Water Reuse Conference
May 15, 2013

Addressing the Environmental Challenges of the 21st Century:

Water & Energy:

Is there a Road to a Sustainable Future?

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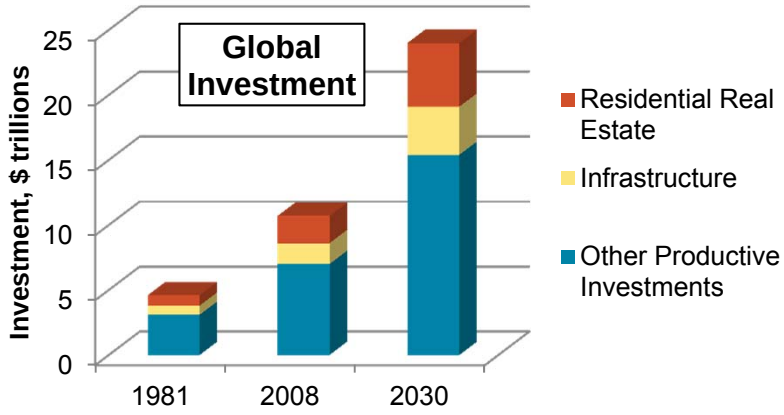
BUILDING A BETTER WORLD

Outline

- The Resource Challenge
- A Multiple Nexus Future
- The Energy Challenge
  - De-carbonization
  - An alternative solution
- The Water Challenge
  - Reuse as an opportunity
  - An alternative solution

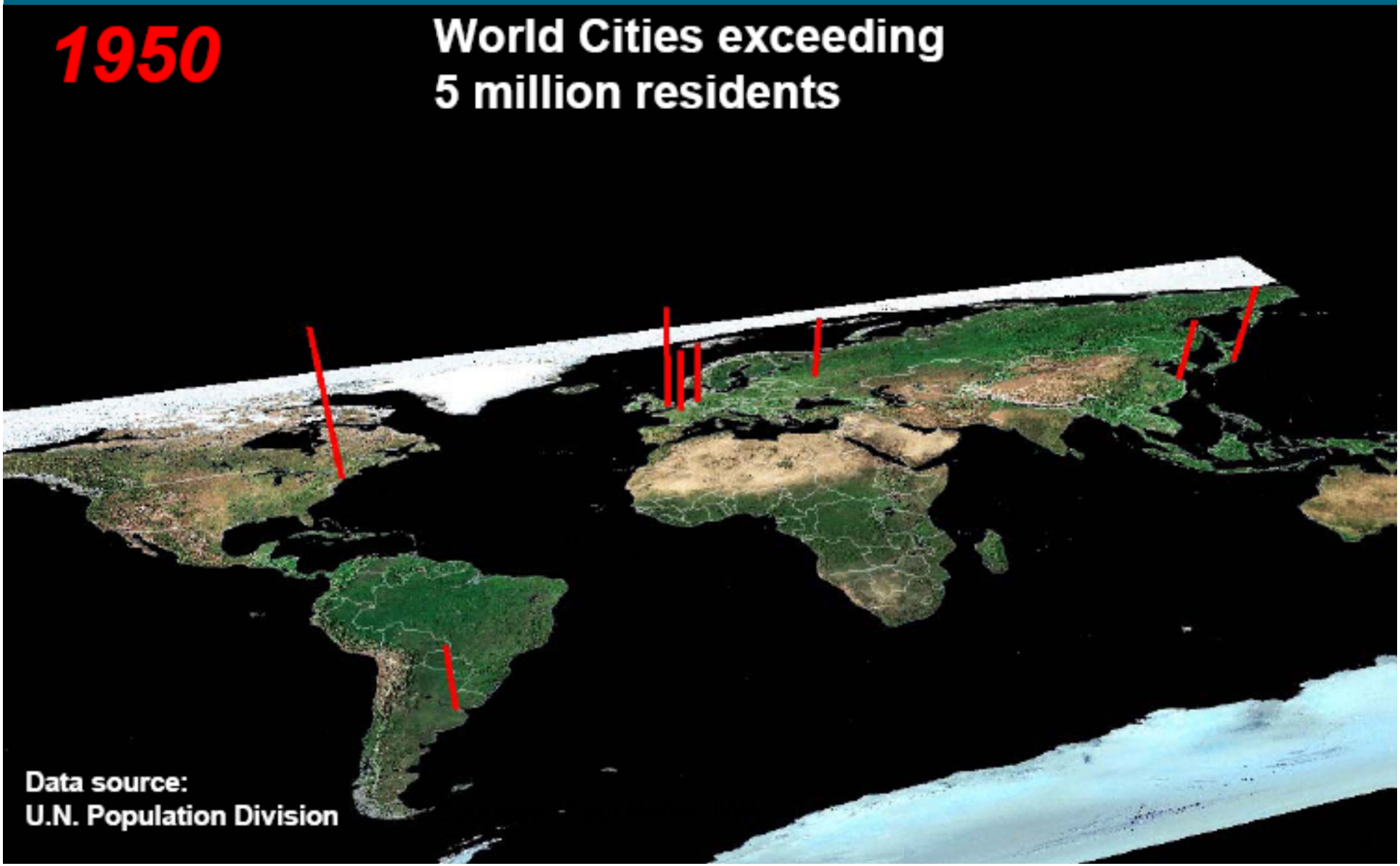
The Resource Nexus Challenge

- 9 billion by 2050; 3 billion more consumers by 2030
- Investment boom; interest rates rising
- Global GDP driven by energy markets
- Increased food demand; diet shifts
- Energy demand increasing
- Water consumption accelerating



Source: McKinsey Global Institute, 2011; Royal Society, 2012; World Economic Forum, 2011

