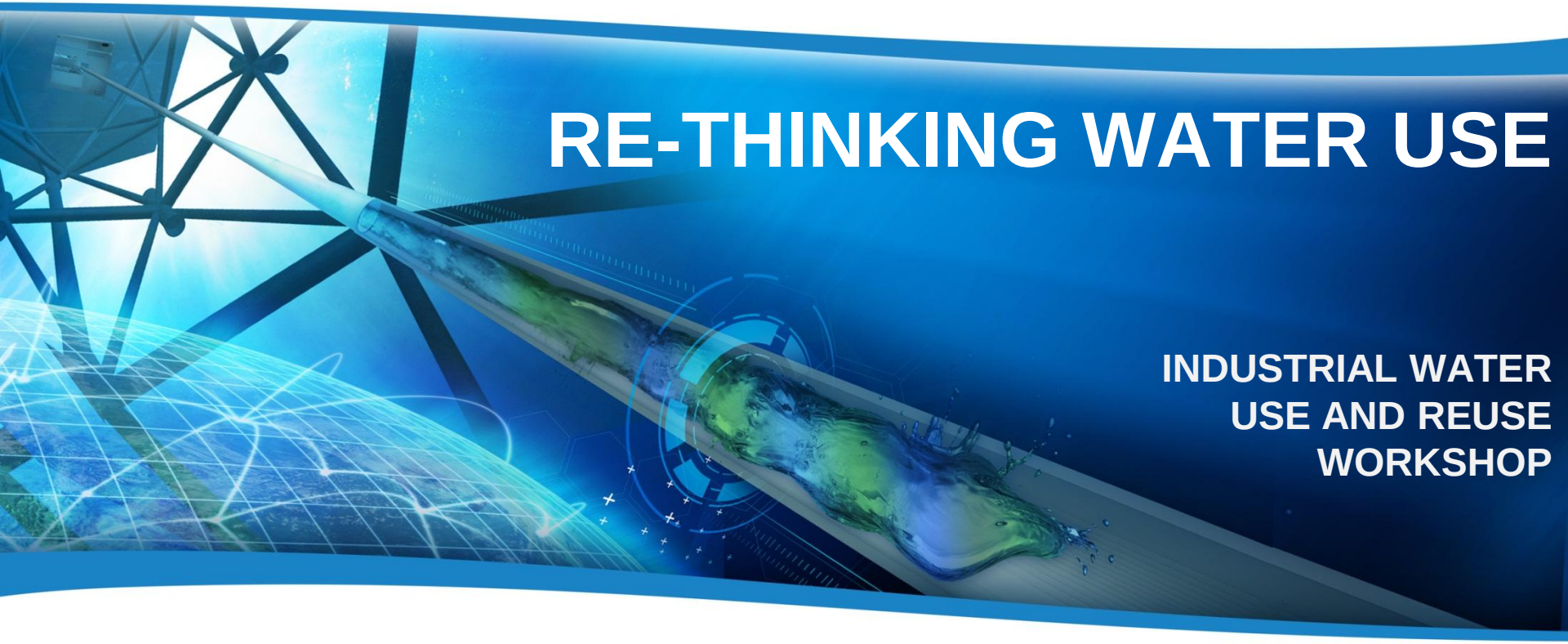
WATER STANDARD



RE-THINKING WATER USE

INDUSTRIAL WATER USE AND REUSE WORKSHOP

May 1, 2013

Impact of America's Oil Bonanza

- The shale-gas revolution in America has been as "sudden and startling as a supertanker performing a handbrake turn."[1]
- The International Energy Agency (IEA) predicts that the U.S. will become the world's largest oil producer by 2020, outstripping Saudi Arabia and Russia.
- The North American hydrocarbon bonanza offers big benefits, but also some pitfalls. The economic pluses are obvious: cheap gas yields cheap electricity, which boosts American industry, especially power-hungry sectors such as aluminum, steel and glass.
- The negatives are not so obvious, but very real. The impact on water supply, reuse and disposal is key.

1) Economist

Shale Boom Powering an Industrial Revolution

- There is an industrial revival going on spurred by the U.S. shale boom.
- New life for the Petrochemical, Steel and ancillary manufacturing industries.
  - Methanex closed its last U.S. chemical plant in 1999; now spending $500M to move a methanol plant from Chile to Louisiana
  - Williams spending $400M to expand an ethylene plant
  - CF Industries spending $2.1B to expand its fertilizer capacity
  - $80B spend anticipated in chemical, fertilizer, steel, aluminum, tire and plastics plants
- U.S. steel chairman, John Surma stated, "Development of our Nations recoverable oil and natural gas resources has the potential to be the once-in-a-lifetime economic engine that coal was 200 years ago."
- "With the price of gas likely to remain 50 to 70% cheaper in the U.S. than Europe and Japan, that will translate into significantly lower costs for electricity generation, fuel to power industrial plants and for feed stock used across many industrial processes."[1]
- The shale boom is changing how we think and act.

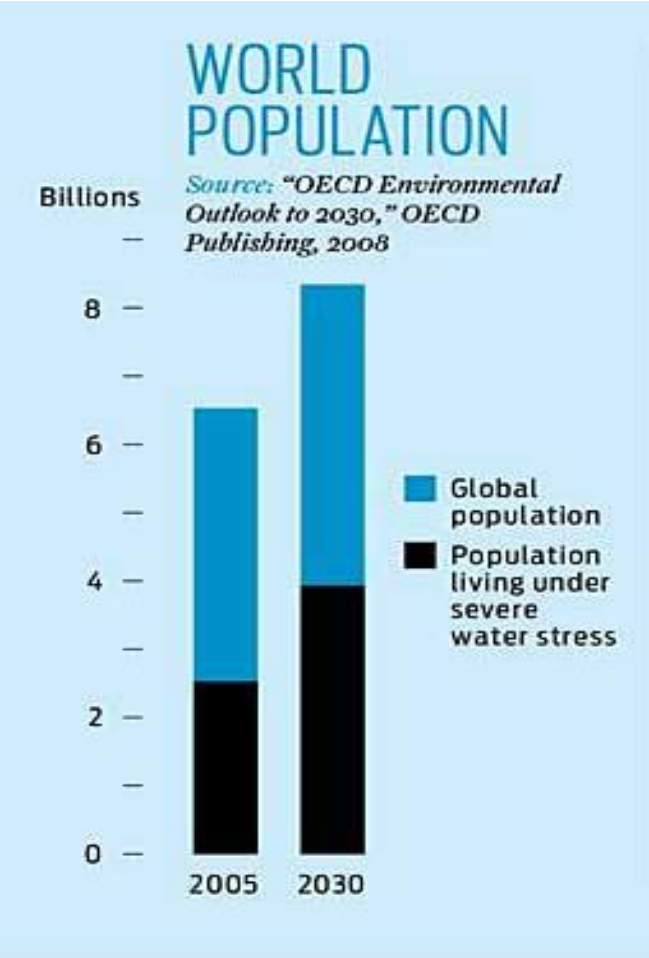
Water availability will be a key factor in realizing this anticipated industrial growth

Source: Justin Rose, BGG

The Industrial Water Challenge

- We live in an era of increasing water scarcity; it's not going away.
- Climate change is real and expensive!
- There is a critical focus on balancing supply, demand and managing competing interests of agriculture, domestic and industrial users.
- Industrial users will always be lower on the allocation and perception scale in any period of restricted use.
- It's all about the food, water, energy and industrial nexus.
- The new challenge is how to manage a growing industrial base in the U.S. and to streamline decision making taking into consideration all commodities.
- We have to understand supply and demand and make informed decisions accordingly.

