Mission 2018

OUR ENERGY FUTURE

Carbon, Nuclear, Alternatives

BROUGHT TO YOU BY

TERRASCOPE

Terrascope: Social Structure

First year learning community

You will develop friendships and bonds that last for you time at MIT and beyond

Terrascope Room 16-xxx a place to study, hang out, interact, cook, eat, SLEEP,
always someone around to talk to

Terrascope lunches: see calendar—eat, listen (or not), learn

Special activities: movie nights, special dinners, and ideas?

Terrascope: Academic Structure

First Semester

- 12.000: Mission 2018: Solving Complex Problems

Second Semester

- 1.016: Communicating Complex Environmental Issues: Building Solutions and Communicating Ideas
- Terrascope Field Experience (Spring Break)
- Terrascope Radio

Solving Complex Problems

- Multidisciplinary, project-based learning experience
- Students work toward a solution to a deceptively simple problem related to Earth's environment
- Each year's theme is different and referred to as "Mission 20XX", where 20XX refers to the graduation year of the class involved

Solving Complex Problems: Motivation

- To build in you the capacity to tackle “big” problems that confront society
- To encourage you to take charge of the learning process
- To show you how to do independent research, to evaluate the quality of information sources, and to synthesize different information streams

Solving Complex Problems: Motivation

- To encourage you to think about optimal solutions rather than correct solutions
- To help you learn to work effectively as part of a team
- To improve your communication skills: web site and formal oral presentation
- To convince you of your potential!!

Past Missions

- To develop strategies for developing countries in the Pacific basin to cope with tsunami hazards and disasters. Due to the unique needs of each country, we specifically focused on developing plans for Peru and Micronesia.
- To develop a plan for the reconstruction of New Orleans and the management of the Mississippi River and the Gulf coast.

Past Missions

- To develop strategies to deal with the collapse of the global fisheries and the general health of the oceans
- To develop a plan to ensure the availability of fresh clean water for western North America for the next 100 years.
- Propose an integrated global solution to the rapid rise in atmospheric CO_2 that will stabilize concentrations at an economically viable and internationally acceptable level.

Subject Structure

- Problem divided into 5 or more subtopics and students divide into teams
- Each team assigned one or more Undergraduate Teaching Fellow(s) and Alumni Mentors and have access to the library staff
- Each team will be responsible articulating the nature of the problem and developing a range of strategies and options to deal with it
- Teams are a starting point—you control their survival

Subject Deliverables

- Each team will communicate through wiki-based structure
- The entire class will describe and justify its overall plan in a comprehensive web site
- Each class explains the design in a sixty to ninety minute presentation before a panel of experts and a general audience. Presentation will be webcast around the world
- "The whole world is watching, the whole world is watching….."

Mission 2010

Mission 2012

Mission 2013

Home Page

"A nation that fails to plan intelligently for the development and protection of its precious waters will be condemned to wither because of its shortsightedness. The hard lessons of history are clear, written on the deserted sands and ruins of once proud civilizations."

-Lyndon B. Johnson (1908-1973) 36th President of the United States,
Letter to the President of the Senate and to the Speaker of the House
Transmitting an Assessment of the Nation's Water Resources, 18 Nov 1968

Purpose

As the next generation of scientists and engineers, we are faced with the repercussions of enormous environmental exploitations throughout the last century. As we struggle to protect the Earth from global warming, seek to find alternative sources of energy to replace our diminishing supply of fossil fuels, and race to rescue the global economy, we cannot forget that our most precious resource, water, is being depleted at an alarming rate. The threat of an impending water crisis affects all individuals around the world and must be addressed immediately. It is our responsibility to plan now for the conservation of the current fresh water supply and seek new sources of water for the future. We need to find a sustainable solution that will save the global population from a massive water crisis and can be sustained for many years to come. Moreover, we must first address this crisis at home, in the arid region of western North America.

Mission 2014

Background

According to the definition given at the 1996 World Food Summit, "Food Security exists when all the people, at all times, have the physical and economic access to sufficient, safe, nutritious food for a healthy and active life" (Burchi p. 7). To those of us in the Western World, the idea may sound basic, but in reality, the world is still far from achieving this goal. In 2010, it is estimated that 925 million people (Silbrain) worldwide remain undernourished, a truly alarming number considering that it represents one seventh of the world's population - more than the population of the United States, Canada, and the European Union combined (WFP 2010). Hunger and malnutrition, the most basic forms of human suffering, remain the world's greatest health risk, affecting more people than AIDS, malaria, and tuberculosis combined (WFP 2010).

FIGURE 1

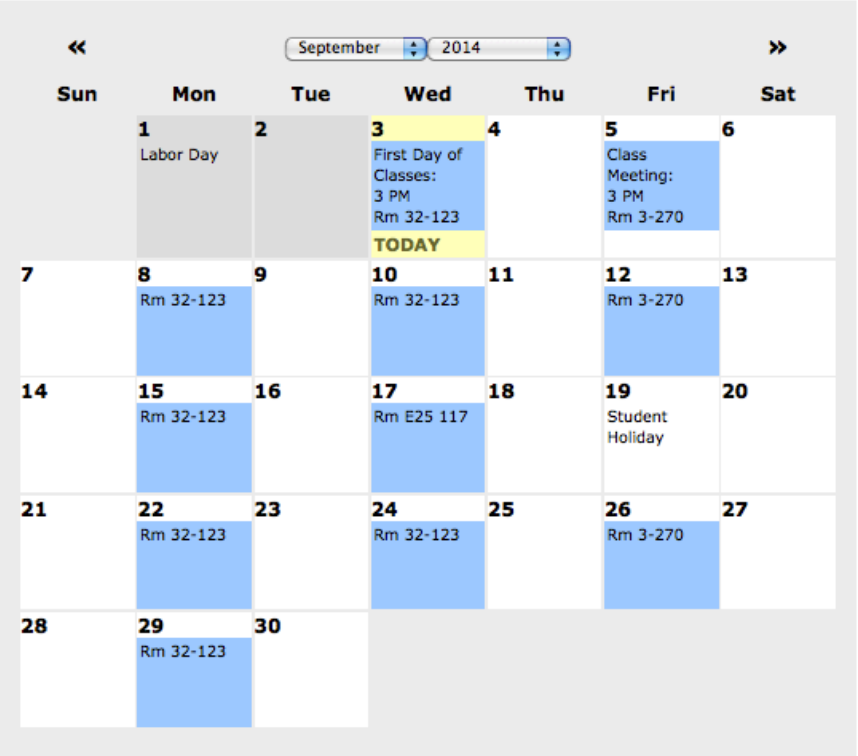
Number of undernourished people in the world, 1969–71 to 2010


Our energy future
carbon, nuclear, alternatives?

Mission 2018 Website

http://web.mit.edu/12.000/www/m2018/about.html

- Faculty and Staff List
- Mentor List
- Class Info
- Calendar
- Lecture Notes
- Web Design Info



Mentors

Team tbd: Lowell Anderson	lra@alum.mit.edu		More info...
Team tbd: Alfredo Kniazzeh	alfredok@alum.mit.edu	781-891-9937	More info...
Team tbd: Paul D. Jacobson	pjacobson@alum.mit.edu	508-548-7945	More info...

“What I have learned is that passion, along with curiosity, drives science. Passion is the mysterious force behind nearly every scientific breakthrough. Perhaps it’s because without it you might never be able to tolerate the huge amount of hard work and frustration that scientific discovery entails….”

“For the next four years you will get to poke around the corridors of your college, listen to any lecture you choose, work in a lab. The field of science you fall in love with may be so new it doesn’t even have a name yet. You may be the person who constructs a new biological species, or figures out how to stop global warming, or aging. Maybe you’ll discover life on another planet. My advice to you is this: Don’t settle for anything less.”

Nancy Hopkins, a professor of biology at M.I.T., has been teaching since 1973.