World's City-Building Rate Accelerating



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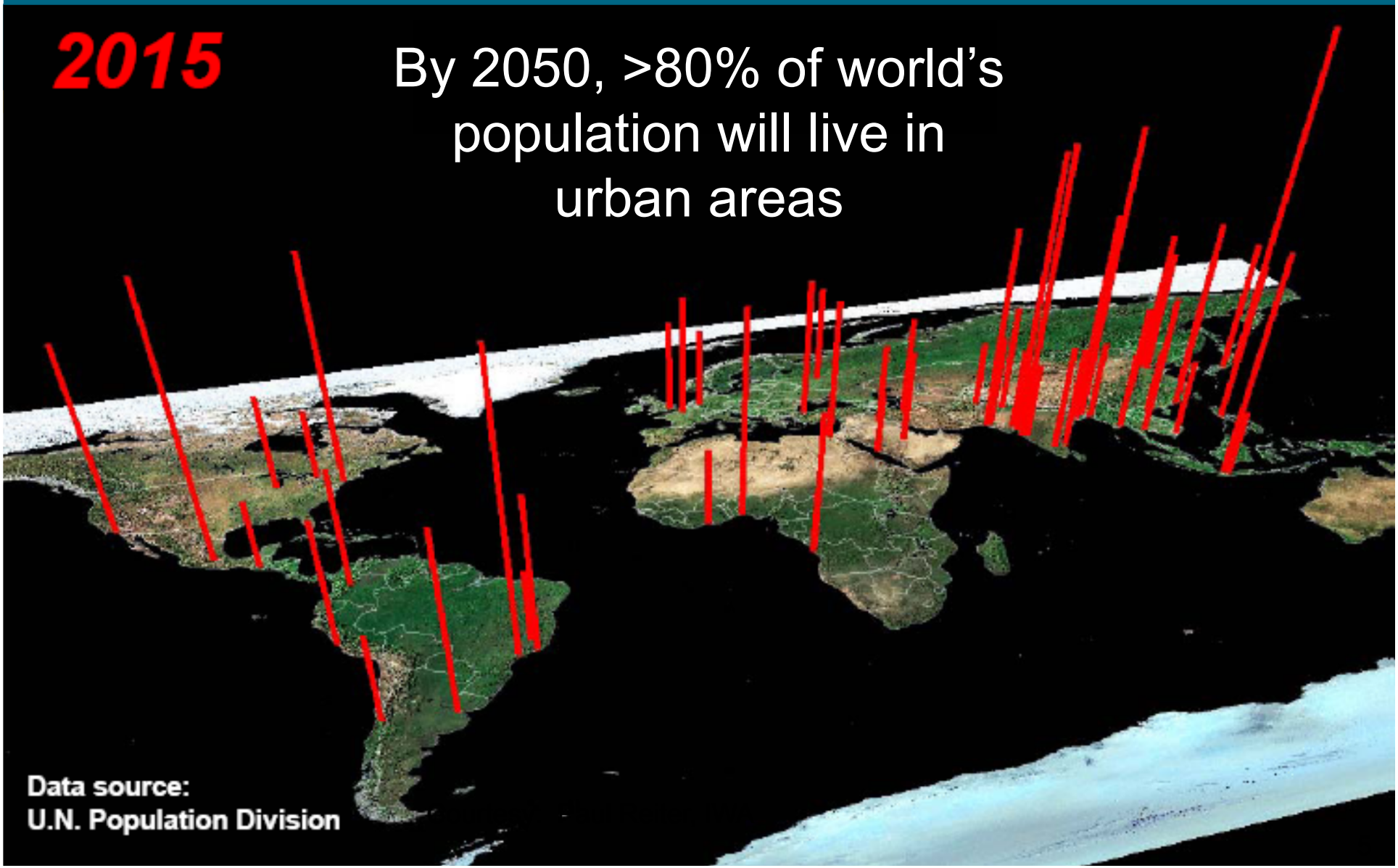
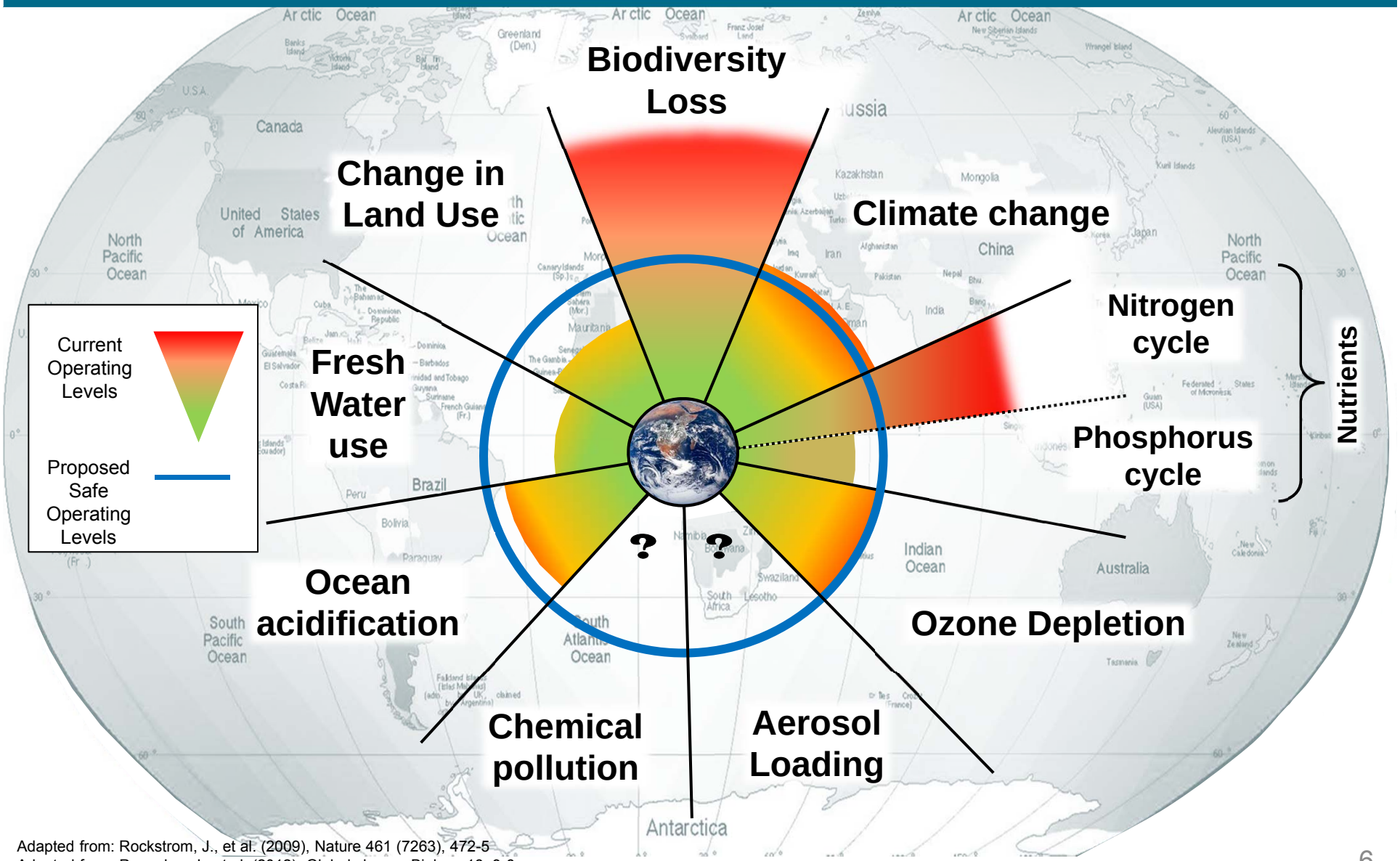
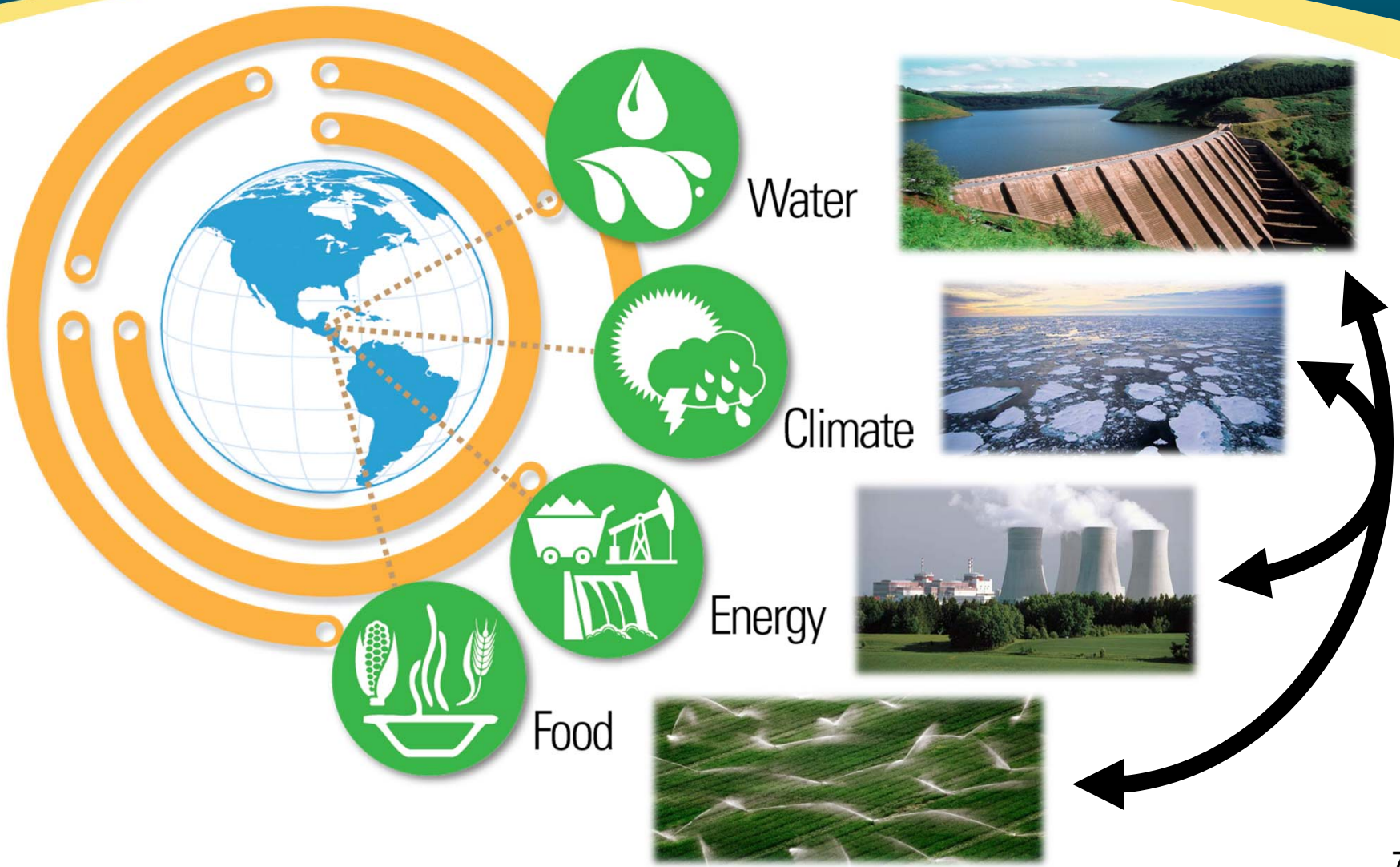