Understanding the Basic's



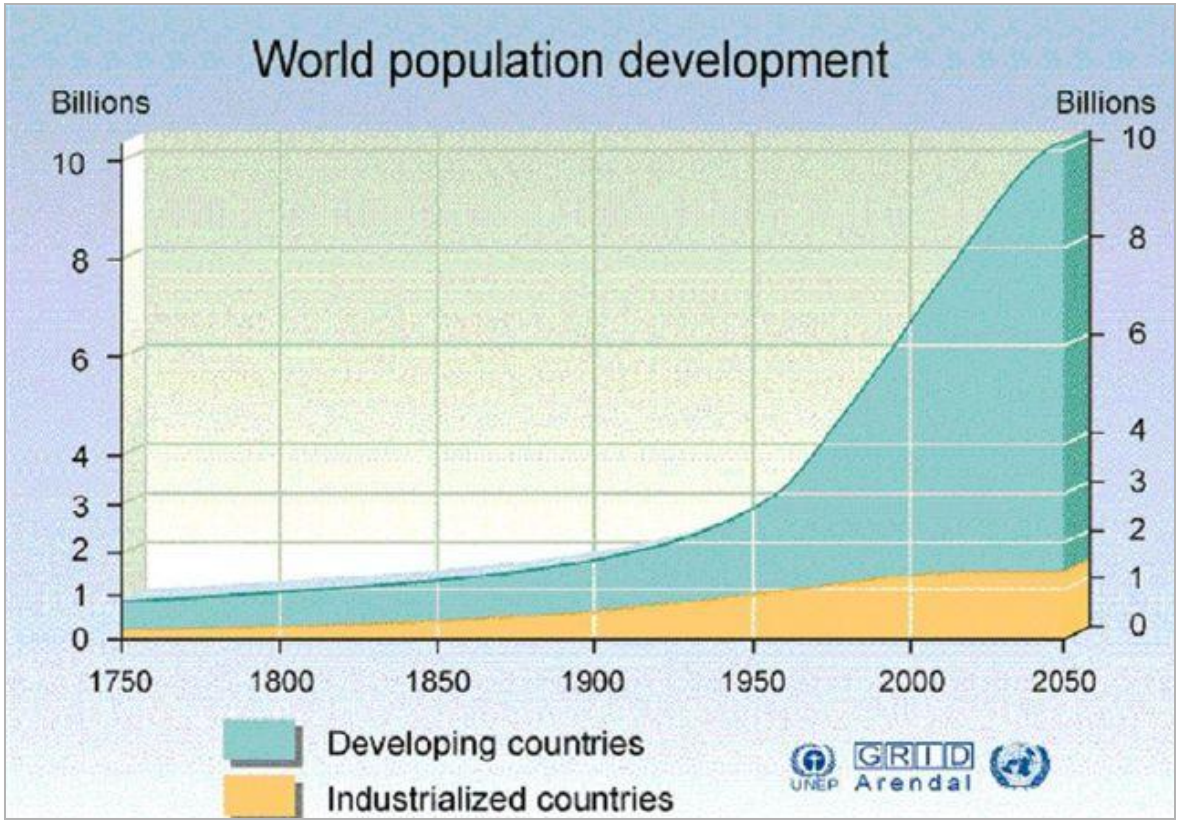
- Water scarcity is a growing problem and is exacerbated by macro-economic drivers.
- The world's population will increase by an estimated 2.5 billion people by 2050.
- By 2025, over half the world's population will live in water-stressed or water-scarce regions.
- Today 50% of the global population lives in coastal areas with this number increasing annually through migration toward the coast.
- Rising standards of living is resulting in increased water consumption.
- As a result of climate change, droughts are extending in duration due to changes in the hydrological cycle.
- 2 billion tons of contaminated water is discharged daily across the world. More people now die from contaminated and polluted water than from all forms of violence including wars.

Water is a non-substitutable commodity.

Supply/Demand imbalances dictate the opportunities and challenges.

Source: IBRD/World Bank, Sick Water (UNDP), UNESCO
OECD Environmental Outlook to 2030. IEEE Spectrum Special Report – June 2010

Population Growth: Driving Demand for Water

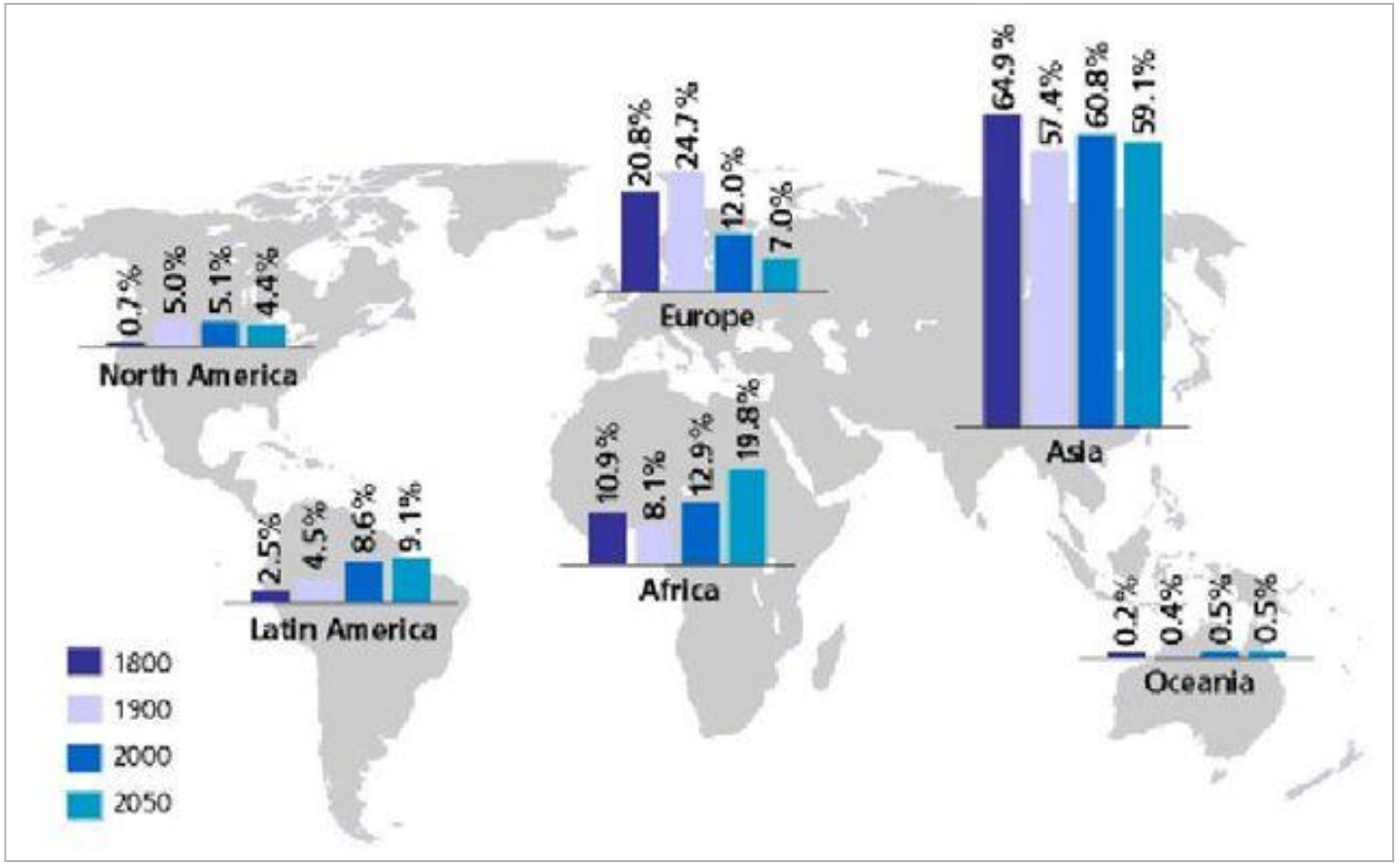


- The world's population has tripled in the last a hundred years yet there is no more fresh water on Earth now than there was 2000 years ago.

