Alstom Power with 12,989 followers. From January 17-31, the online package received over 23,000 page views (an average of over 1,500 page views/day) and more than 500 publication downloads.

***Material published and disseminated***

- **Working Paper: Thirsty Energy:** The first working paper of the initiative, Thirsty Energy, has been published and disseminated. It introduces the energy-water nexus, examines the water requirements of power generation, and outlines some potential technical and institutional solutions for improving the management of the nexus.
- **Case Study Report:** Modeling the Water-Energy Nexus: How Do Water Constraints Affect Energy Planning in South Africa?
- **Case Study Report:** Thirsty Energy: Modeling the Water-Energy Nexus in China
- **Brief:** Thirsty Energy: Understanding the Linkages between Energy and Water
- **Brief:** Thirsty Energy (II): The Importance of Water for Oil and Gas Extraction
- **ESMAP- Report:** Special Feature: Energy Access and the Energy-Water Nexus.
- **Other communication Material:**
    - Infographic: Why Does the Energy Sector Need Water?
    - Infographic: Thirsty Energy - Energy and Water's Interdependence
    - Feature Story: Will Water Constrain Our Energy Future?
    - Feature Story: Thirsty Energy: Water-Smart Energy Planning in South Africa
    - Blog: Ahead of World Water Day: Let's Talk about … Energy?
    - Blog: 4 Ways Water Shortages Are Harming Energy Production
    - Blog: Thirsty Energy: Making the Energy-Water Nexus Work For Us

All this material and other (brochures, presentations, interviews, etc.) can be found in the Initiative's website: http://www.worldbank.org/thirstyenergy

*Highlight:* The Thirsty Energy infographics have been the most viewed infographics of the entire World Bank website in 2014 (see http://blogs.worldbank.org/voices/globaldev-what-caught-your-attention-2014 ) and the most retweeted material from World Bank water in 2014 (see https://storify.com/worldbank/worldbankwater-year-in-review)

Some examples of Thirsty Energy in the media:

- Actu Environnment: Quand l'énergie a soif : vers une gestion conjointe des ressources? (September 8, 2014)
- Ecosystem Marketplace: World Bank Initiative Moves Talk On Water Energy Nexus To Action, Interview with Diego J. Rodriguez, Senior Economist (August 13, 2014)
- El Pais: América Latina debe cuidar el agua para calmar su sed de energía (August 11, 2014)
- OOSKA News: Climate Change Critical to World Bank's Thirsty Energy Initiative (May 27, 2014)
- Engerati: Video: African Utility Water Week, Interview with Diego J. Rodriguez, Senior Economist (May 27, 2014)
- CNBCAfrica: Africa's Power Story, Interview with Diego J. Rodriguez, Senior Economist (May 14,2014)
- The Guardian: Thirsty energy: the conflict between demands for power and water (Feb 6, 2014)
- Forbes: World Bank's Announcement of 'Thirsty Energy' Initiative Signals Growing Importance of Energy-Water Nexus (Feb 5, 2014)
- Interview with Diego J. Rodriguez, Senior Economist, Water Unit, The World Bank. "The World Bank's Thirsty Energy initiative: Will water constrain our energy future?"

***Events where the initiative was presented:***

- **2018 – March:** 8th World Water Forum, Brasilia, Brazil. Diego Rodriguez, Senior Water Resources Management
- **2017 – June:** Conference on Infrastructure and Sustainability, organized by ICEX and the Ministry of Economy, Industry, and Competitiveness of Spain. Madrid, Spain.
- **2015 – April:** 7th World Water Forum, Daegu, Korea. Diego Rodriguez, Senior Economist of the Water Global Practice presented the initiative in 2 sessions
- **2015 – April:** IADB Workshop on "Capacity Building on Water and Sanitation", Quito. Presentation: Agua y energía: tratando de entender una inter-dependencia compleja. Anna Delgado, Technical Specialist (*in Spanish*)
- **2015 – March: Water Week Latinoamerica 2015,** Vina del Mar, Chile (March 2015). Module 3: Water and Energy Scenarios Panel (March 2015). Presentation: "Thirsty Energy – Energia Sedienta" (PPT). Anna Delgado, Technical Specialist *(in Spanish)*
- **2014 – November**: **XXVIII Annual Convention of the National Association of Water Utilities** (ANEAS in Spanish), Merida, Mexico. Presentation: "Opportunities for synergies in the water and energy sectors" (PPT). Diego J. Rodriguez, Senior Economist *(in Spanish)*
- **2014 – September**: **World Water Week 2014,** Stockholm, Sweden. Presentation: Producing Electricity with less water panel "Thirsty Energy, a World Bank Initiate" (PPT) Diego J. Rodriguez, Senior Economist
- **2014 – June**: **UN Sustainable Energy For All Forum** United Nations HQs, NYC. Anna Delgado, Technical Specialist presented the initiative in the Water-Energy-Food Nexus panel.
- **2014 – May**: **Clean Energy Ministerial 5 (CEM5).** Seoul, Korea. Roundtable: The Energy-Water Nexus: Overview and Relevance for the CEM.