Pushing Our Planetary Boundaries

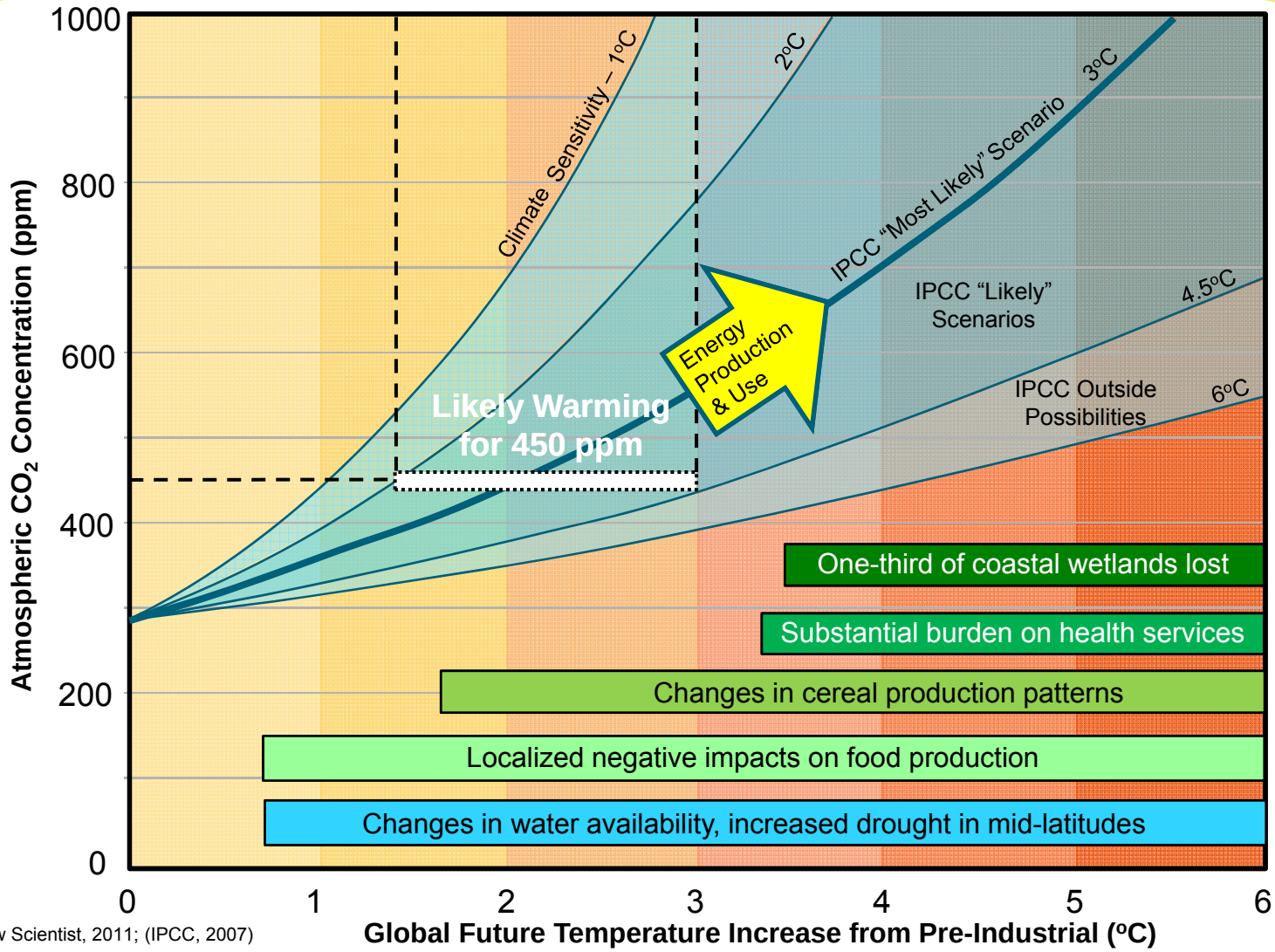


Adapted from: Rockstrom, J., et al. (2009), Nature 461 (7263), 472-5
Adapted from: Penuelas, J., et al. (2012), Global change Biology 18, 3-6

We are in a State of "Resource Multi-Nexus"



Global Climate Change: Consequence of the Nexus



Adapted from: New Scientist, 2011; (IPCC, 2007)

Energy Demand:
A Challenging Future…Arriving Now

- **Demand for energy – 40% gap by 2030**
- **70% of requisite infrastructure not built**
  - **$21 trillion investment required**
  - **Extra $10 trillion needed to decarbonize capacity**
- **75% of increase met by fossil fuels**
  - **China to expand by 1300 GW by 2030**

Source: Palmer & Nair , 2011; Zhou, et al., 2011; World Economic Forum, 2011

Roadmap to Sustainable Energy Future: What will global societies choose?