- Today's population of 6.7 billion is already placing unsustainable demands on water resources, currently using over 2.1 trillion cubic meters of water per year—the equivalent of two times the volume of Lake Superior (the largest lake in the world).

Source(s): The Sustainable Scale Project (graphics)
UN Urban Population, Development and the Environment, 2007

Population Growth: Driving Demand for Industrial Growth

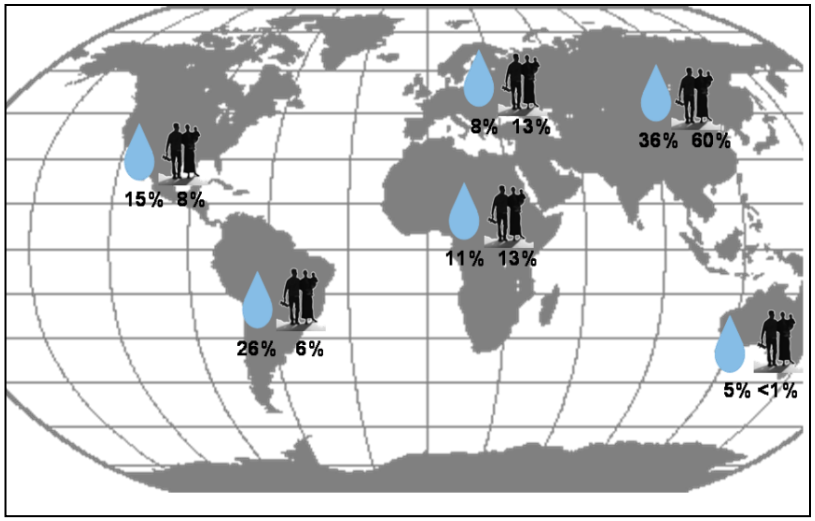


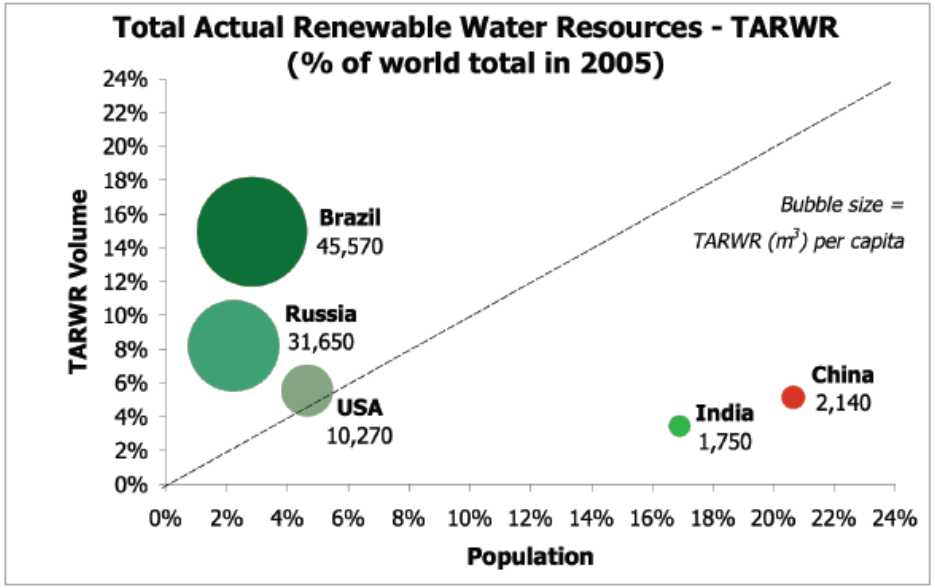
- By 2050, the population is expected to increase to 9.2 billion.
- The additional 2.5 billion persons—*the equivalent to two more Chinas*—will be absorbed mostly by the less developed regions, where infrastructure and water resources are unlikely to be able to handle such a large increase in population.

Source(s): The Sustainable Scale Project (graphics)
UN Urban Population, Development and the Environment, 2007

Resource Allocation: Unequal Distribution Stress Factors

Global water supply versus global population by region

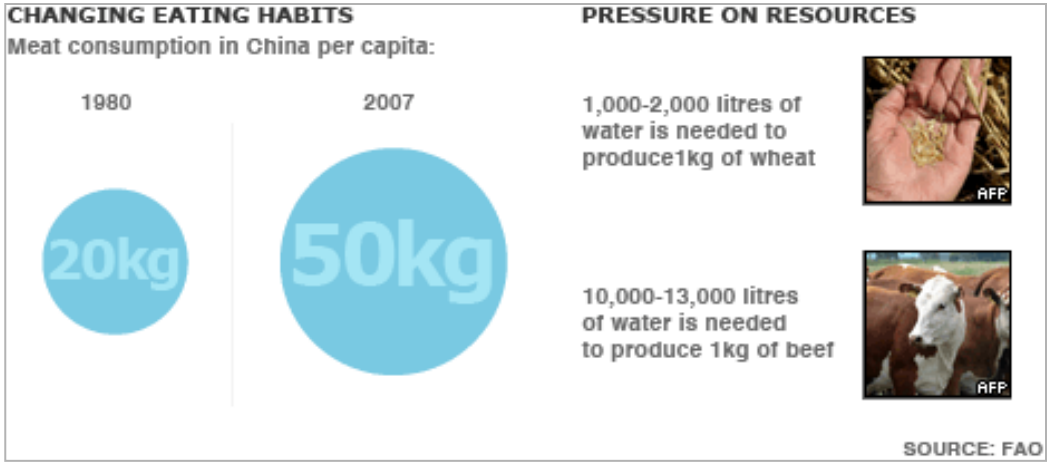


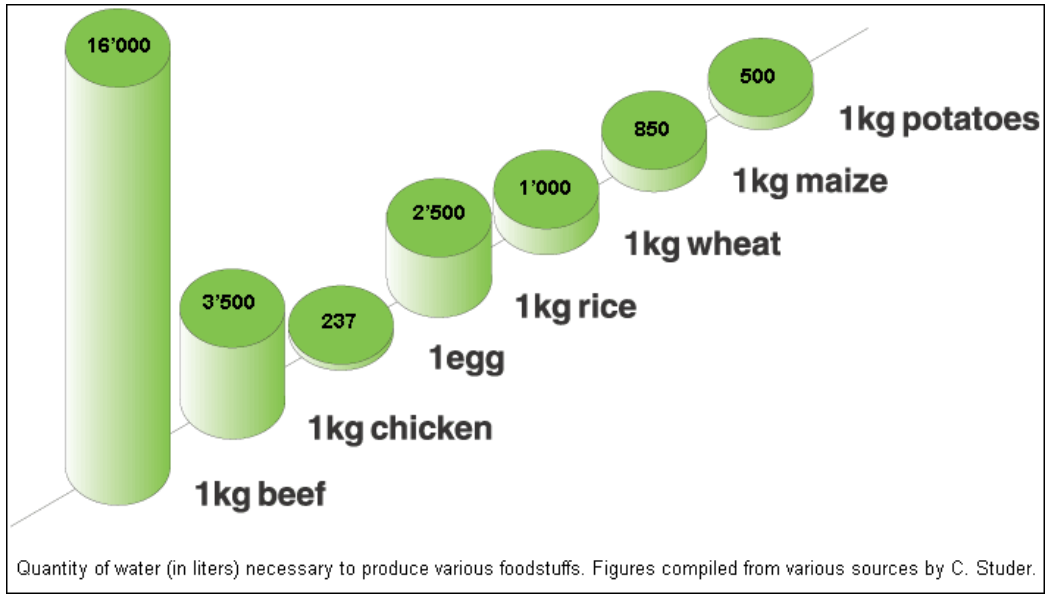


- Fresh water resources are often not located near areas of population concentration.
- Two-thirds of the world's population live in areas that receive only one-quarter of the world's annual rainfall.
- Over half of the world's water resources are located in only six countries.
- Russia enjoys a ratio of 9% of the world's water supply for only around 2% of the world's population.
- China faces severe water shortages with over 22% of world population and only 8% of world fresh water resources.