Extracted from OP-ED contribution in New York Times, September 5 2009

Important Contacts

Michael P Eddy (mpeddy@mit.edu)
(Teaching Assistant)

Chris Sherratt (gcsherra@mit.edu)
(Library staff)

Daniel Sheehan (dsheehan@mit.edu)
(GIS specialist)

Ari Epstein (awe@alum.mit.edu)
(Terrascope staff and Terrascope Radio)

Debra Aczel (daczel@mit.edu)
(Terrascope Administrator)

Sam Bowring (sbowring@mit.edu)
(Terrascope Director)

Spring Break Field Trip
March 21-29th 2015

MEET THE Staff

And

UTFs

Come on down!!

Staff

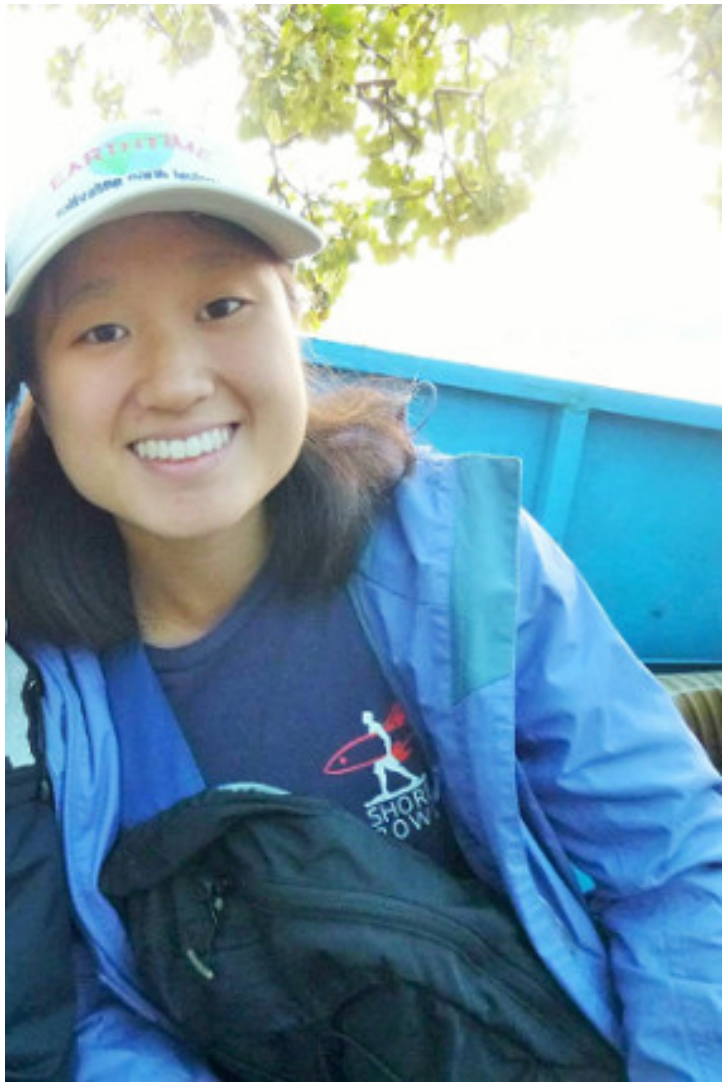
Ari Epstein

Debra Aczel

Alumni Mentors—a valuable resource!