1

Business-as-Usual

2

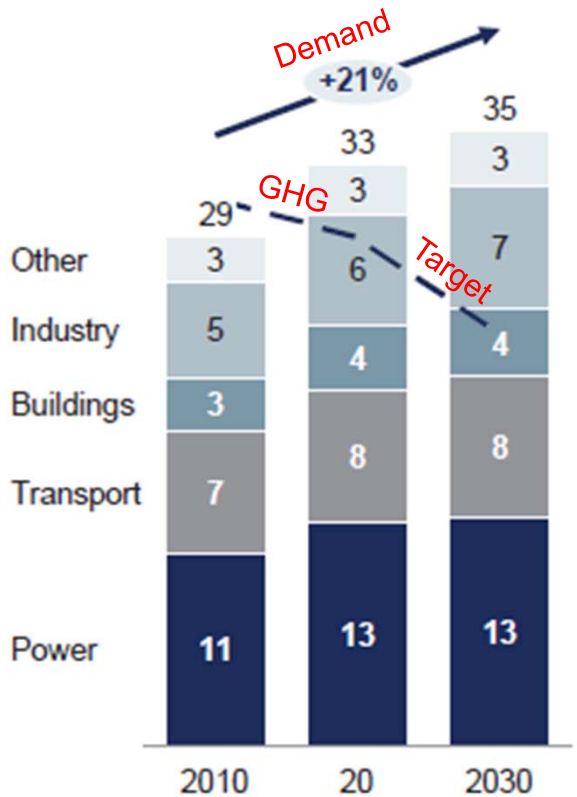
Technology Advances excluding Carbon Cost

3

Technology Advances including Carbon Cost

Energy De-carbonation is Crucial: Is it feasible? Is it realistic?

Business-as-usual



1

2

3

Source: McKinsey Global Energy Perspective, 2012

"2 Percent Solution"
Is it feasible? Is it realistic?

- Average annual energy use efficiency ≈ 1%/yr
- At current 1%/yr rate, by 2100 → 40% more energy deficit than today
  - unable to sustain population demands
- Minor interventions → push to 2%
- 2%/yr triples efficiency by 2065
  - 1/3 of today's use
  - all live at western standard
  - consumes 1/2 of today's rate

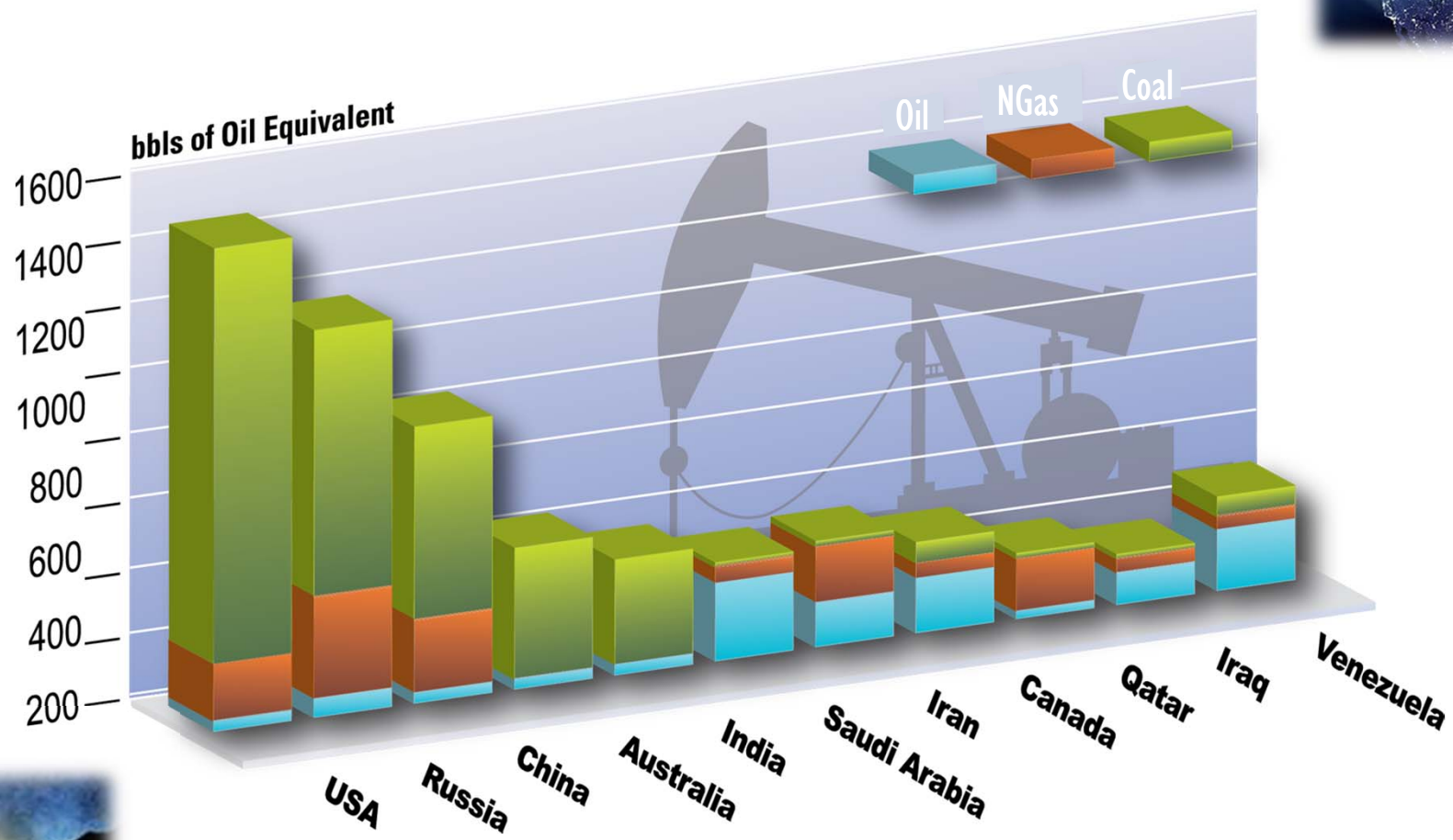
"THE SOLUTION TO POLLUTION IS CONSERVATION."

- Richard Muller, UC Berkeley

First priority is conservation; second is new technology.