Source(s): UN Educational, Scientific and Cultural Organization
FAO-AQUASTAT, 2005, Fusion Analysis

Rising Standards of Living





Quantity of water (in liters) necessary to produce various foodstuffs. Figures compiled from various sources by C. Studer.

- By 2050, food demand is expected to increase by 70%-90% due to population growth and increasing incomes.
- Crop water consumption is expected to grow by the same order of magnitude.
- Higher income levels result in more varied and protein-rich diets, increasing the amount of water it takes to satisfy food requirements.
- Consumption of meat, a far more water-intensive good than grain, in China has grown from 20kg per capita to 50kg per capita in about 25 years.
- As standards of living increase, demand for industrial products increase; power; and consumables.

Source(s): United Nations Water Development BBC

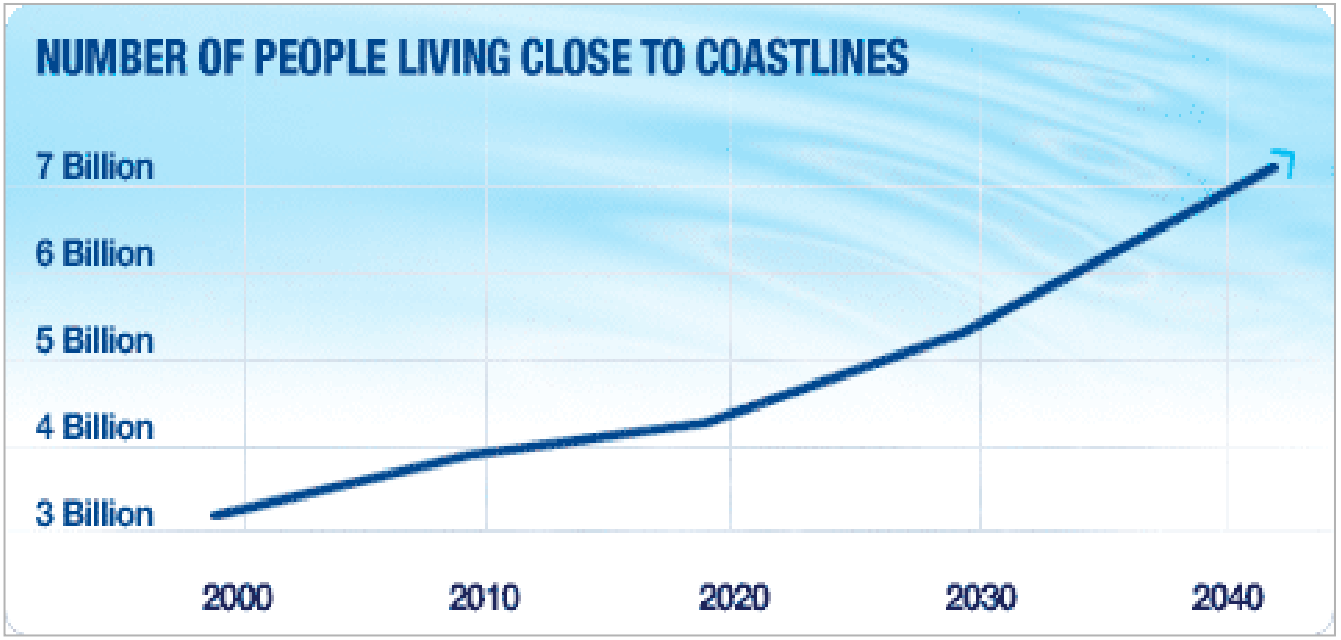
Population Concentration on Coastlines

- Populations worldwide are concentrated along or near coasts occupying only 10% of the earth's land. Industry follows people.

Ten Largest Cities

1) Tokyo	***Coastal***	***4) Shanghai***	***Coastal***	*7)*	São Paulo	Inland
2)	Mexico City	Inland	***5) Lagos***	***Coastal***	***8) New York, USA***	***Coastal***
3) Mumbai	***Coastal***	***6) Los Angeles***	***Coastal***	***9) Calcutta***	***Coastal***
				10) Buenos Aires	***Coastal***

- This concentration pollutes and depletes coastal and ocean resources and places pressure on fresh water resources, leading to water crises for many coastal communities.
- Coastal population will grow to around 7 billion globally by 2040, further compounding problems of fresh water access.



Source(s): Solutions for a Water-Short World, Population Reports
US Department of Commerce Nahkeel

Climate Change

With record droughts and the changes in water patterns, the continuing effect of climate change has an immediate impact on the availability and delivery patterns of fresh water.

Murray-Darling Basin - Australia
August 2010

Amazon River -Brazil

September 2006

Lake Mead - Nevada

April 2007

Kouris Reservoir - Cyprus

March 2008

Climate Change Impacts

- Rising costs
- Calculation of "Water Footprint" for all users
- Regulatory caps for water use
- Regulatory restrictions for specific industrial activities
- Conflicts with local communities and regional and political implications
- Impact on site locations and permitting for industry
- Operational disruptions and associated financial loss

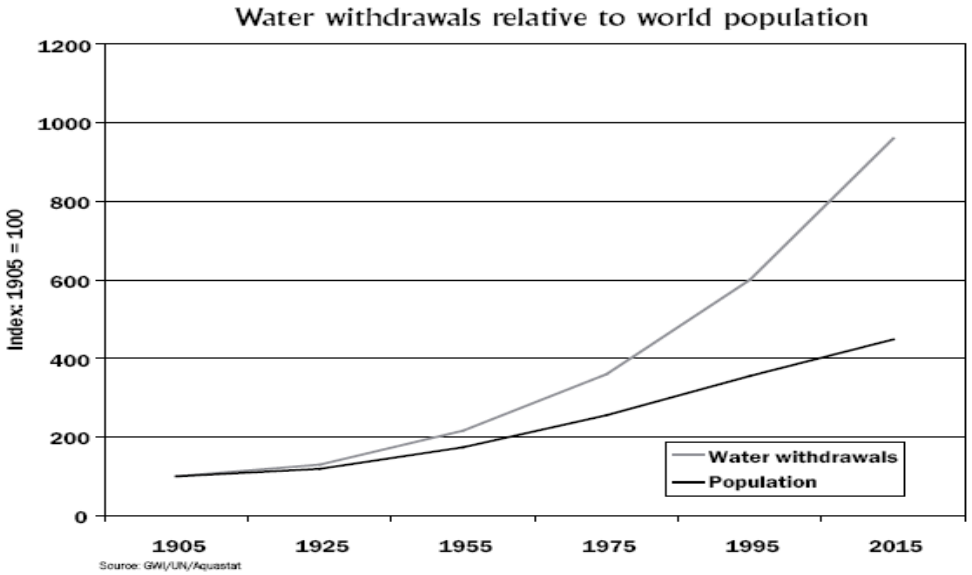
Water and its availability and quality will be the main pressures on societies, the environment and industry under climate change.