- **2014 – May**: **African Utility Week,** Cape Town, South Africa. Interview with Diego J. Rodriguez, Senior Economist, Water Unit. "The World Bank's Thirsty Energy initiative: Will water constrain our energy future?"
- **2014 – May**: **The Global Water Investment Summit**. London, UK
- **2014 – March: Nexus 2014: Water, Food, Climate and Energy Conference.** Chapel Hill, USA. Presentation: "Thirsty Energy" (PPT), Anna Delgado Martin, Technical Specialist. Video here
- **2014 – January**: **World Future Energy Summit: Launch of Thirsty Energy and High Level Panel Discussion**, Abu Dhabi, UAE
- **2014 – January**: **2014 UN-Water Annual International Conference,** Zaragoza, Spain. Presentation: "Interlinkages and trade-offs Between Water and Energy." (PPT) Diego J. Rodriguez, Senior Economist and Thirsty Energy Task team Leader. Presentation: Understanding the Water Requirements of the Power Sector" (PPT) Anna Delgado Martin, Technical Specialist. Videos of the presentations can be found here
- **2013 – September: World Water Week 2013,** Stockholm, Sweden. Presentation: "Quantifying the Trade-Offs of the Water and Energy Nexus" (PPT) Diego J. Rodriguez, Senior Economist
- **2013 – March: World Bank Sustainable Development Network Forum 2013,** Washington DC, USA. Presentation: "Vulnerability, Response and Resilience of Energy Sector to Climate Change, Water Perspective" (PPT)

***Collaboration with other organizations and institutions:***

Thirsty Energy engaged with diverse partners to share knowledge and best practices, to coordinate dissemination efforts, to prepare events, etc. The team collaborated with several international organizations working on the topic such as the International Energy Agency, UN Water, UN Sustainable Energy for All, GIZ, SIWI, etc. These collaborations, amongst other efforts, have led to the publication of more material on water and energy and on the initiative.

***Thirsty Energy Contributions to other publications:***

- Springer International Publishing. The Importance of the Water-Energy Nexus for Emerging Countries When Moving Towards Below 2 °C. (2018)
- The Water, Food, Energy, and Climate Nexus: Challenges and an Agenda for Action. Chapter 13 of the book "The Challenge of Climate Change in the Energy-Water Nexus"
- International Energy Agency (IEA) and the World Bank. 2015. "Sustainable Energy for All 2015—Progress Toward Sustainable Energy" – chapter on the Nexus (pages 247-256) (June 2015)
- Global Water Forum: Water for thermal power plants: Understanding a piece of the water energy nexus (June 2015)
- World Council of Civil Engineers, UN Water and Fundacion Aquae: Water Monographs II: Water & Energy. (pages 14-23) Issue WM 2-2014, pages 14 to 23. (Winter 2014).
- EY Utilities Unbundled Issue 17 - Quenching energy's thirst. Special feature The water-energy nexus — Part 2 (pages 40-45)
- Global Water Forum Blog: "Integrated Approaches to Addressing Thirsty Energy" (May 2014)
- IFC HandShake: A quarterly journal on PPPs. Issue 13: Power. "Thirsty Energy" pages 38-41. (April 2014)