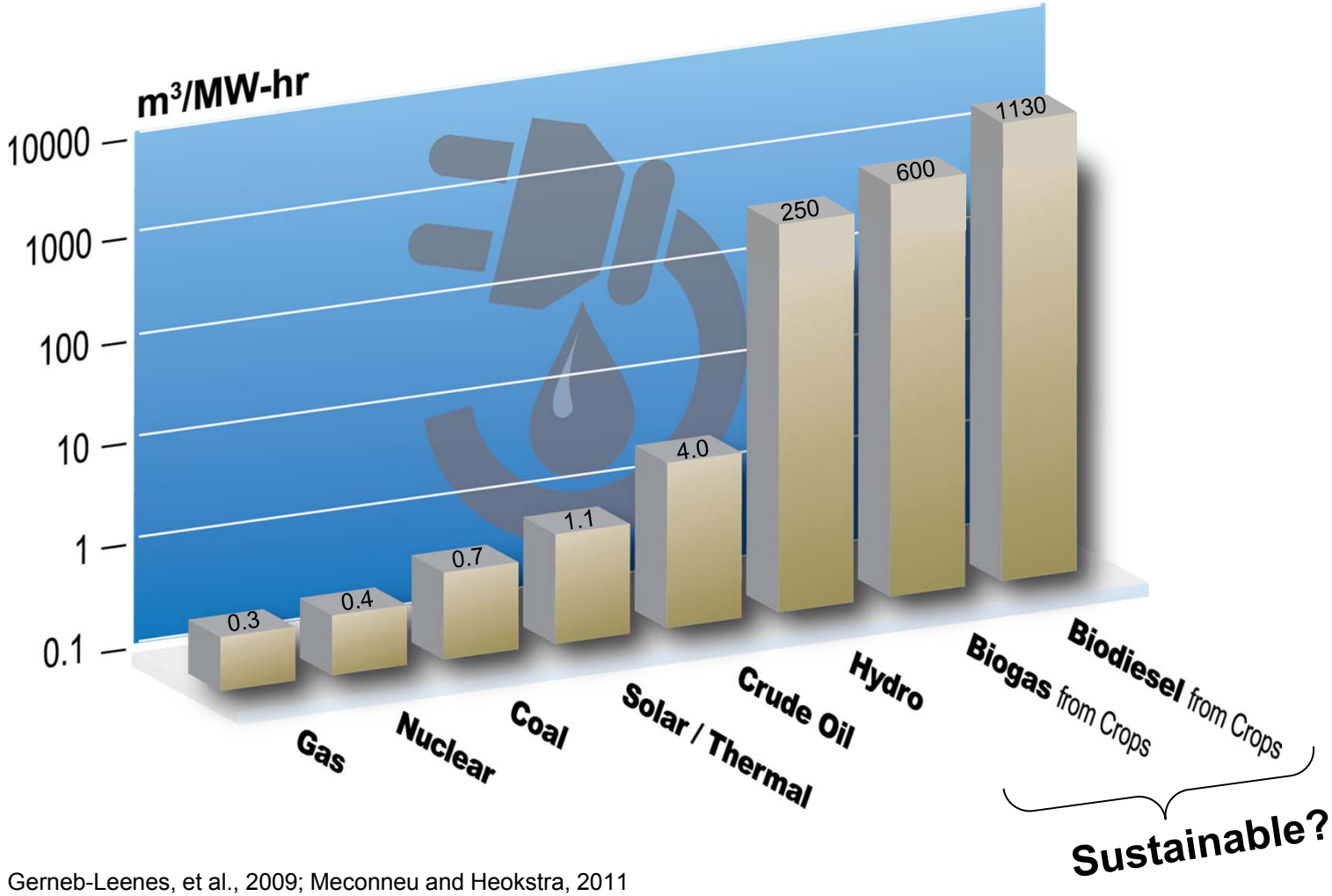
Source: Rosenfeld, A., *Lawrence Berkeley National Laboratory*, UC Berkeley (2011)

How are Energy Sources Distributed in Powering Our World?