Source: IPCC Technical Paper, "*Climate Change and Water*", June 2008; Ceres Water Scarcity and Climate Change; "*Growing Risks for Businesses and Investors*", April 2009; *Research and Markets Report 2007-Desalination Markets 2007: A Global Industry Forecast*

Water Scarcity has a Real Impact

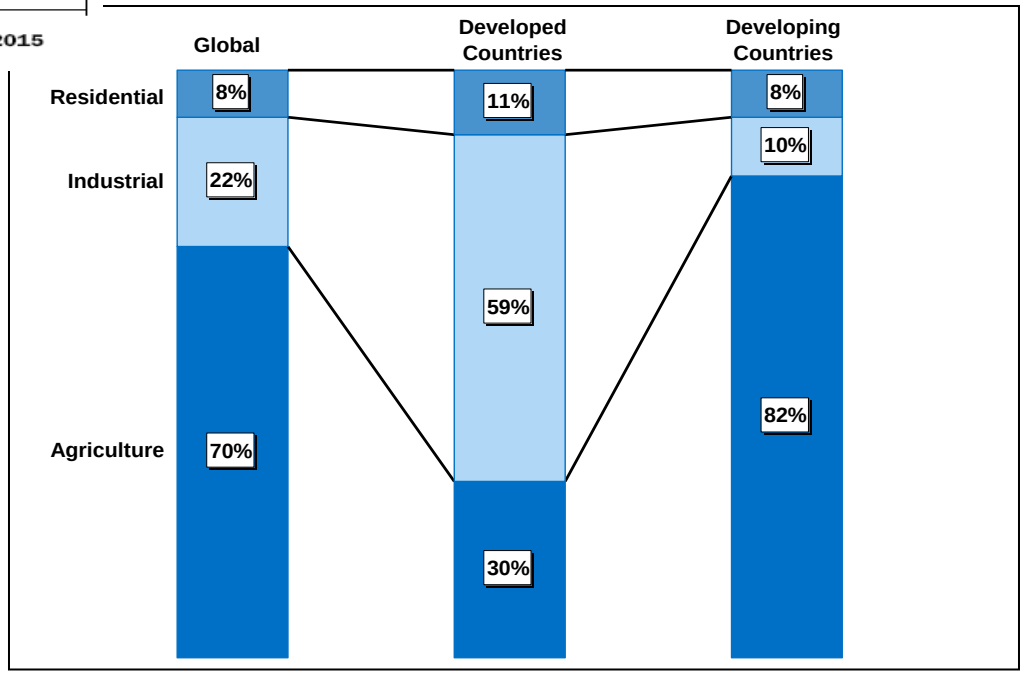
- In the 2011 drought, Texas suffered an estimated $7.62 billion in agricultural losses.
- The Texas 2012 State Water Plan prepared by the Texas Water Development Board, concluded, if drought conditions recur and water management strategies are not implemented, Texas could suffer annual economic losses of $11.9 Billion growing to $115.7 Billion by 2060.
- Regional planning groups identified 562 projects and estimated it will take $53 Billion to implement recommended water management strategies and projects.
- Texas is now also looking at a growing manufacturing base, expecting 12.8% more drilling activity in the Eagleford and 15.1% in the Permian for 2013, and needs to grow its power generation capacity.

Patterns of Water Usage: Increasing Competition



- The same forces of population growth and increasing incomes will also raise demand for manufactured goods and energy consumption.
- Industrial water needs are expected to increase 50% in the next 10 years.

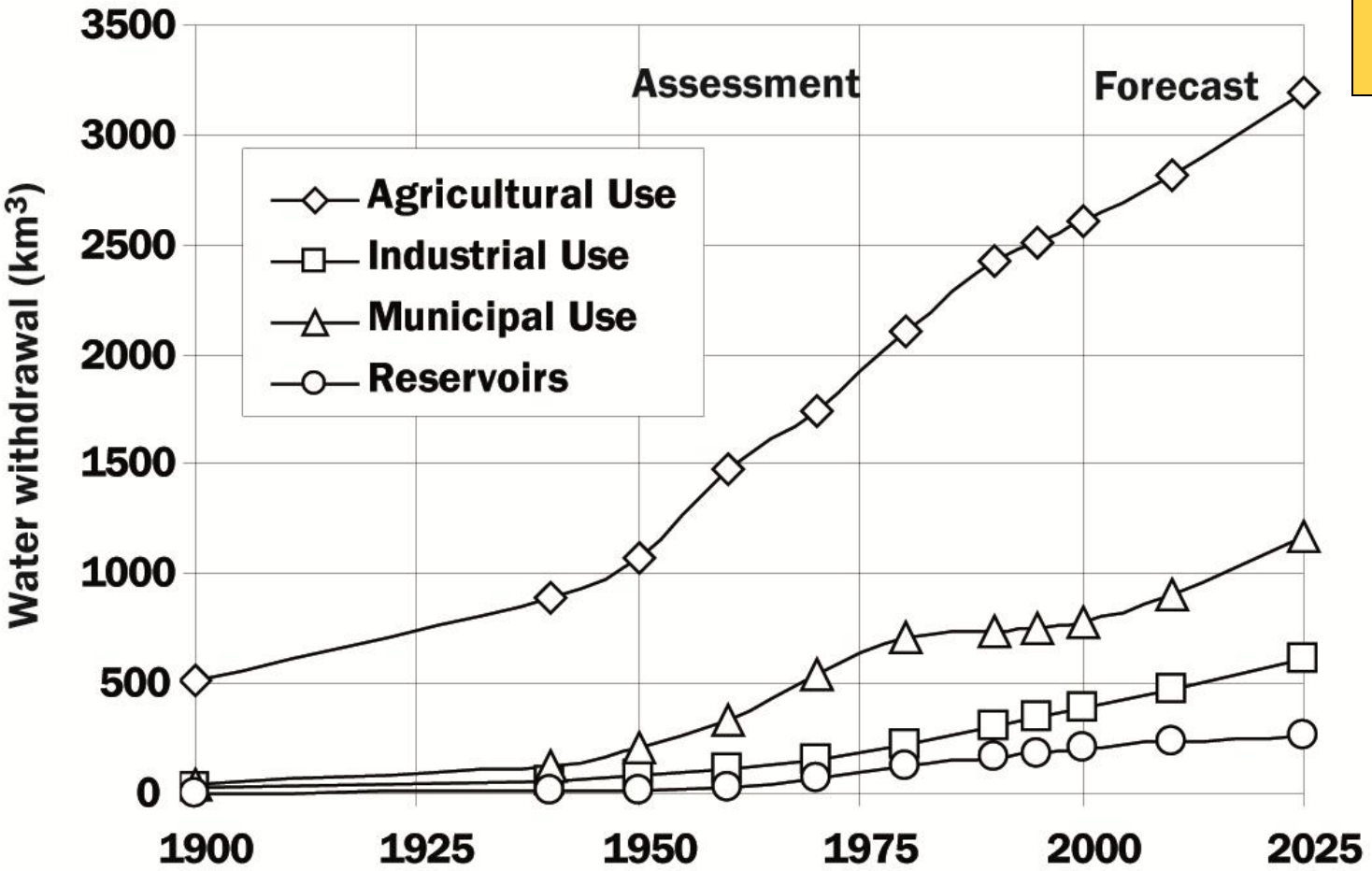
- Competition for water resources between industry and agriculture will only intensify in the future with a very real threat of chronic food shortages and surge in prices due to water scarcity.