Bob Gurnitz—chief mentor

TA: Mike Eddy



Judy Pu

UTFs

Juju Wang

Anisha Gururaj

Lealia Xiong

Joseff Kolman

Libby Koolik

Jaya Narain

Ali Trueworthy

Fiona Paine

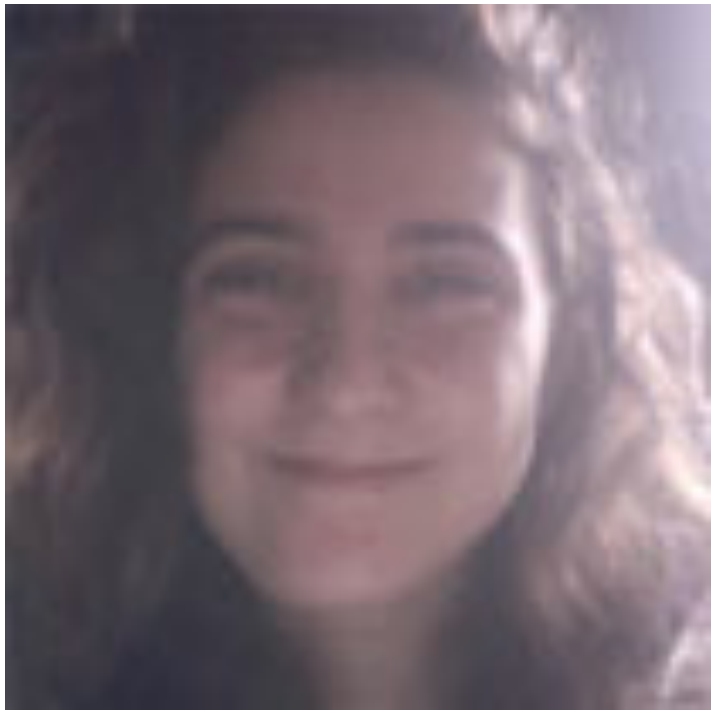
Anna Jungbluth

Julia Longmate

Anthony Occidentale

Francesca Majluf

Dirk Stahlecker



Rin Yunis

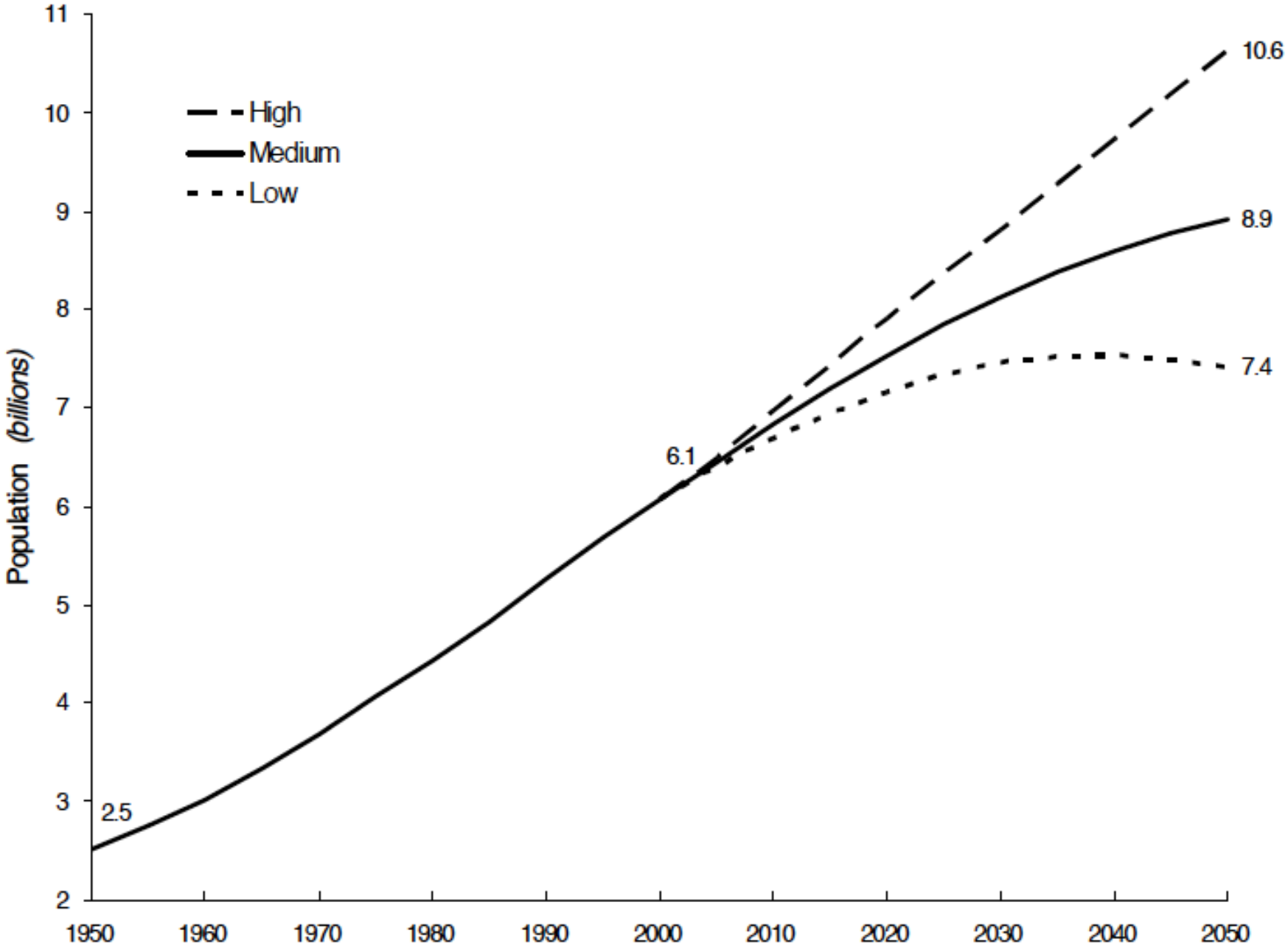
Patience Stevens

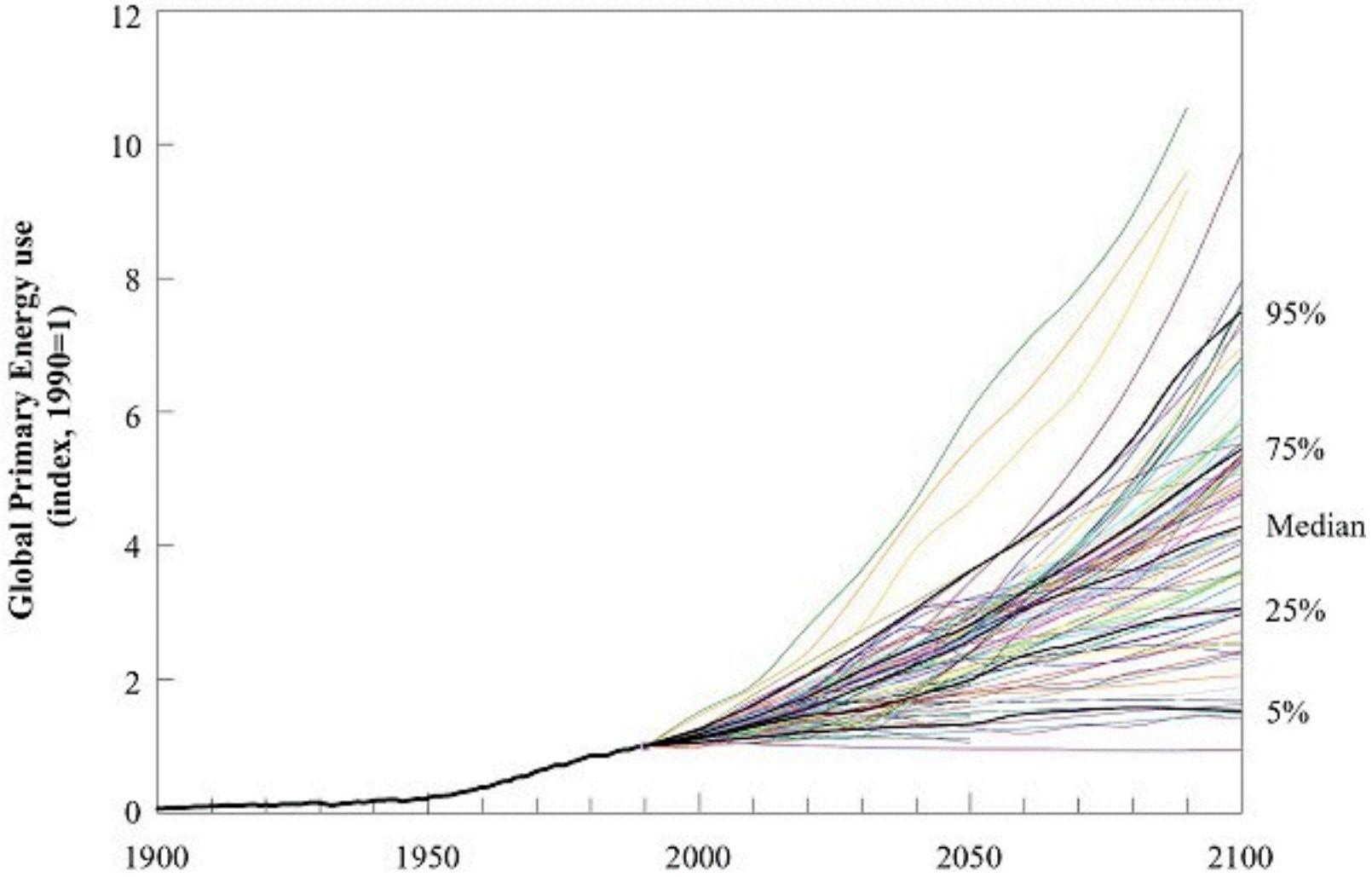
Kristina Kim

Your Mission is to....

Your Mission is to devise a global energy production portfolio for the next fifty years that will reduce the rate of increase in human produced greenhouse gases and attempt to maintain a constant atmospheric concentration. A crucial aspect of your Mission is to decide whether our future will be dominated by continued consumption of Carbon fuels or whether we will transition to nuclear power and to explore the relative costs of change and/or inaction.

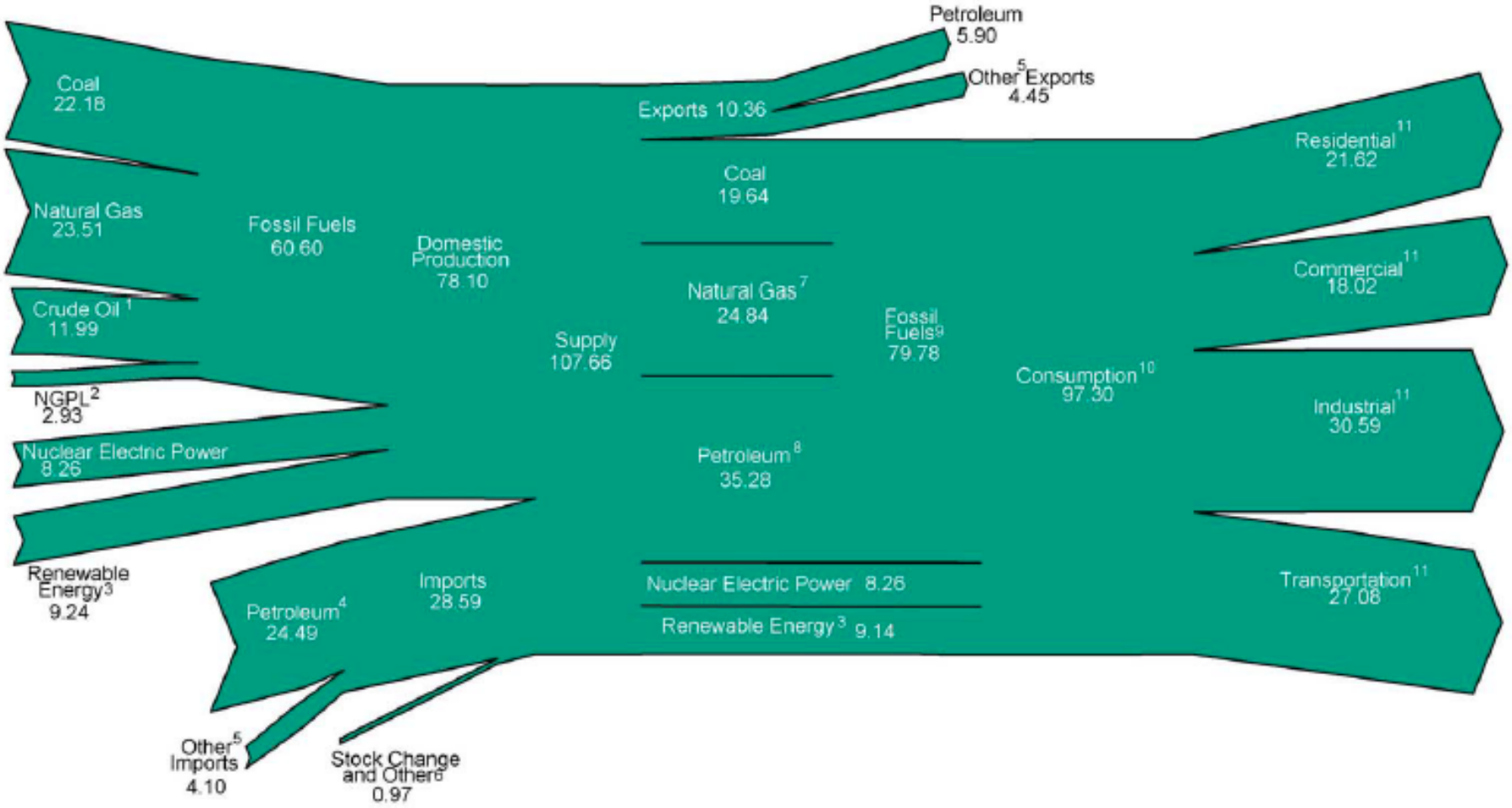
Figure 1. Estimated world population, 1950-2000, and projections: 2000-2050