- Pipeline Magazine. Issue 202: " A fluid situation: the Water-Energy Nexus" (pages 51-53) (April 2014)
- Cornerstone Magazine. "Thirsty Energy: Integrated Energy-Water Planning for a Sustainable Future" pages 9-11. (Spring 2014)
- WWAP (United Nations World Water Assessment Programme): The United Nations World Water Development Report 2014. Water and Energy. Volume 1 Chapter 5 "Infrastructure" pages 48-53 (March 2014)
- World Water Week 2013 Report, "Thirsty Energy: Water for Power Generation – It's not Only Hydropower" pages 40-44. (August 2013)

### *Private Sector Reference Group*

Due to the pivotal role of the private sector in the energy and water sectors, a Private Sector Reference Group (PSRG) was established to share experience and knowledge, to provide technical advice, and to scale-up outreach efforts. Abengoa, Alstom, Veolia and EDF were members of the PSRG.

Thirsty Energy was also part of the International Technical Committee of the Water for Energy Framework (W4EF) Action Group. The main objective of this Action Group, led by EDF and supported by the European Innovation Partnership on Water, was to develop a common terminology and methodology to help energy actors assess the relations between energy production sites and local water environments.

## *Implementation of Work at the Country Level*

### *SOUTH AFRICA*

Background

- Water scarce country with stressed basins and strict water allocation
- Competition for water across sectors will increase – power plants have priority, which could negatively affect other sectors such as agriculture
- Coal Thermal Power plants account for almost 90% of the power capacity installed. Fracking for Shale Gas is being explored, which will put additional pressure on water resources

South Africa was chosen as the first case study of the initiative. Thirsty Energy partnered with the Energy Research Center (ERC) of the University of Cape Town to properly incorporate water constraints in their energy planning tool. The ERC has developed and maintained now for many years an energy optimization model for South Africa (TIMES/MARKAL - SATIM). The ERC has been improving this modeling capacity and the model has been used to inform ESKOM, Ministries of Water and Energy, National Planning Commission, and others, to design a series of national policies on energy, climate and other related issues. The model can now be used to evaluate alternative policies and the impact of those policy decisions on energy and water resources. The energy-water nexus analysis conducted shows that the cost of water supply matters in energy planning in South Africa. For example, when taking water supply infrastructure costs into account, the energy model chooses dry cooling for most power plants. Thus, dry cooling makes economic sense in South Africa, even if it decreases power plant's efficiency and has higher capital costs. This has huge implications for the energy sector's water needs. After

incorporating the true cost of water supply into the energy model, the power sector's water intensity drops by 75%. Once the costs of water are reflected in the model, technologies that are less water intense and that initially seemed more costly become more competitive. This finding is important because it shows that looking at a system as a whole (including water), results in different energy choices than if we just optimize for energy resource development alone. The preliminary results were shared at a technical workshop with key stakeholders such as ESKOM, the Department of Energy, the Water Research Council, and the Centre for Energy Systems Analysis and Research (SANEDI). The feedback from the participants was incorporated in the analysis and in the final report.

One contribution of the new model is its ability to represent the energy sector's water needs by region, and to understand which type of water infrastructure will be required to supply the sector. Given that virtually all water in South Africa is already allocated, any future increased demand for water in the energy sector will require new water infrastructure. However, planning, designing, and building infrastructure require long-term engagement. So, the results from this exercise can help ensure the timely planning of investments for the delivery of water to the energy sector and avoid future financial losses.

The report presents an innovative proof of concept for the integration of water constraints into an energy-planning tool to support decision making. The results highlight the type of tools that can be used to examine the water–energy nexus in the context of a country's development, and the insights that can be gained from water-smart energy planning.

- **A Feature Story was prepared summarizing the conclusions:** Thirsty Energy: Water-Smart Energy Planning in South Africa
- **Case Study Report can be found here:** Modeling the Water-Energy Nexus : How Do Water Constraints Affect Energy Planning in South Africa?
- **PPT Summarizing Main findings can be found here:** PPT

### *CHINA*

Background

- Recent efforts by the National Energy Administration (NEA) to assess water needs by the energy sector and integrate water resource constraints into the upcoming five-year energy plan
- Most of the energy resources in China are in water scarce areas and the NEA wants to understand the impact of water resources on energy development and vice-versa.