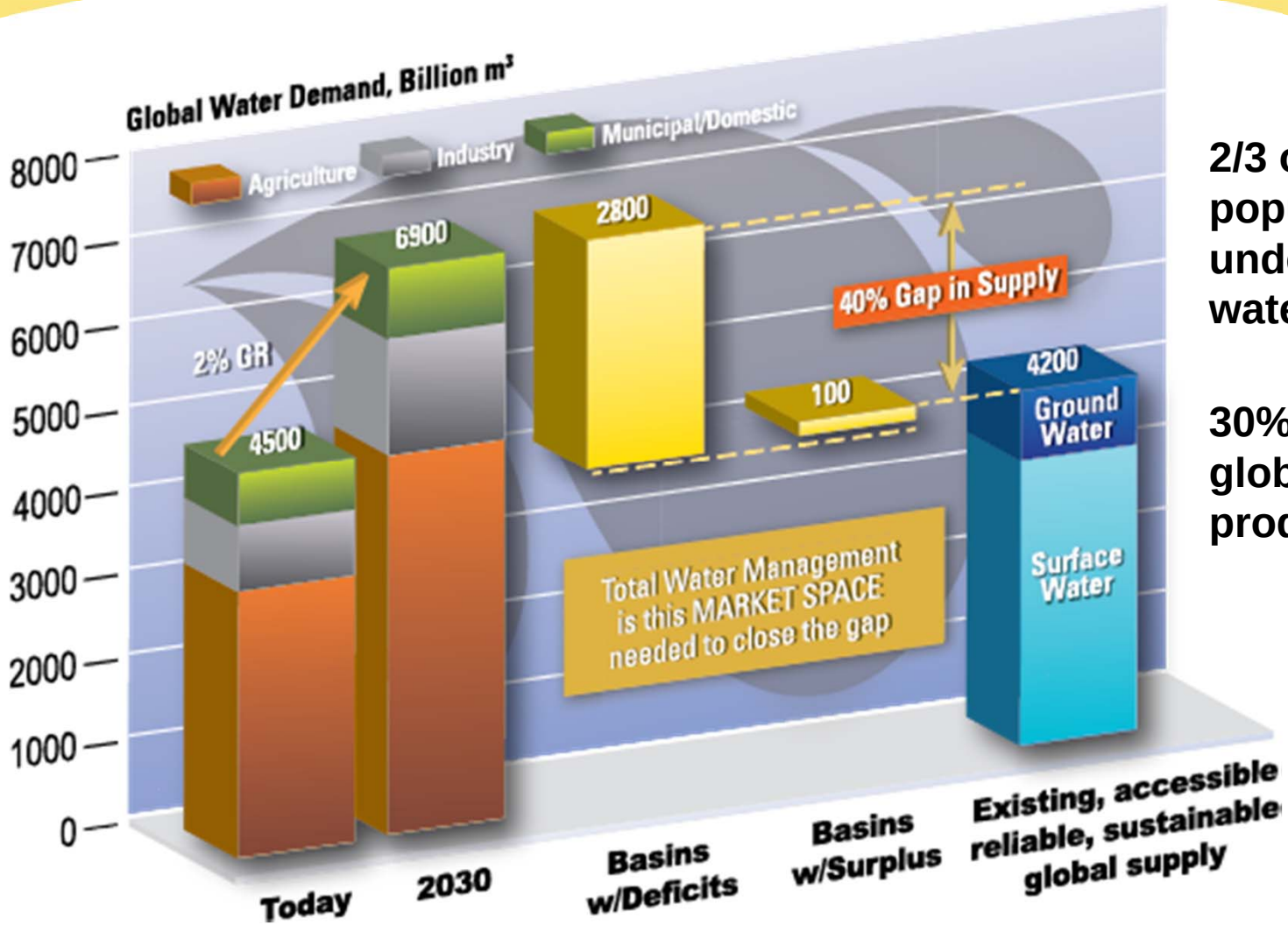
Source: Muller, R., 2012

Water's Footprint in Energy Production



Source: Gleik, 1994; Gerneb-Leenes, et al., 2009; Meconneu and Heokstra, 2011

Water Recovery Should be First Priority

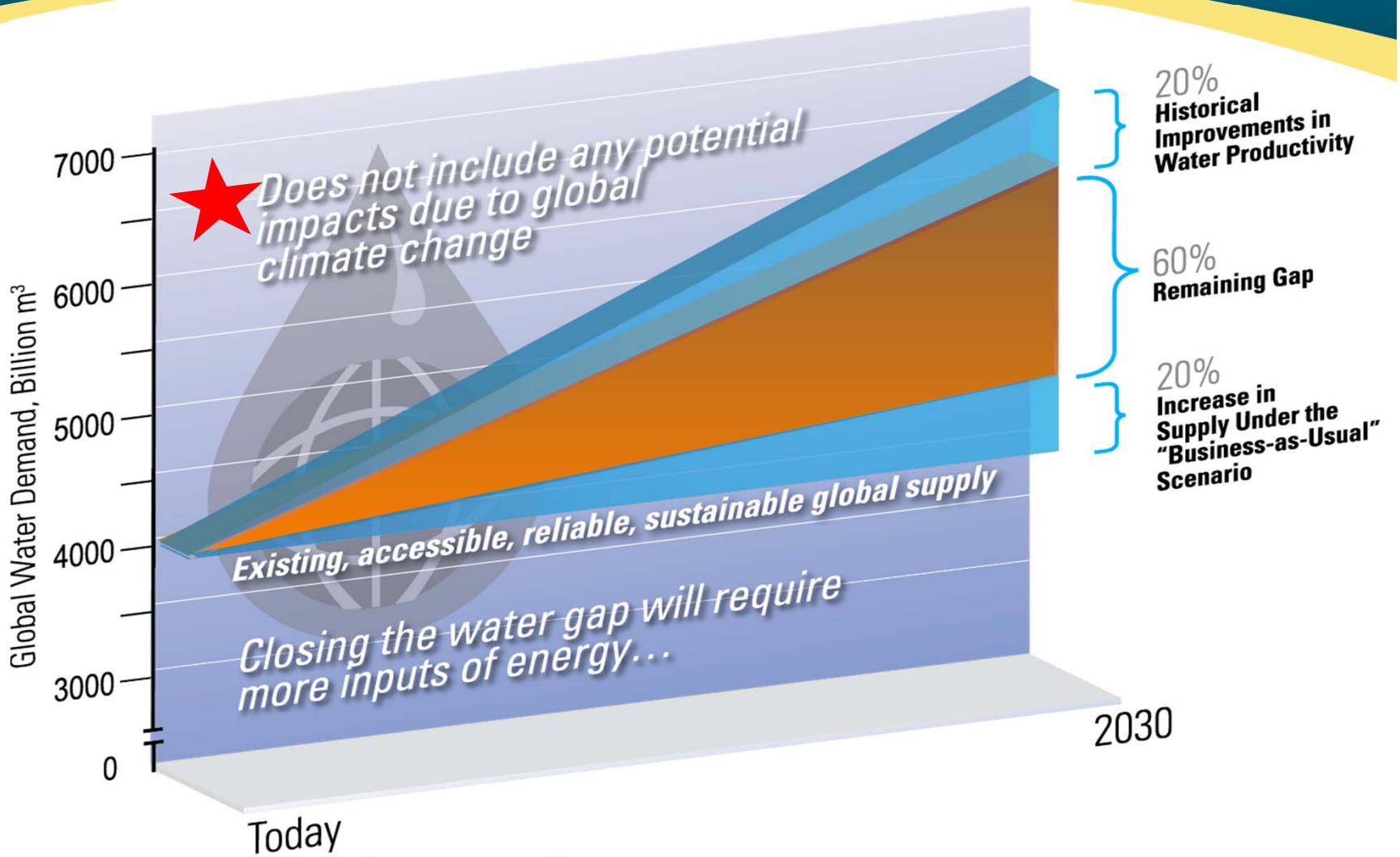


2/3 of global population under high water stress

30% loss in global grain production

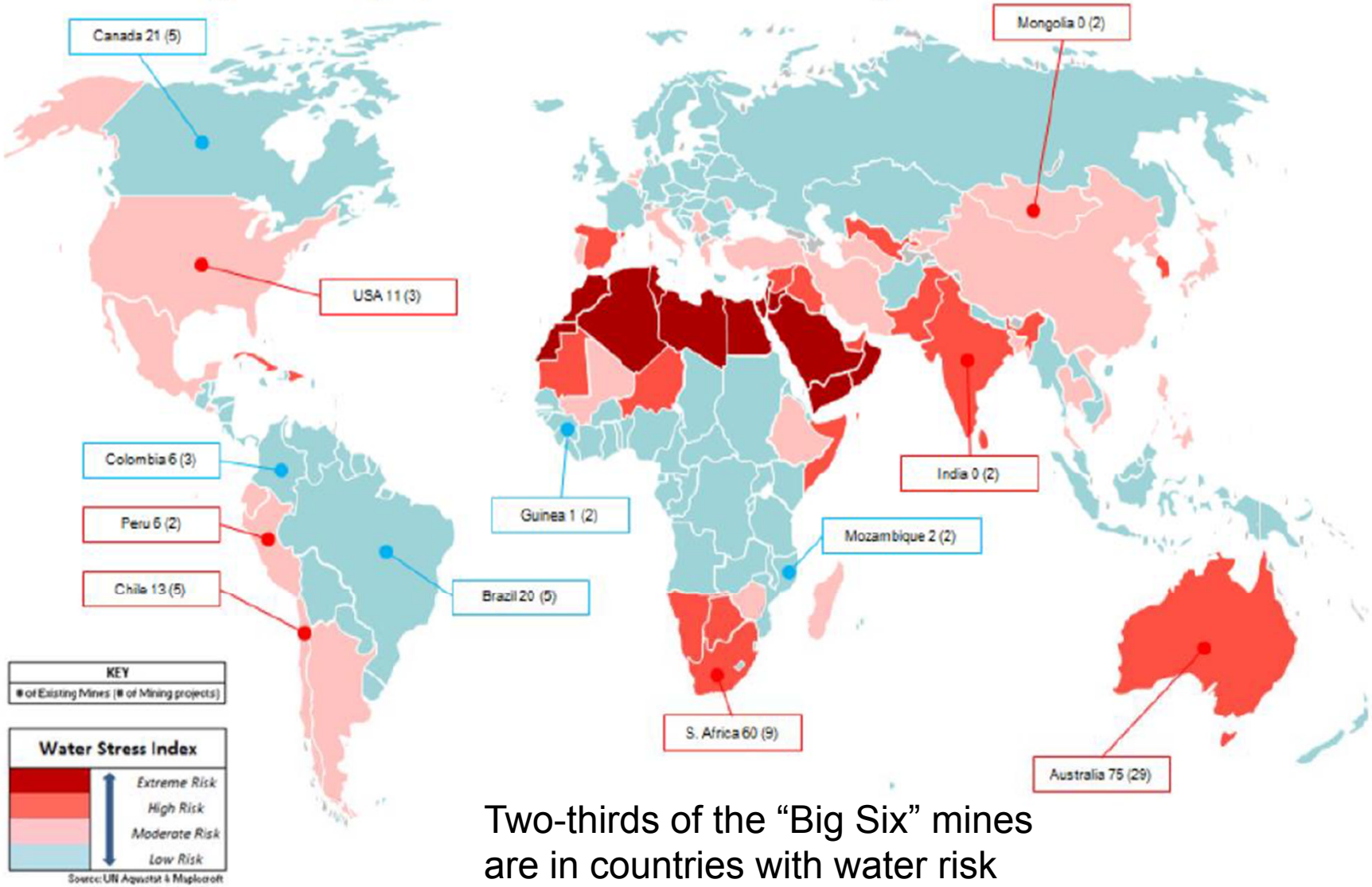
Source: 2030 Water Resources Group; Global Water Supply and Demand Model, 2009