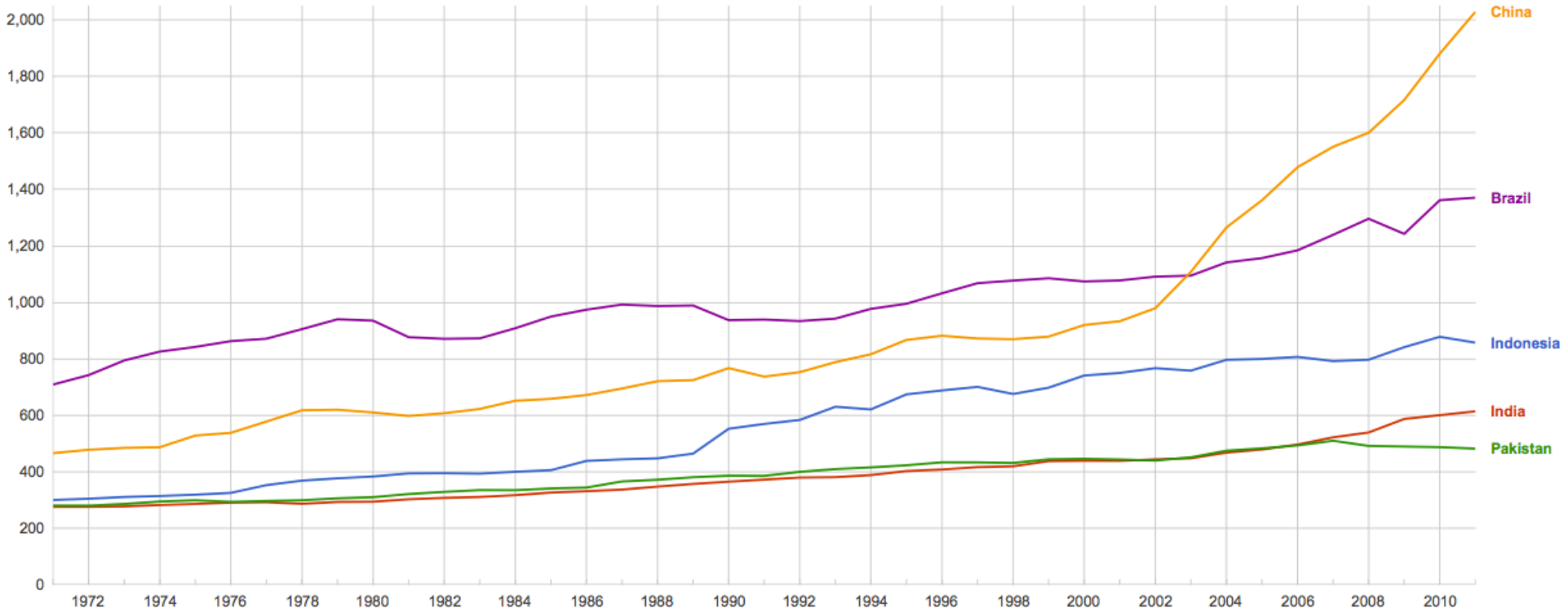

Global Primary Energy use
(index, 1990=1)
12
10
8
6
4
2
0
1900
1950
2000
2050
2100
95%
75%
Median
25%
5%

US Energy Sources and Energy Consumers

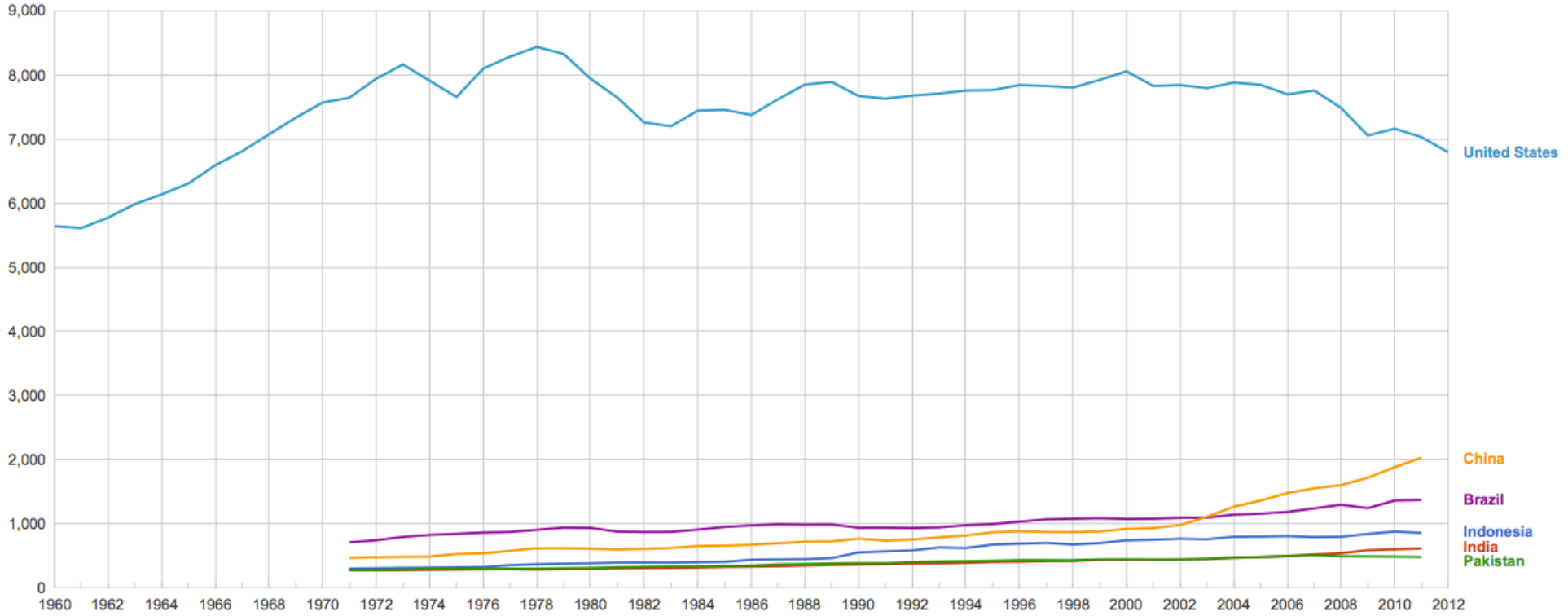
Figure 1.0 Energy Flow, 2011
(Quadrillion Btu)



