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**thirsty energy**  
a World Bank Global Initiative





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# Water – Energy Interdependence

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## energy needs **water**

Energy production  
processes require  
water

- hydropower
- thermoelectric cooling
- power plant operations
- fuel extraction and refining
- fuel production

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## water needs **energy**

Water production, processing,  
distribution, and end-use require  
energy

- extraction
- treatment
- transportation



# Why is the energy-water issue important?

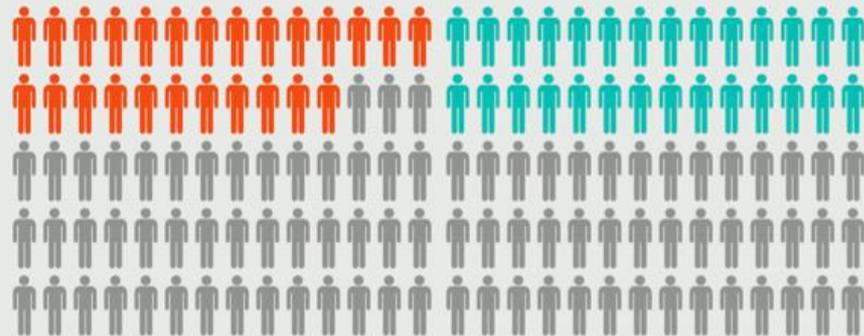
Of the **7 Billion** people on Earth today,

**2.5 Billion** have unreliable or no access to electricity

Source: EIA, 2012

**2.8 Billion** live in areas of high water stress

Source: WWAP, 2012

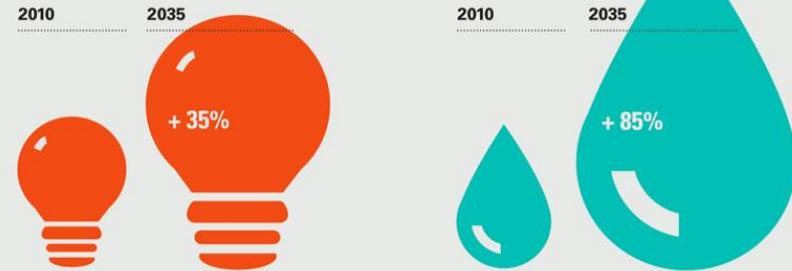


By 2035, energy consumption will increase by

**35%**

which will increase water consumption by

**85%**



Source: EIA 2012

Increasing pressure on **finite water resources**

→ **Water scarcity is increasing** as demand for water intensifies with population and economic growth

→ **Climate change is exacerbating** water and energy challenges

# The energy-water challenge is already present and very real



## Water shortages hit US power supply

Updated 10:54 20 August 2012 by Sara Reardon

OP-ED CONTRIBUTOR

### Will Drought Cause the Next Blackout?

By MICHAEL E. WEBBER

Published: July 23, 2012 | 150 Comments

Austin, Tex.

### China power crunch to worsen as drought slashes hydro

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## Asia Risks Water Scarcity Amid Coal-Fired Power Embrace

(Reuters) - The worst drought to hit central China in half a century has brought water levels in some of

as bayou floods Tue, May 17 2011 Japan keeps Fukushima

Bloomberg News

## China, India Lack Water for Coal Plant Plans, GE Director Says

## Connecticut nuclear power plant shut down one unit due to hot water from Long Island Sound

Published: Monday, August 20, 2012

## Maharashtra: Parli power plant shuts down after severe water crisis

Reported by Rashmi Rajput, Edited by Amit Chaturvedi | Updated: February 17, 2013 17:33 IST

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# THE HINDU Business Line

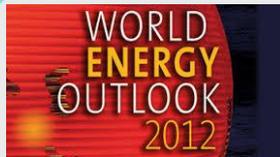
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## 'Water becoming a serious constraint for power generation'

The power plant has an installed capacity of 1130 MW.