Water: The Environmental Challenge of the 21st Century



Source: 2030 Water Resources Group (2009)

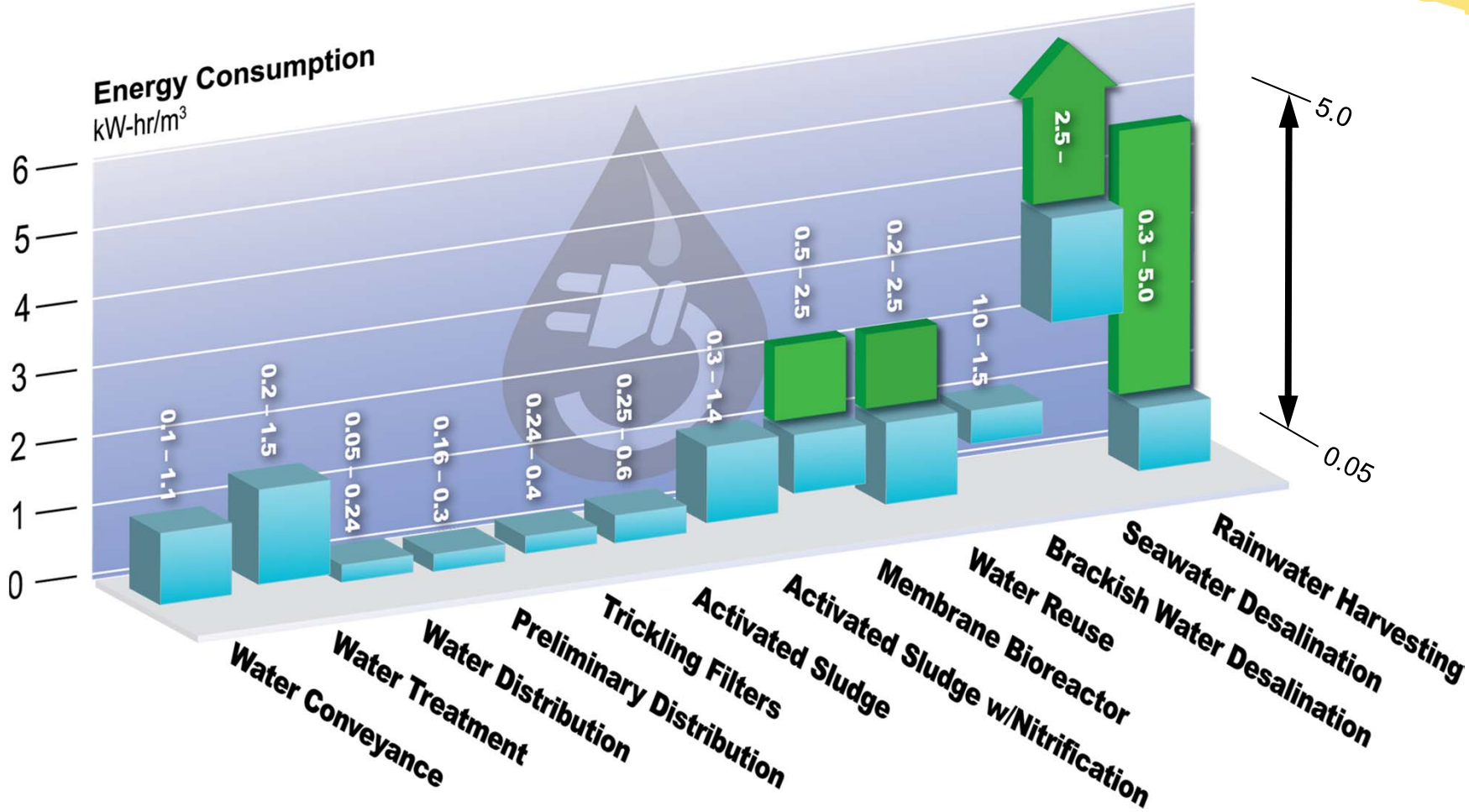
Global Water Scarcity and Mining Industry



Two-thirds of the "Big Six" mines are in countries with water risk

Source: Moody's Investor Service, Global Mining Industry, 2013

Energy's Footprint in the Water Sector

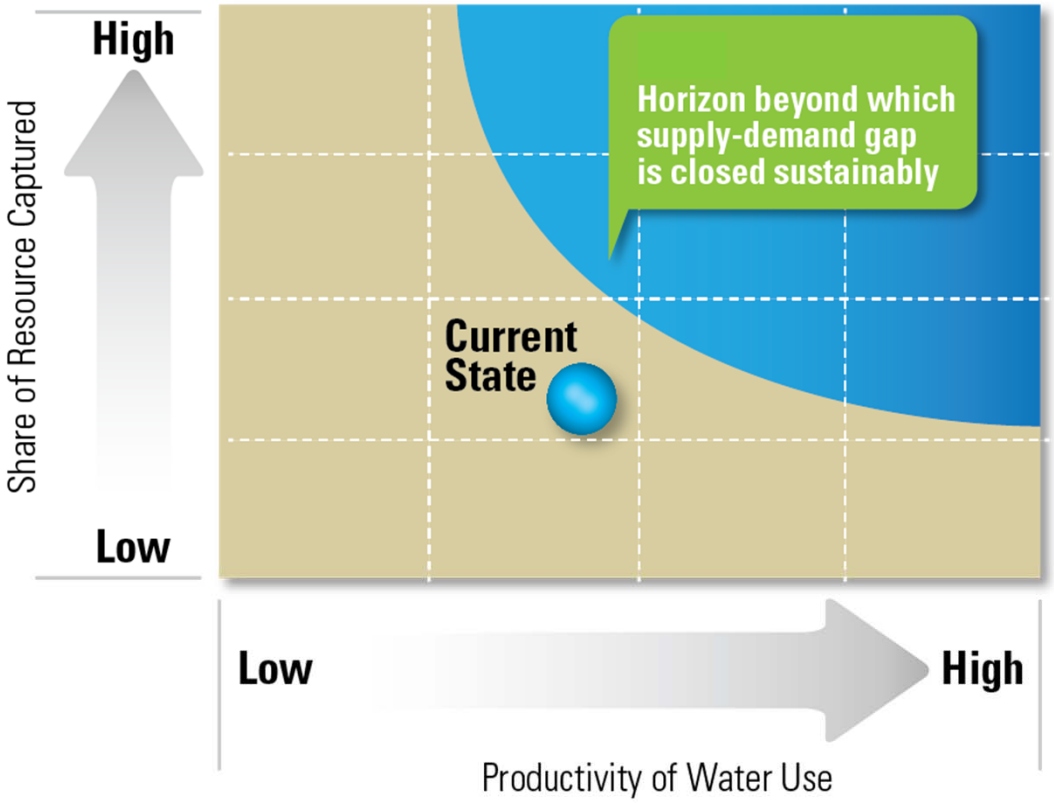


Source: Wilson, 2009; Meda and Cornel, 2010; Voutchkov, 2010; Lazarova et al., 2012

Where are the Solutions?