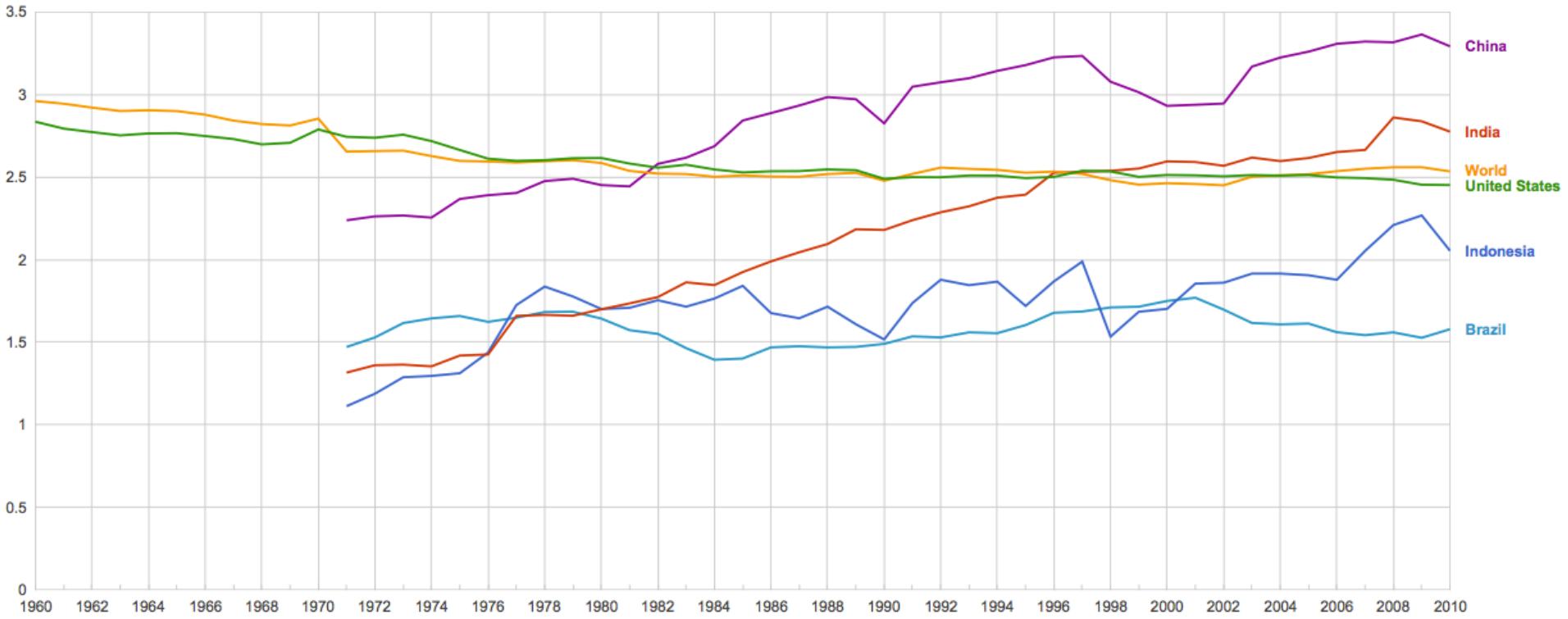
Per Capita Energy Consumption of the 5 Most Populous Countries (Excluding USA) in Kg of Oil Equivalent



Per Capita Energy Consumption of the 6 Most Populous Countries in Kg of Oil Equivalent



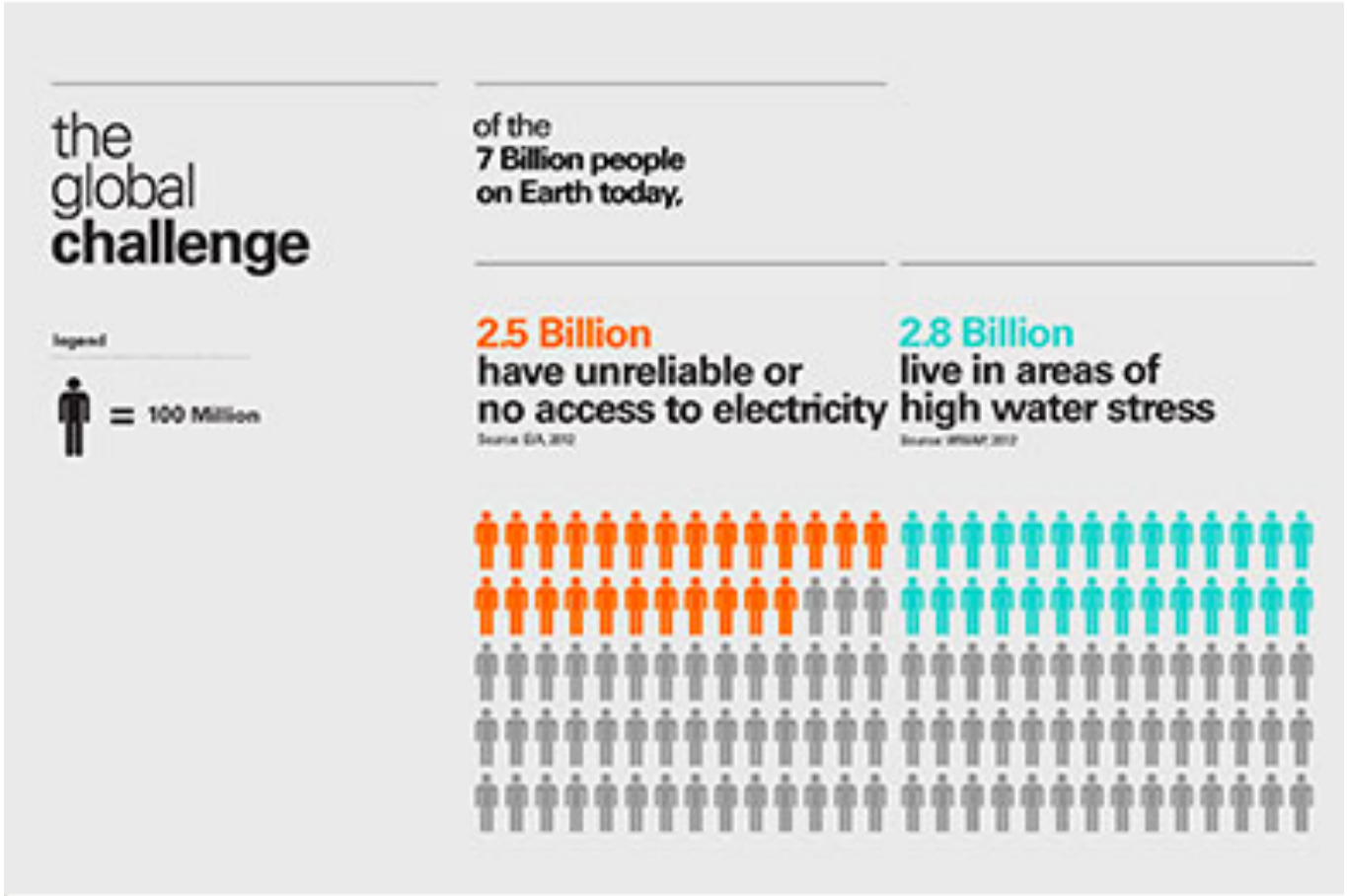
Kg CO2 Emitted per Kg of Oil Equivalent Energy Use



Global human population today at noon

7, 189, 712, 120

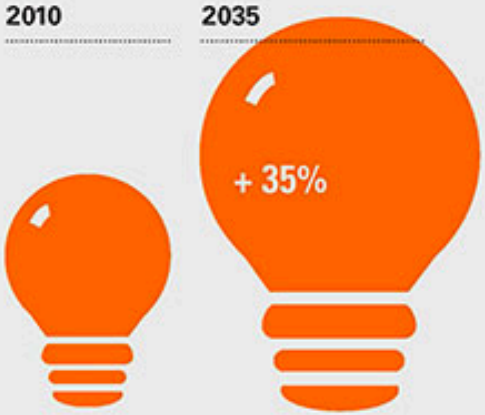
1. China	1,355,692,576	6. Pakistan	196,174,380
2. India	1,236,344,631	7. Nigeria	177,155,754
3. United States	318,892,103	8. Bangladesh	166,280,712
4. Indonesia	253,609,643	9. Russia	142,470,272
5. Brazil	202,656,788	10. Japan	127,103,388