Source: GWI/UN/Aquastat

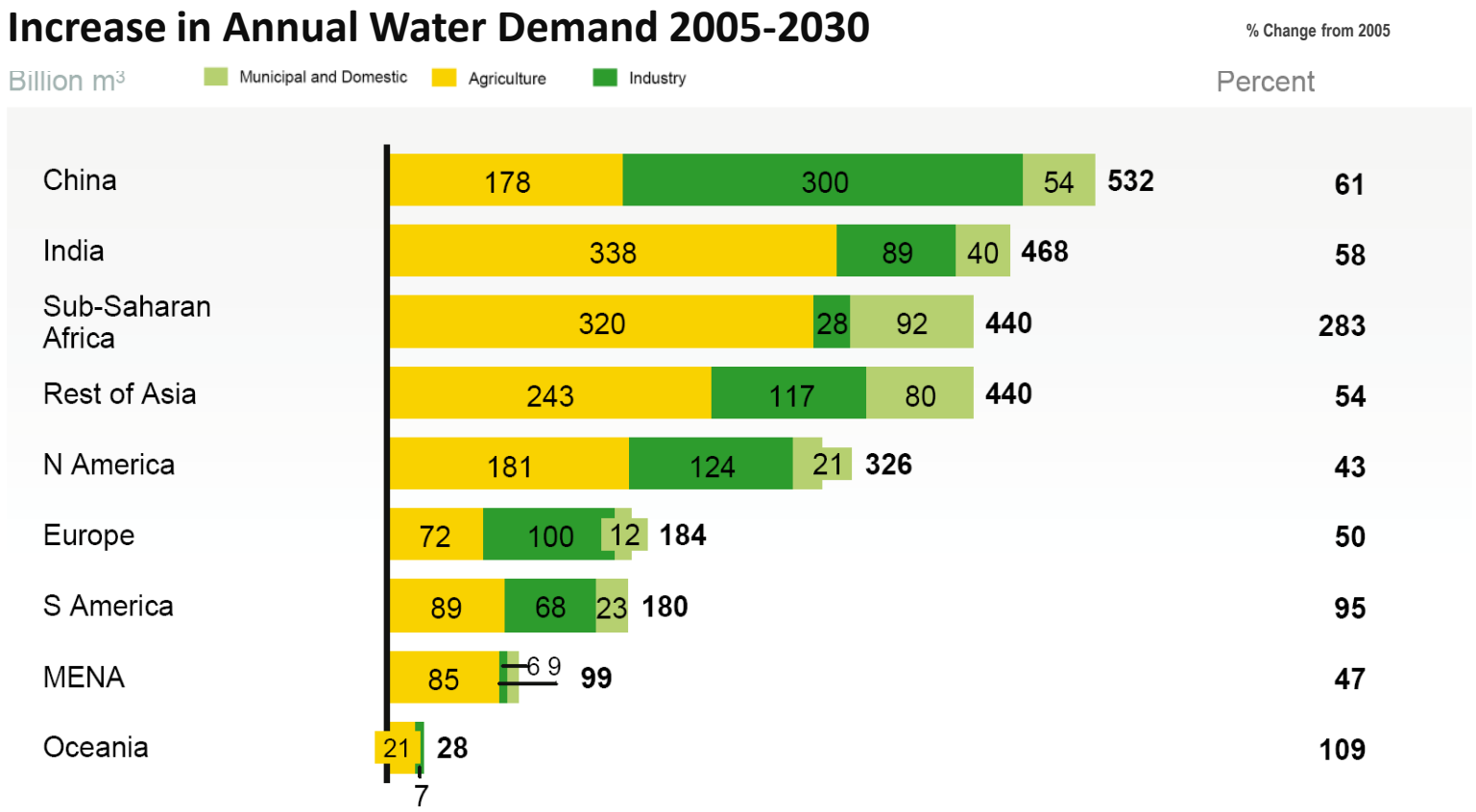
Allocation of Water Resources Globally

Demand +32% by 2025



Source: Christopher Gasson Publisher, Global Water Intelligence

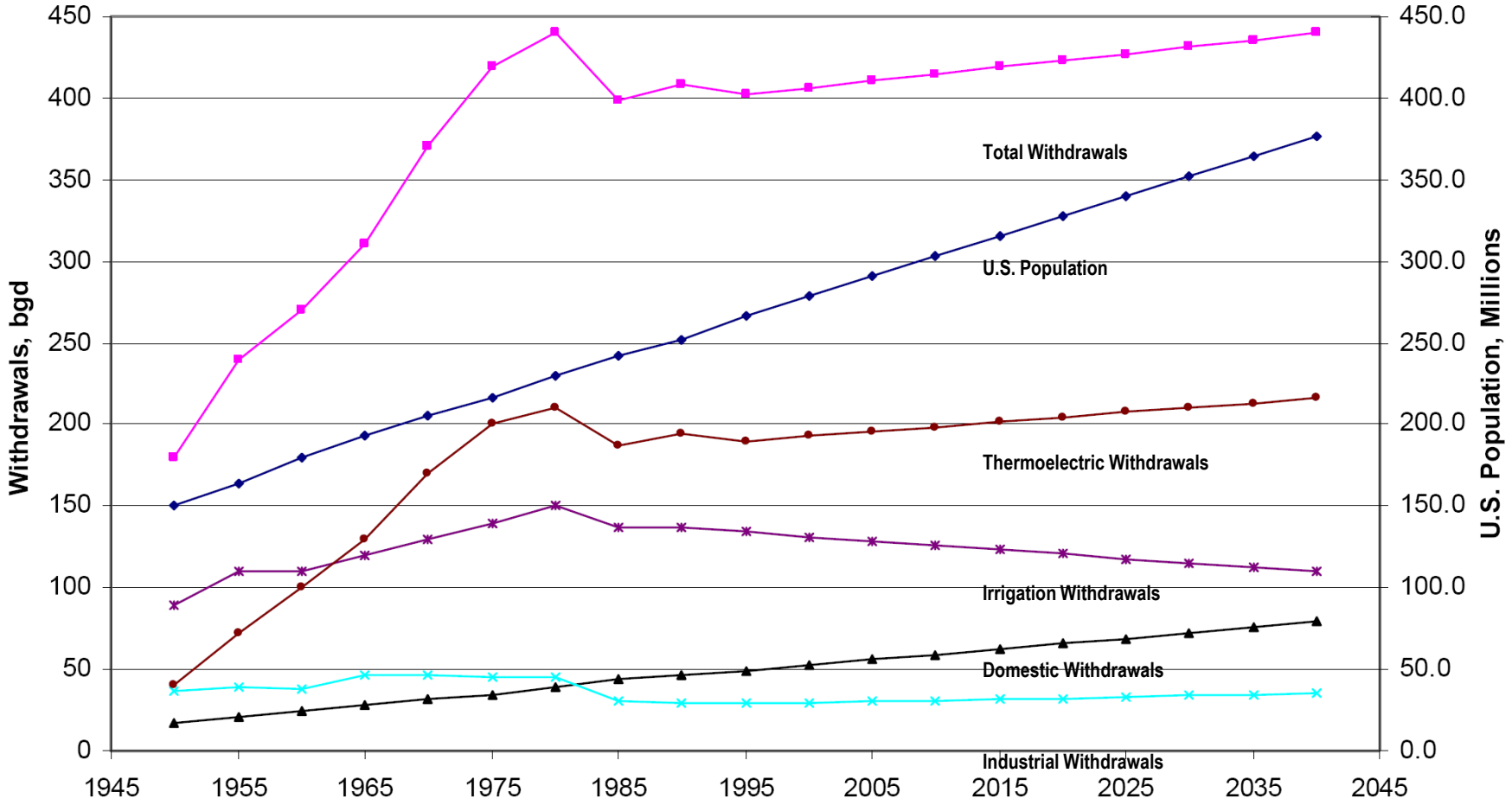
Global Demand: Where is the Growth?



SOURCE: 2030 Water Resources Global Water Supply and Demand model; baseline agricultural production based on IFPRI IMPACT-WATER base case

How will the shale boom change these estimates?