The main objective of the activity in China was to support the NEA in its planning process and in its effort to integrate water resources in the five-year energy plan, and to assess the long-term sustainability of the plan, identifying whether water resources are available to meet the needs of the sector expansion and ensuring that water resources are used efficiently and in a sustainable manner.

During the first Stakeholder Meetings with NEA, Energy Research Institute, Institute of Water Resources and Hydropower Research, and Tsinghua University. During the meeting we discussed the challenges to integrate water and energy planning, including the regional and temporal differences between energy and water and the importance to match water basins with the energy areas and the administrative

regions. It was agreed that the approach would be to build on an existing TIMES energy system optimization model of China by complementing it with the existing information from the water resource models at IWHR, creating a "water-smart" energy model. At the same time, information from the energy model will be used as input for the water models from IWHR, to ensure that their models have more accurate data on the energy sector water demand and location, creating a model that is much more realistic on the demands of the sector.

- **Case Study Report can be found here:** Thirsty Energy: Modeling the Water-Energy Nexus in China

Chapter 2 of this report provides an overview of the water-energy nexus in China, and the current water and energy picture in China are described in chapters 3 and 4. Chapter 5 describes the methodology and approach for preparing the water supply cost curves and integrating that information into the TIMES-ChinaW model. Chapter 6 describes the Water Smart Energy planning model. Chapter 7 explores China's future water-energy nexus using the abovementioned model and summarizes the main findings for specific water, energy, economic, and environmental impacts that resulted from the examined energy and environmental policies. Chapter 8 explains the limitation of the methodology and the analysis and Chapter 9 draws conclusions on main findings in China and mentions next steps for consideration to continue advancing this increasingly critical aspect of sustainable planning.

The most important message of this case study is that policies being pursued to mitigate climate change impacts in China could reduce both $CO_2$ emissions, and water needs by the energy sector—with only modest increase in energy system cost.

### *MOROCCO*

Background

- Recent merge of power and water utility (ONEE) → potential for synergies and integrated planning
- Water constraints can impact growth, increasing competition for water across sectors (especially irrigation); ambitious renewable targets for 2020 to meet 7% annual growth in electricity consumption; climate change vulnerability

First Stakeholder Workshop: ONEE's energy and water areas were recently merged with a mandate to improve the integrated planning and investments of energy and water. The objectives of the workshop were to 1) illustrate with cases from the United States, South Africa, and others, the experiences with water stress and the development of the energy sector; the merits of long-term integrated energy water planning and the identification of future challenges and potential opportunities, 2) learn from ONEE on the current planning and investment design frameworks in water and energy, and 3) to discuss the potential scope of the initiative's support to formulate an integrated vision for ONEE and the opportunity to broaden the scope to the entire water sector.

Therefore, a preliminary assessment of existing knowledge and modeling capacity in Morocco was completed, a dialogue was initiated with ONEE (power and water utility), and a first technical workshop was convened to explore opportunities for integrated water-energy in Morocco. However, in the first workshop it was noted that the main counterpart should be the Ministry of Water Resources and not ONEE given that integrated planning needs to happen at the national level and the fact that the nexus

encompasses other sectors. Therefore, the team engaged with the government, and shifted the scope of work to ensure that we achieve the objectives of interest to the client. The Ministry of Water Resources requested the Bank to prepare a roadmap document that analyses the situation in Morocco, including potential water-energy-food constraints and highlight the potential synergies and opportunities for integrated planning. The analysis was presented to the Ministry of Water Resources and the final results were shared in a workshop with the ministry of Water Resources, Ministry of Agriculture and Ministry of Energy.

***Timeline:***

• A 2-day technical workshop on the water-energy nexus was conducted with government officials and water and energy utility stakeholders.

• After the workshop, the Ministry of Water Resources asked the World Bank to prepare a roadmap document that analyzes the situation in Morocco, including potential water-energy-food constraints and highlights the potential synergies and opportunities for integrated planning.

• Work plan and preliminary analysis were presented to the Ministry of Water Resources

• The Ministry of Water Resources approved work plan and sent collaboration letters to the Ministry of Agriculture, ONEE (Electricity and Water Utility), and the Ministry of Energy

• Report was completed and shared with ministry of Water Resources, Ministry of Agriculture, and Ministry of Energy