Full Infographic: Energy and Water's Interdependence

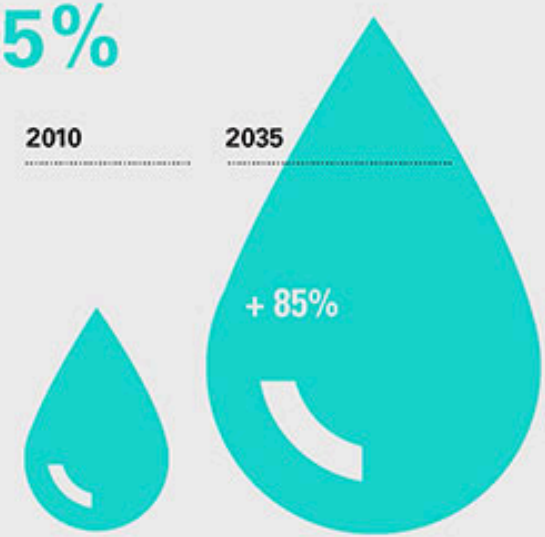
By 2035,
energy consumption will increase by

35%



which
will increase water consumption by

85%



increasing pressure on
finite water resources

Source: IEA, 2012

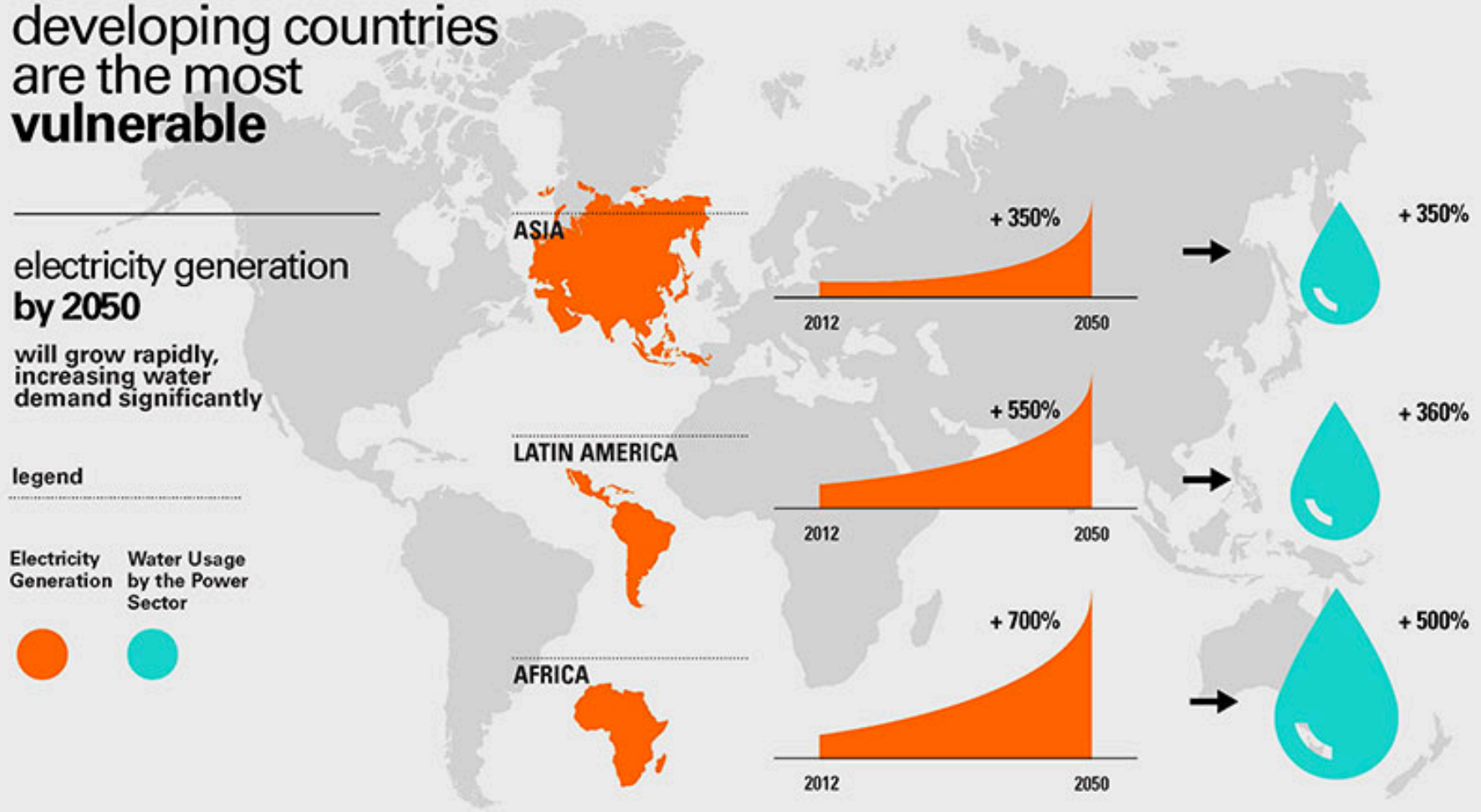
developing countries are the most **vulnerable**