Increasing U.S. Water Withdrawals



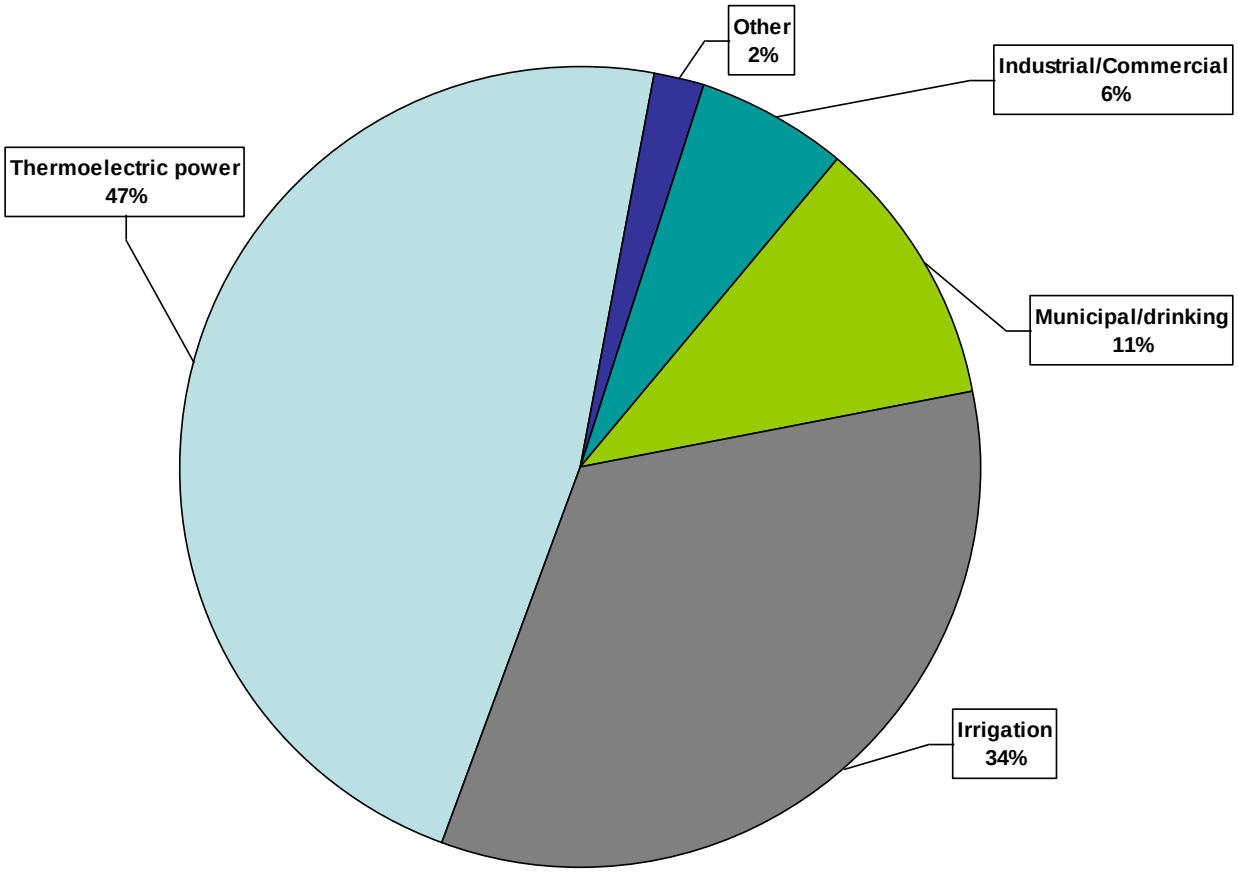
United States industrial demand had reduced as a result of outsourcing production to developing nations, but that is changing.

Source: Dziegielewski et al, 2003, Institute of Water Resources of the USACE U.S. Department of Interior

Sources of Water Demand in U.S.

Patterns in the U.S. are different from developing countries

- 1 m^3 of industrial water is 70x more valuable than 1 m^3 of irrigation
- To produce I kw takes 21 liters of water
- To produce 1 kg of steel takes 95 liters of water
- To produce 1 kg of paper takes 326 liters water
- Emergence of the concept of virtual water
- “Industry” is the easy target in an environment where there are competing interests

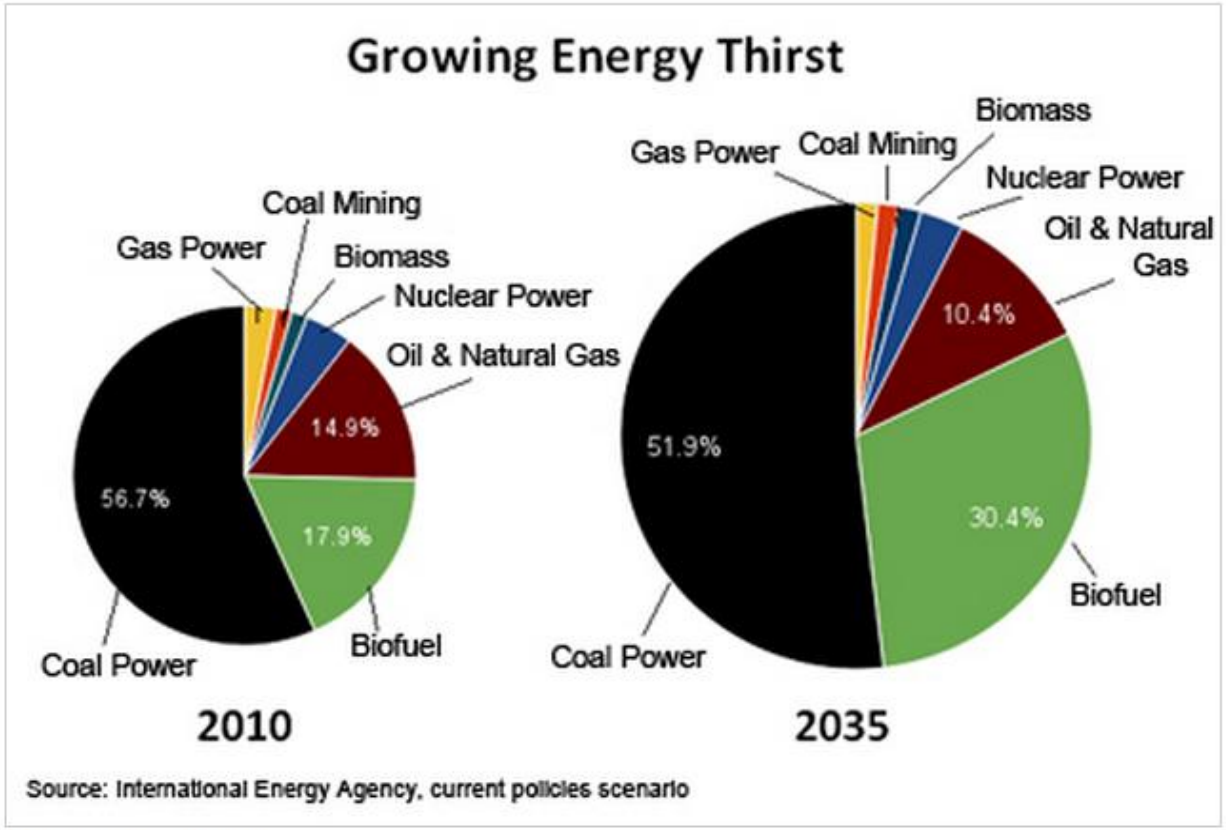


65% of water in the U.S. is currently surface water, 20% groundwater and 15% saline

Source: US Department of the Interior

Water Use for Energy Industry

Water volumes needed for energy to double by 2035!



National Geographic

This did not account for the rapid growth of the shales

Source: International Energy Agency

Today's Growth Environment

Macro Uncertainty Abounds

- World economies are fragile
  - Global deleveraging cycle will be a drag on growth everywhere
  - Europe is a mess with no resolution in sight
  - China is a black box – possibly headed for a "hard landing"
  - U.S. recovery is nascent, slow and hooked on fiscal stimulus
- Politicians not inspiring confidence
- Despite this, U.S. stock market is hitting new highs and debt yields are very low
- U.S. Oil & Gas Boom is providing the only bright spot and industry is growing

Source: Limerock

The Battle Lines are Being Drawn

- Who wins when water is scarce; not industry.
- Recently an example in Texas highlighted the potential risks:

  Dow Chemical made a priority call for water. The Texas Commission on Environmental Quality (TCEQ) determined that Dow could not divert the amount of water it needed, but allowed junior water rights holders to continue to use their appropriations. They were Municipal and Electric users and TCEQ argued public health, safety and welfare issues were at play.