# the energy sector recognizes the magnitude of the issue



The first time that WEO includes special section on **the water needs and the possible future water constraints** of the energy sector

Impact on the world's top **energy and power** companies

Source: CDP Global Water Report 2013



of energy companies

&



of power utility companies

Indicate that **water is a substantive risk** to business operations



of energy companies

&



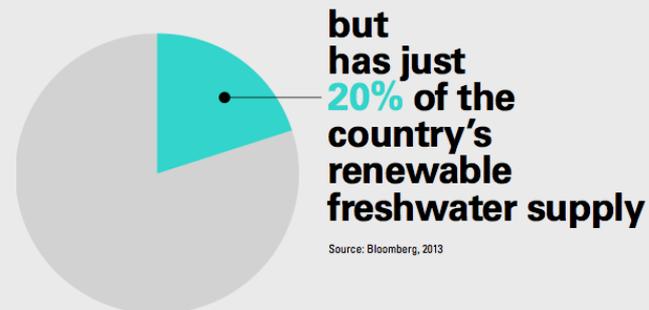
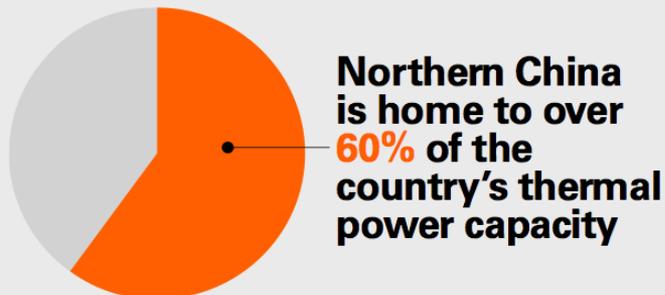
of power utility companies

Have experienced **water-related business impacts** in the past 5 years

# Challenges will be more complex in the future if we don't act now



- expansion plans for coal power plants in **China** might not be feasible due to water scarcity issues (Bloomberg, 2013)
- more than **50%** of power plants in **India** and **Southeast Asia** are in areas that will likely face water shortages (WRI, 2013)
- **Europe's** coal and nuclear power generating capacity will decrease by **6% to 19%** between 2031-2060 due to increased water temperature or lack of cooling water (Rubbelke and Vogele, 2011)
- nearly **93%** of **Middle East's** onshore oil reserves are exposed to medium to extremely high water risk (WRI, 2013)



Source: Bloomberg, 2013

# Energy sector needs water and is vulnerable to water issues



## water risks for energy sector

**Increased water temperatures** can prevent power plants from cooling properly

**Decreased water availability** can affect thermal power plants, hydropower, and fuel extraction processes due to their large water requirements