electricity generation **by 2050**

will grow rapidly, increasing water demand significantly

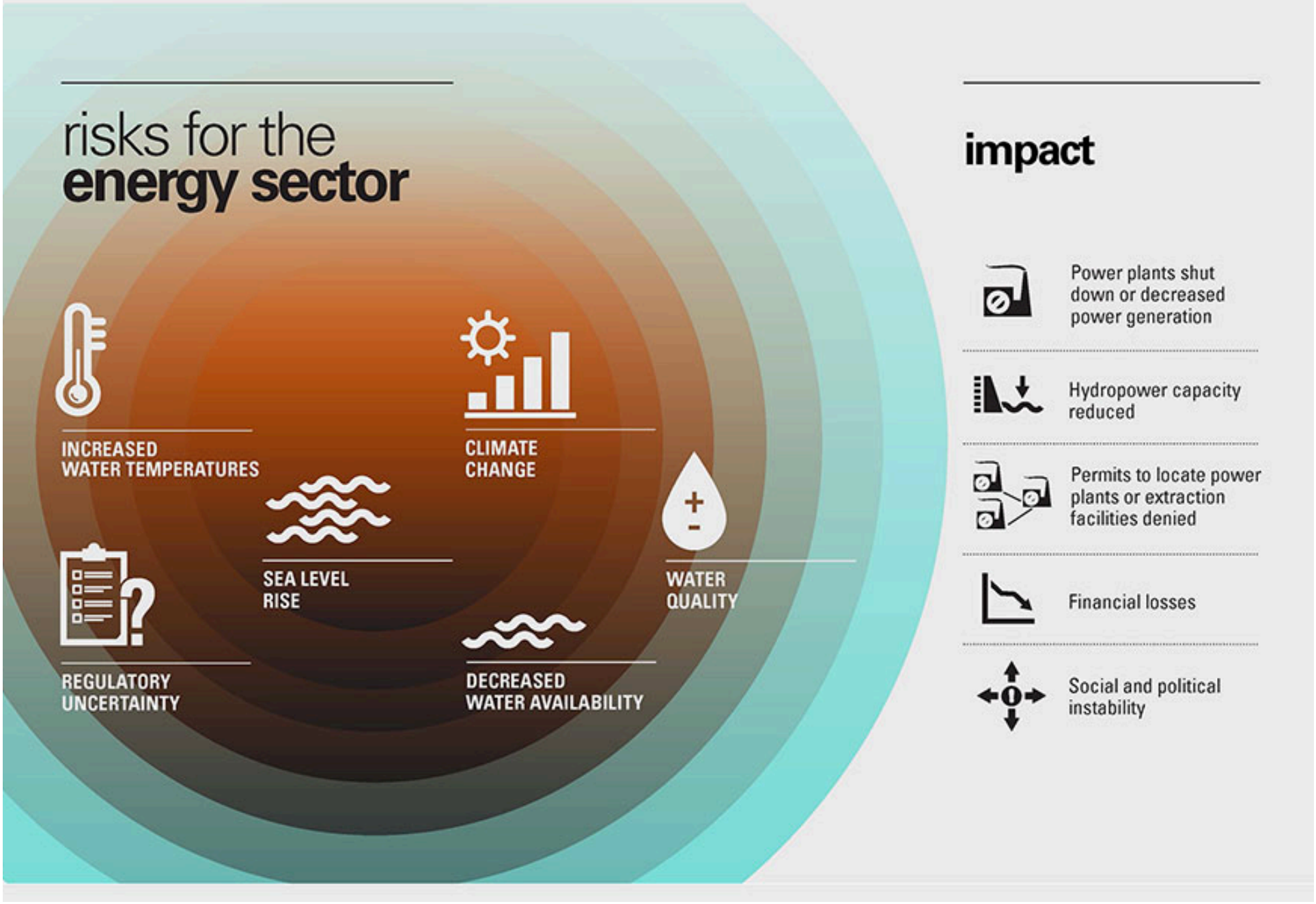
legend

Electricity Generation	Water Usage by the Power Sector



Source: WEC, 2010

risks for the **energy sector**



impact

- 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

impact on the world's top **energy companies and power utilities**

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

Source: CDP Global Water Report, 2013

it's already **happening**

The Americas

U.S.

Power plants shutting down or reducing power generation

due to low water flows or high water temperatures, resulting in financial losses

Companies that extract natural gas and oil via hydraulic fracturing faced higher water costs or were denied access to water

due to one of the worst droughts in American history

Source: U.S. Department of Energy, 2013

California's hydroelectric power generation was 38% lower than the prior summer

due to reduced snowpack and low precipitation in the summer of 2012

VENEZUELA

Record lack of rainfall resulted in low water flows and several power interruptions

Source: NYTimes, 2013

BRAZIL

Dams in the southeast and central west of Brazil were at 28% of their water capacity in 2012

due to the worst drought in 50 years. This number is below the mark considered sufficient to guarantee electricity supply

Source: Reuters, 2013

A drought in the north-east of Brazil led to eight months of power rationing

resulting in R$54 billion ($26bn) of financial losses for the industry and impacting economic growth in 2001

Source: BBC, 2013

it's already **happening**

Europe, Middle East and Africa

FRANCE

Several nuclear power plants shut down or reduced production

due to high water temperatures threatening cooling processes in 2007

France experienced drastic cuts to power exports in 2003 due to water shortage

Source: World economic forum 2011, water security, inland press

50%
cutback in power exports

GHANA

Severe drought reduced hydropower capacity, resulting in power rationing

which had significant economic impacts between 2006 to 2007

NAMIBIA

Uranium mining operations are threatened by water shortages

due to the worst drought in three decades

Source: Bloomberg, 2013

SOUTH AFRICA

All new power plants have been forced to shift to dry cooling systems

which cost more to build and operate and are less efficient than wet-cooled systems

Source: South Africa Water for Growth and Development Framework

Europe's

coal and nuclear power generating capacity between 2031-2060 will decrease by 6 to 19% due to increased water temperature or lack of cooling water

Source: van Vliet et al, 2012

Nearly 93% of the

Middle East's

onshore oil reserves are exposed to medium to extremely high overall water quantity risk

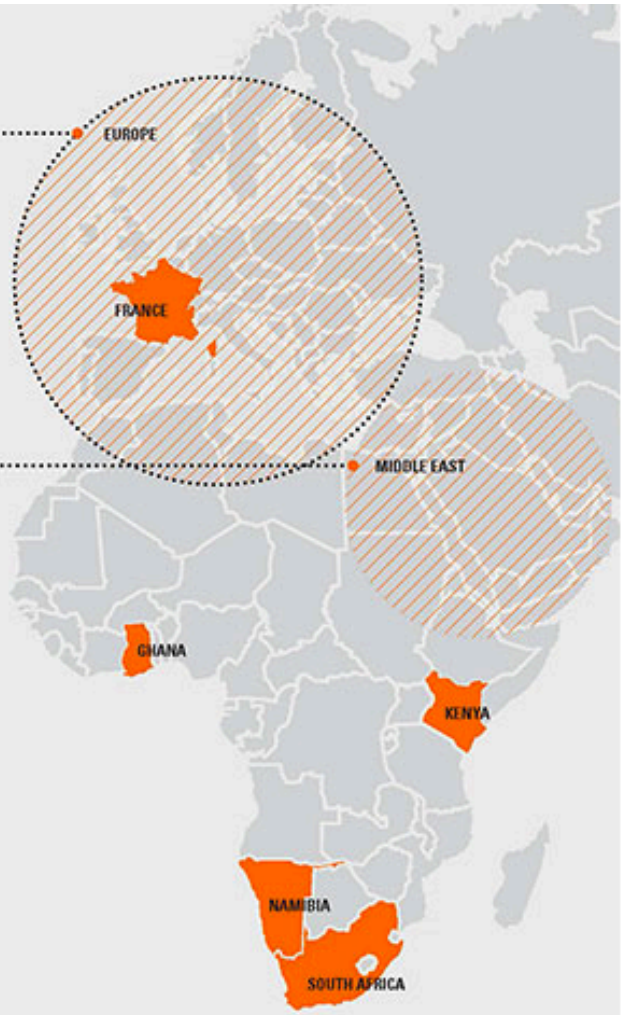
Source: WRI, 2013

KENYA

Massive drought decreased hydro generation by 25% in 2000

which had to be replaced by more expensive fuel-based generation. Losses in hydropower generation and industrial production due to water shortage during 1999/2000 were over $2 billion

Source: Climate variability and water resources degradation in Kenya, World Bank, 2006



it's already **happening**

Asia and Australia

Expansion plans for coal power plants in China and India might not be feasible due to water scarcity issues

More than half of the power plants in India and Southeast Asia are in areas that will likely face water shortages in the future.

Source: WRI, 2010

INDIA

A thermal power plant shut down because of severe water shortages in Maharashtra

Source: IndiaTimes, 2013

In 2012, hydropower production was reduced by 6% due to low rainfall during the monsoon season

Source: National Geographic, 2012

SRI LANKA

Almost 85% of hydro-power generation capacity was lost due to a drought in 2012

Source: Reuters, 2012

AUSTRALIA

During the worst drought in 1,000 years:

- 3 coal power plants had to reduce electricity production to protect municipal water supplies in 2007
- Water levels in the Snowy hydro system were 8% of installed capacity
- Electricity prices increased