- The implications are significant for industry, but in this case also agriculture; rice farmers.
- Appointment of water masters and water czars.
- Lack of effective Federal and State leadership.

The Market is Taking Note

- We have to better understand and assess the impact of water scarcity on future corporate growth and adopt effective water risk management practices.

- Ceres, an advocate for sustainability leadership, has focused on making corporate disclosure of water risk a priority for investors and also a mechanism for effective water management.

- Investors want to understand how well companies are managing water related risks and opportunities.

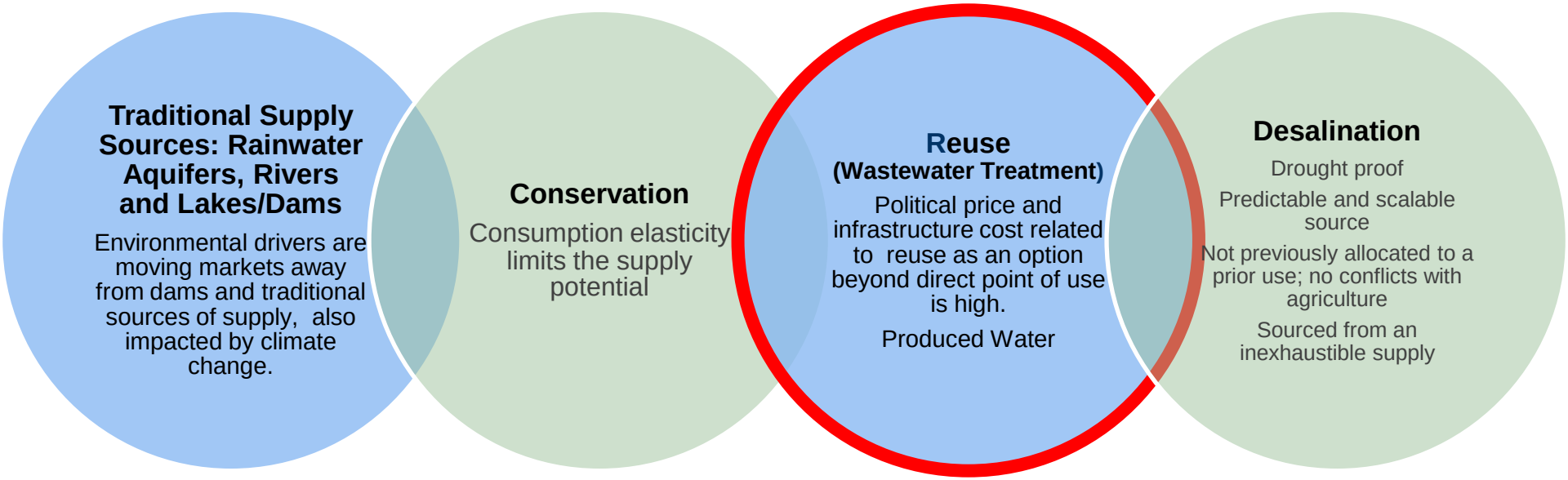
- Ceres has developed a first-of-its-kind tool called the Ceres Aqua Gauge which is designed, in part, to help investors analyze corporate water risk.

- Ceres recently stated that this standardized tool is endorsed by investors managing over $2 Trillion in assets and helps these investors assess the impact of water risks on the companies they are evaluating.

Industry will have to Adapt

Water shortages are not going away.

Additional water supply for increasing demand can only be obtained through four (4) basic sources:



Water availability will drive decisions on where to locate new industries, but for existing infrastructure, all options have to be considered.

Focus on Efficiency and Reuse

- An estimated 20mgd of fresh water is pumped through U.S. industries today. That is going to increase significantly.
- The water withdrawn is pumped back into municipal wastewater treatment facilities or disposed into bodies of water after treatment.
- In a water short environment, rising regulatory compliance obligations and increasing cost, water reuse has to be considered.
- Need for water security and re-thinking wastewater as a source of potential profit and just smart water risk management.
    - Ecolab and Dow in Freeport addressed water use within Nalco's 3D Trasar Cooling Water Technology and yielded a savings of 1 billion gallons of water per annum and $4M per annum in OPEX.
- Increase in innovation and technology related to treatment and reuse.

Upstream Sector Analogy

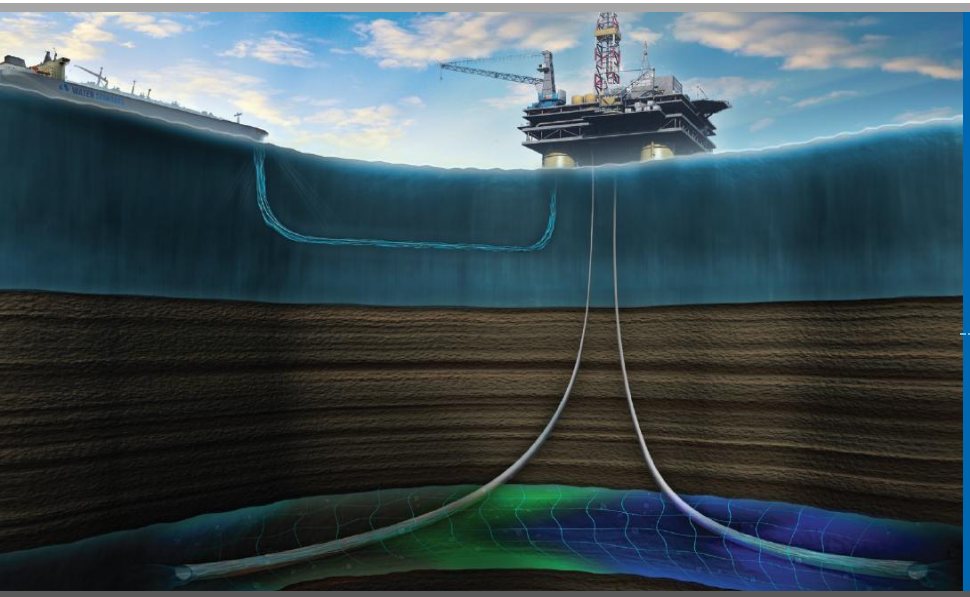
- Competing interests for accessing water supplies and bad press have resulted in fundamental changes in the use of water in hydraulic fracturing.
  - EPA estimates it takes between 70 and 140 billion gallons to fracture 35,000 wells a year.
  - Dealing with Flowback is challenging and cost of treatment or disposal is significant.
  - Result is a focus on:
    - Reuse of flowback after treatment
    - Reinjection of flowback with minimal treatment
    - Moving away from water to use of propane gas, compressed air or CO_2 foam
  - Tremendous R&D and new technology advances to treat water.

- Produced Water Reuse
  - U.S. generates approximately 21B bbl per annum with Produced Water as the highest volume by product associated with production (98%).
  - Increased environmental regulation and requirement for treatment before discharge; movement to ZLD offshore.
  - Innovation in treatment methods for reinjection and Enhanced Oil Recovery.

Where does this Leave the Industrial Sector

- There is a lot of uncertainty and a lot of opportunity.
- Water use has to be looked at holistically and industrial users have to face the reality they will always be vulnerable to criticism.
- In the face of the lack of effective political leadership and regulatory certainty, the industry will have to be ahead of the curve, self-regulate and innovate.
- In an environment of dwindling water resources it is not only a supply issue, but also a demand side management issue.
- As the U.S. industrial base grows and competition for water as a limited resource grows, industry has to manage water risk.
- Effective Water Management = profit and success and drives long-term decisions.

WATER STANDARD



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