**Regulatory uncertainty**

**Sea level rise** could impact coastal energy infrastructure

**Water quality** can impact energy operations if it is not regulated and managed adequately



Power plants shut down or decreased power generation



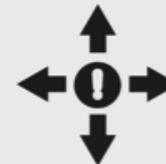
Hydropower capacity reduced



Permits to locate power plants or extraction facilities denied



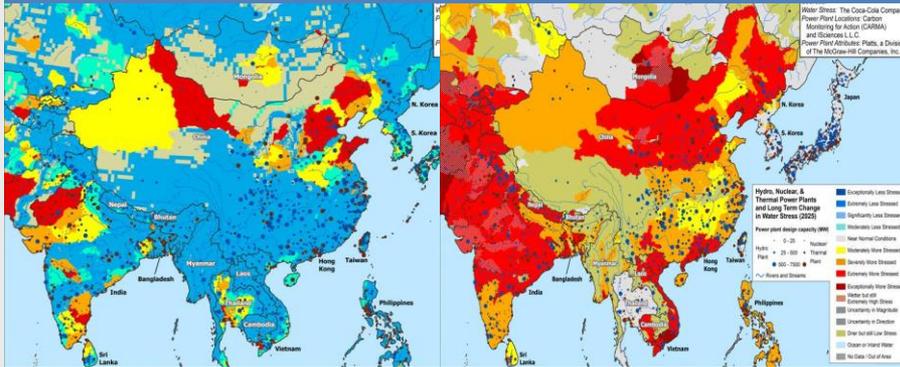
Financial losses



Social and political instability

# Energy Services will be increasingly affected by the consequences of climate change

## Water scarcity changes in Asia

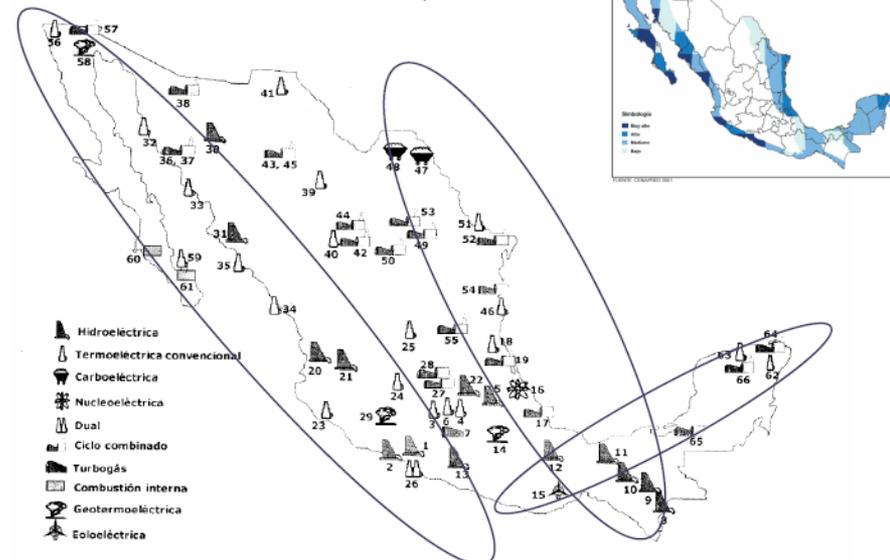


SOURCE: WRI, 2012. The baseline water stress is defined as the ratio of total annual freshwater withdrawals for the year 2000, relative to expected annual renewable freshwater supply based on 1950–1990 climatic norms.

## Projected changes in hydropower generation



## Principales centrales generadoras en 2008



## Relative location of power plants vs. hurricane/typhoon zoning areas in Mexico

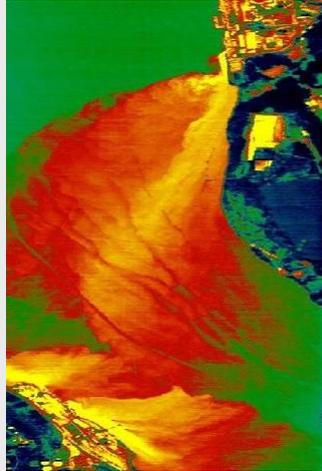
SOURCE: ESMAP PRESENTATION ON CLIMATE IMPACTS ON ENERGY SYSTEMS. NOVEMBER 16, 2010

# Moreover...**water quality** can be an issue if not regulated/managed properly

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Thermal pollution from once through cooling has adverse effects on ecosystem



Drainage from Abandoned coal mines



Fracking requires large amount of water and also generates waste water that needs to be treated



# In an interconnected world, water is no longer a local problem only We need to understand and quantify tradeoffs

**Climate impact:** Major increases in climate variability expected, with increased frequency of droughts and floods. Heaviest impact will be borne by the poorest, who are already underinvested in adaptation to current climate

## Health and human settlements



- Changing settlement patterns, with a 2004-15 to see 40% increase in urban population without basic WSS access
- 80% of all people lacking WSS access in rural areas
- Half of urban water supplies are from groundwater with very little knowledge of hydrology
- Rapid urbanization