Source: Smart and Aspinall, 2009

CHINA

China's "Big Five" power utilities are all highly exposed to water disruption

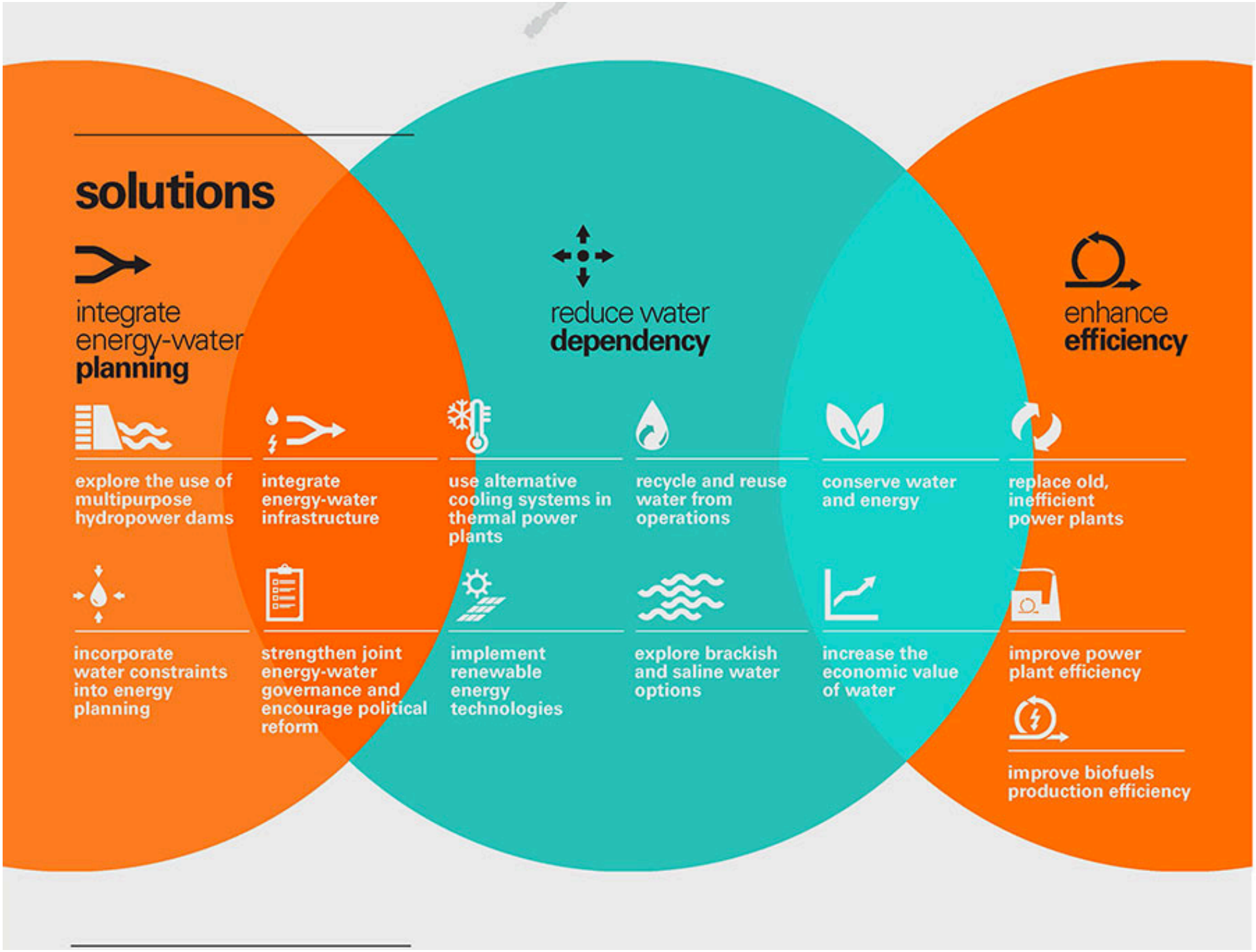
The worst drought to hit central China in half a century severely impacted hydropower generation

Source: Reuters, 2011

Northern China is home to over 60% of the country's thermal power capacity

but has just 20% of the country's renewable freshwater supply

Source: Ekosenborg, 2013


solutions
integrate energy-water planning
explore the use of multipurpose hydropower dams
integrate energy-water infrastructure
incorporate water constraints into energy planning
strengthen joint energy-water governance and encourage political reform
reduce water dependency
use alternative cooling systems in thermal power plants
recycle and reuse water from operations
implement renewable energy technologies
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

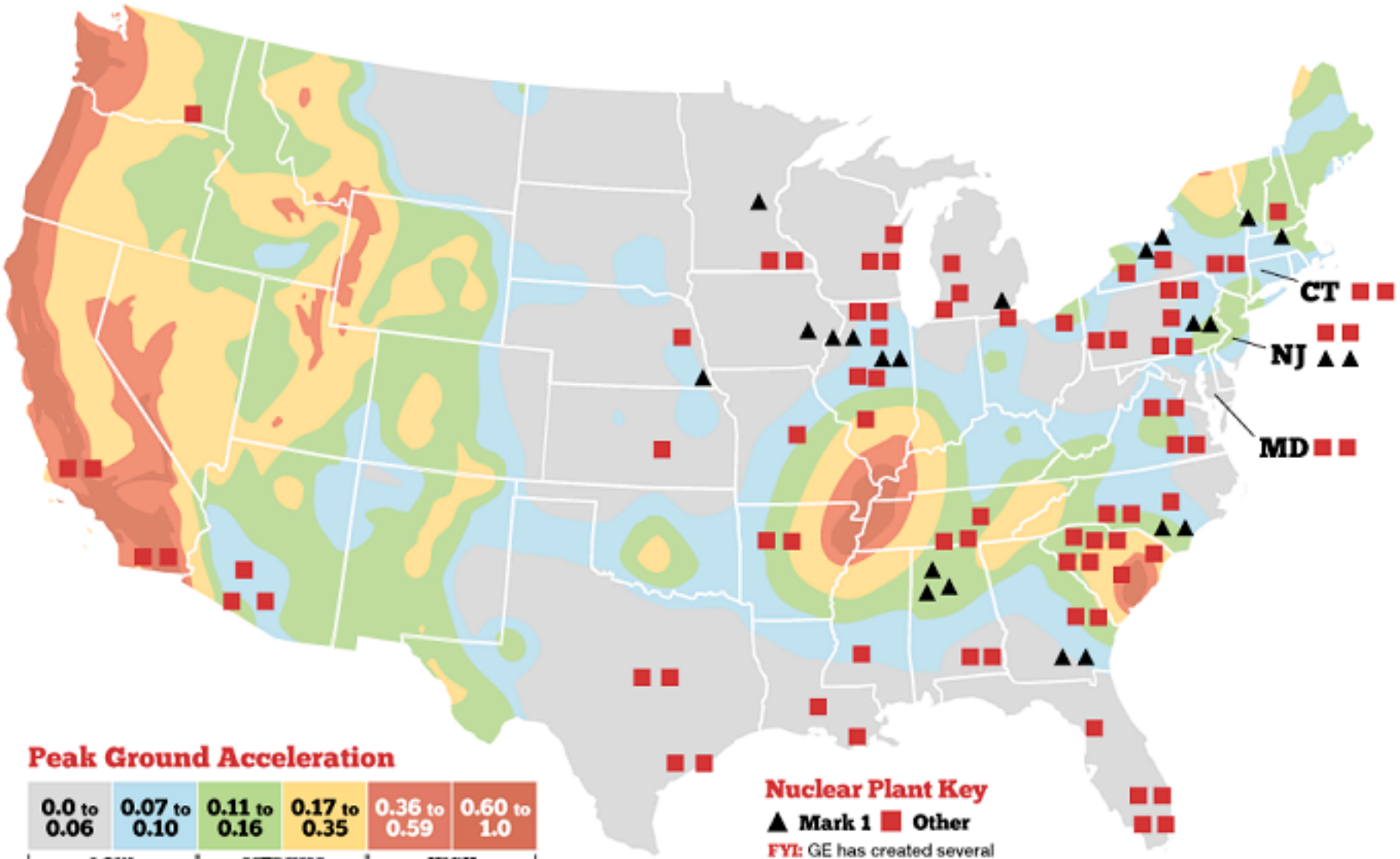
A World Bank Initiative

WHAT?

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

HOW?

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



SOURCES: USGS, NUCLEAR REGULATORY COMMISSION, REUTERS

A SHORTFORMBLOG ORIGINAL: BY ERNIE SMITH & CHRIS TOGNOTTI

Our chance to lead against climate change. 2000 MIT voices strong, and counting.

MIT EARTH RESOURCES LABORATORY

MITei

MIT CEEPR

MIT Center for Energy and Environmental Policy Research

Center for 21st Century Energy

First “assignment”

- What is your opinion of the role nuclear power should and will play in our future? Explain

- At home, how is the household power you consume generated? Any idea what it costs?

Email your answers to sbowring@mit.edu before 2 PM Friday September 5th.

Second “assignment”

Part A: Read four short papers on “Tragedy of the Commons” on website

Hardin 1968

Kay 1997

Hardin 1998

de Villiers 2012

Come to class on Monday September 8th ready to discuss

QUIZ

Where is class this Friday?

QUIZ

3-270

Be there