**Lack of sanitation access can cost countries up to 6% of GDP**

## Food and agriculture



- 70% increase in food production will be required in 40 years (with it already 70% of withdrawals)
- Half the world's food is grown on groundwater, much of which is unsustainable
- Use of crops for biofuels affecting food prices

**Unreliable water supply and farm-to-market access can deprive farmers of 2/3rd of their potential income**

## Energy and industry



- Global energy consumption expected to increase by ~50% from 2007-2035
- Water-intensive thermal and hydro account for 90% of current power generation
- Power outages caused by lack of cooling water already seen in many countries

**Energy security is threatened by water challenges; 3% of Kenya's GDP from lost hydro production over 1998 - 2000**

## Environment



- Ecosystem damage largely coincides with high water stress (e.g., Indo-Gangetic Plain, North China Plain) and fertilizer runoff (dead zones)
- Over-consumption of water, water pollution and inadequate pricing of the resource results in loss of massive ecosystem benefits

**Losses of biodiversity and ecosystem services with increasingly visible economic cost (e.g., China losing 5% GDP to pollution)**

Competition for water allocation

Impaired water quality affecting all uses

Major demand increases...

...with the potential to derail growth

# We need to understand and quantify tradeoffs

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## Dry cooling vs cost of electricity

Dry cooling systems require no water for their operation, but decrease efficiency of the plant:

- increasing capital and operational costs
- increasing GHG emissions per kwh

## Water – GHG tradeoff

Some policies to reduce GHG emissions can increase water requirements by the energy sector if not designed properly

- biofuels, carbon capture...

## Water for energy vs. water for agriculture

The value of water for energy might be higher regarding economic outputs, but agriculture is often required for

- national security reasons (food)
- social reasons (people employed in the agricultural sector)

## Understand Environmental impacts and trade-offs

## Hydropower

Assessing tradeoffs, environmental and social impacts and exploring the use of multipurpose dams is necessary for sustainable development



# the challenge: how do we plan & how do we design our investments in a sustainable way?

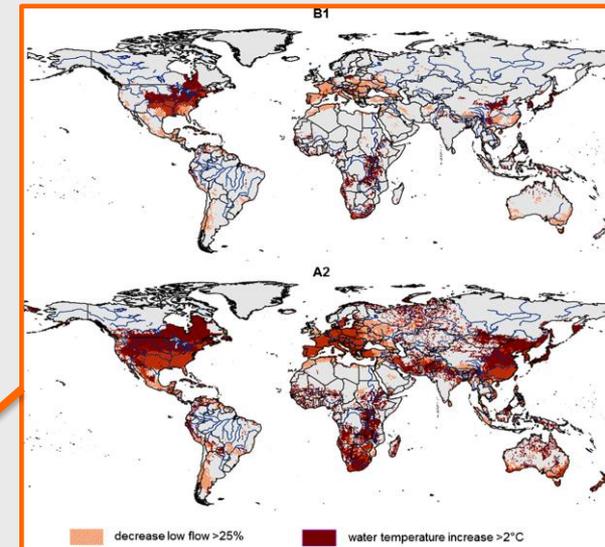
## Political-level challenges impede effective planning:

- The two sectors have been regulated separately
- Current energy planning is often made without considering changes in water availability and quality, competing uses or the impacts of climate change.

**Challenges in securing enough water for energy and energy for water will increase** with population and economic growth and climate change

**Stronger integrated planning will be necessary** to evaluate tradeoffs, find synergies, and ensure sustainable development

Hot Spots – where “low flows” and “water temperature increase” meet



SOURCE: VULNERABILITY OF US AND EUROPEAN ELECTRICITY SUPPLY TO CLIMATE CHANGE. VAN VLIET ET AL, 2012

# There are many solutions, we need to start somewhere



## solutions



integrate  
energy-water  
**planning**



explore the use of  
multipurpose  
hydropower dams



incorporate  
water constraints  
into energy  
planning



integrate  
energy-water  
infrastructure



strengthen joint  
energy-water  
governance and  
encourage political  
reform



use alternative  
cooling systems in  
thermal power  
plants



implement  
renewable  
energy  
technologies



reduce water  
**dependency**



recycle and reuse  
water from  
operations



explore brackish  
and saline water  
options



conserve water  
and energy



increase the  
economic value  
of water



enhance  
**efficiency**



replace old,  
inefficient  
power plants



improve power  
plant efficiency



improve biofuels  
production efficiency



# Thirsty Energy initiative

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to contribute to a **sustainable management and development** of the water and energy sectors by **increasing awareness and capacity** on *integrated planning* of energy and water investments **identifying and evaluating trade-offs and synergies** between water and energy planning.

1

Rapid assessments in priority basins/countries

2

Implementation of case studies using existing tools when possible

3

Knowledge dissemination, advocacy and capacity building



# methodological approach

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- **Demand Driven , Entry point is Energy Sector**
- **Engagement with relevant stakeholders from day 1**, involving local partners from energy and water sectors to identify potential constraints and synergies
- **Build on existing country knowledge and modeling tools** whenever possible to ensure continuity and sustainability of initiative
- **Client ownership and capacity building** are crucial to ensure the success of the initiative
- **Flexible modeling framework** to facilitate tailored analyses over different geographical regions and challenges
- **Economic tools to assess the tradeoffs between competing sectors** and to provide policy recommendations to mitigate potential effects
- **Robust treatment of risk and uncertainty**
- **Incorporate the long-term effects of climate change**
- **Case studies or pilots to illustrate the different challenges** that are most relevant for client countries
- **Form stronger alliances.** The challenge presented by the nexus is too large for any country, region, development finance institution or implementing agency to tackle alone.



# CASE STUDIES

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- **South Africa**

- Working with Energy Research Center
- Incorporating Water Constraints into their energy planning tools: TIMES model
- Will use CGE model to understand trade-offs

- **Morocco**

- In conversation with ONEE (recently merged water & energy utility)
- Stakeholders consultations and interactive workshop with experts to determine working plan and understand their interest/concerns

# Knowledge sharing, communication and awareness raising

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- Implemented strategy from day 1
- Created Communication and Awareness package:
  - Infographics
  - Working Paper as Background on the topic
  - Blogs
  - Brochure
  - Twitter
  - Collaborating with partners on key messages
    - UN World Water Day: Water and Energy
- Capacity building in case study countries
- South to South Knowledge Sharing



# Partners

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## Funding Partners:

- Water Partnership Program
- ESMAP
- Korea Trust Fund for Green Growth

## Private Sector Reference Group

- Abengoa
- Électricité de France (EDF)
- Alstom
- Veolia

## Other collaborating partners

- International Energy Agency (IEA)
- Stockholm International Water Institute
- World Resources Institute (WRI)
- GIZ
- UN Water / Sustainable Energy For All
- UNESCO



# What next?

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- **Ongoing initiative:** Interest growing from several countries and regions
- **Outcomes:**
  - Innovative tools, approaches and solutions developed and implemented to help Bank teams and countries 'green' their growth
  - Policy guidance and Improved design of investments, strategies and plans in energy
  - Knowledge deepened in the water and energy nexus
  - Energy-water integrated planning practice enhanced
  - Water mainstreamed in the energy sector
  - Improve interdisciplinary collaboration among sectors



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# A World Bank Initiative



thirsty  
energy

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## WHAT?

- Quantify tradeoffs
- Identify synergies
- Promote integrated planning
- Enhance sustainability of energy and water investments
- Design assessment tools and management frameworks

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## HOW?

- Operationalize solutions
- Form strong alliances
- Build capacity
- Share knowledge
- Model for uncertainty
- Break disciplinary silos





Thank You

<http://www.worldbank.org/thirstyenergy>