- Does water reuse play a role?
- How much water do we need?
- How much water do we use here in the US?
- How can everyone obtain what they need?

Three Options for Closing the Supply-Demand Gap



Closing the gap requires a set of solutions that is a mix of each of these

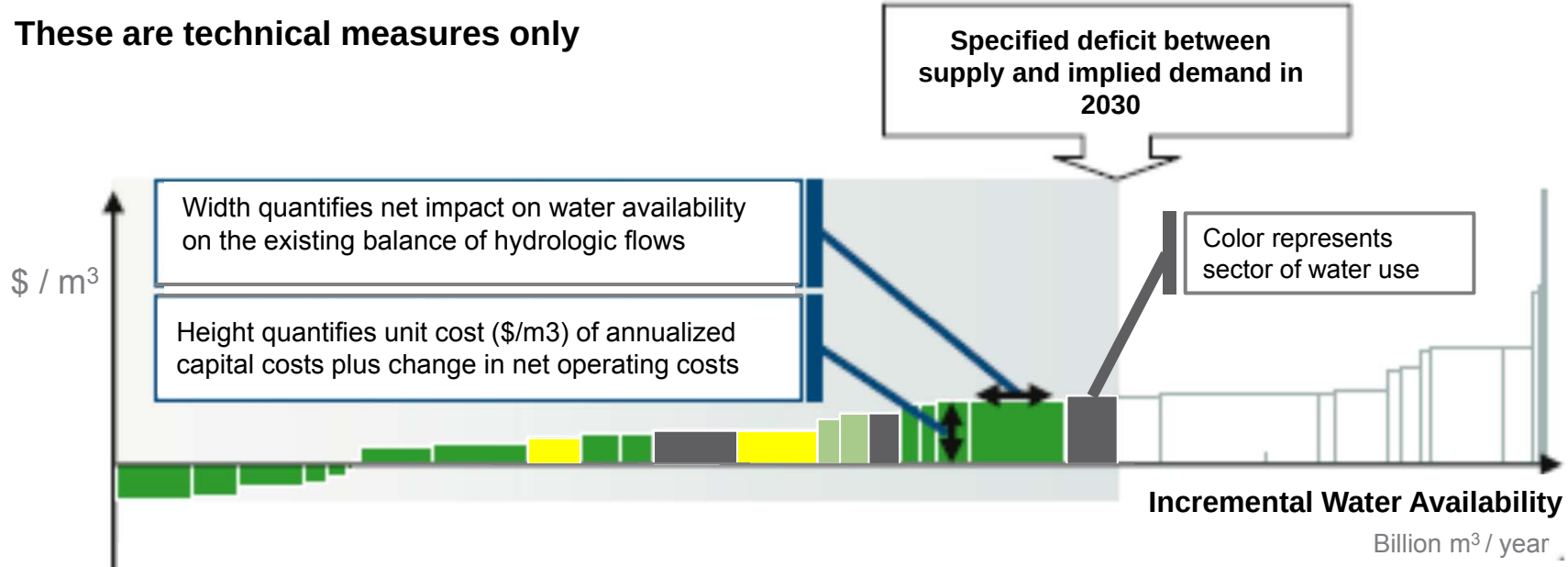
Water Reuse is a "Cornerstone Solution"

Source: 2030 Water Resources Group (2009)

Solutions Exist for the Supply-Demand Deficit: Making Water Available

Net Marginal Cost in 2030

These are technical measures only



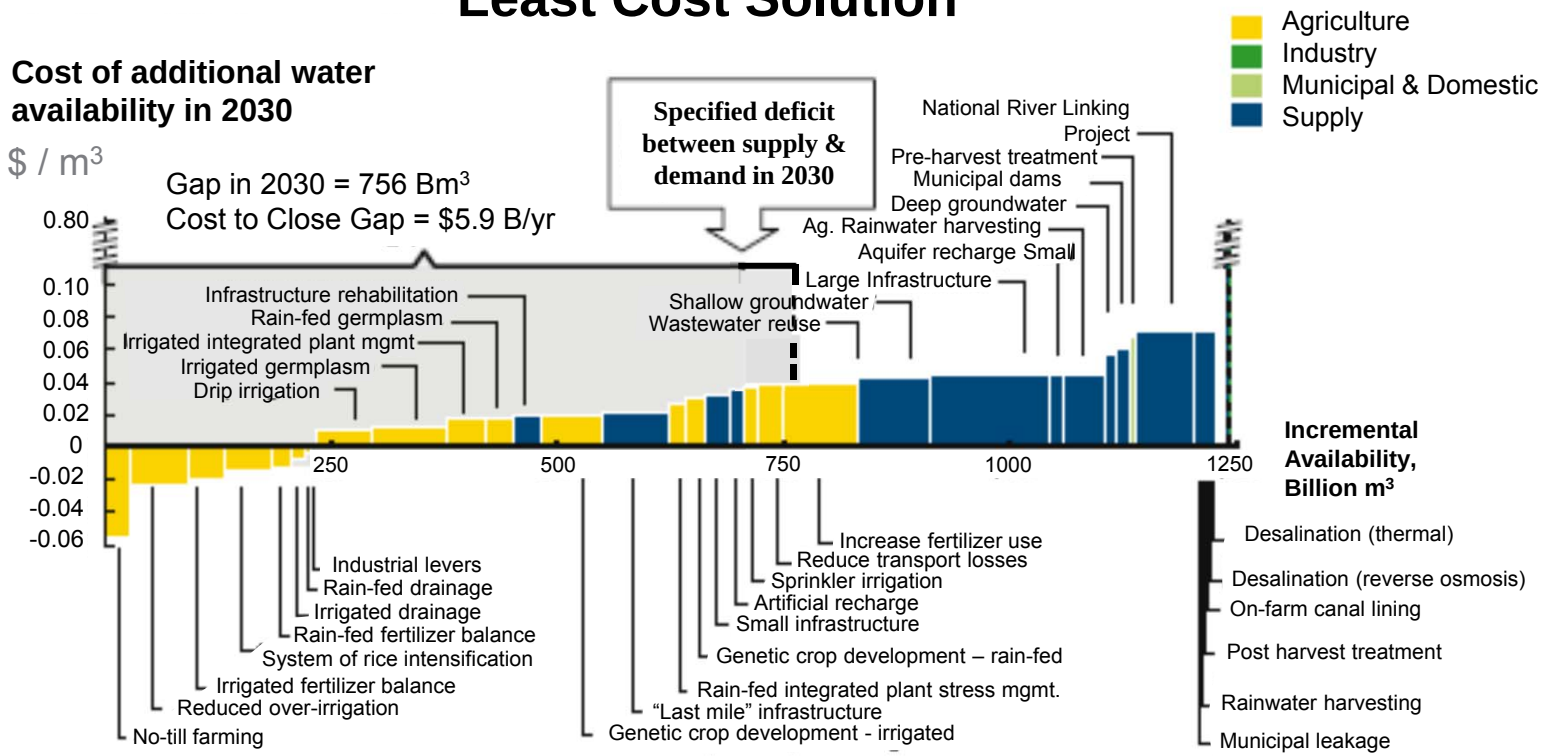
Measures with a negative cost, representing a *net financial gain*

Measures with a positive cost, representing a *net financial cost*

Source: 2030 Water Resources Group (2009)

India – Water Availability Curve

Least Cost Solution



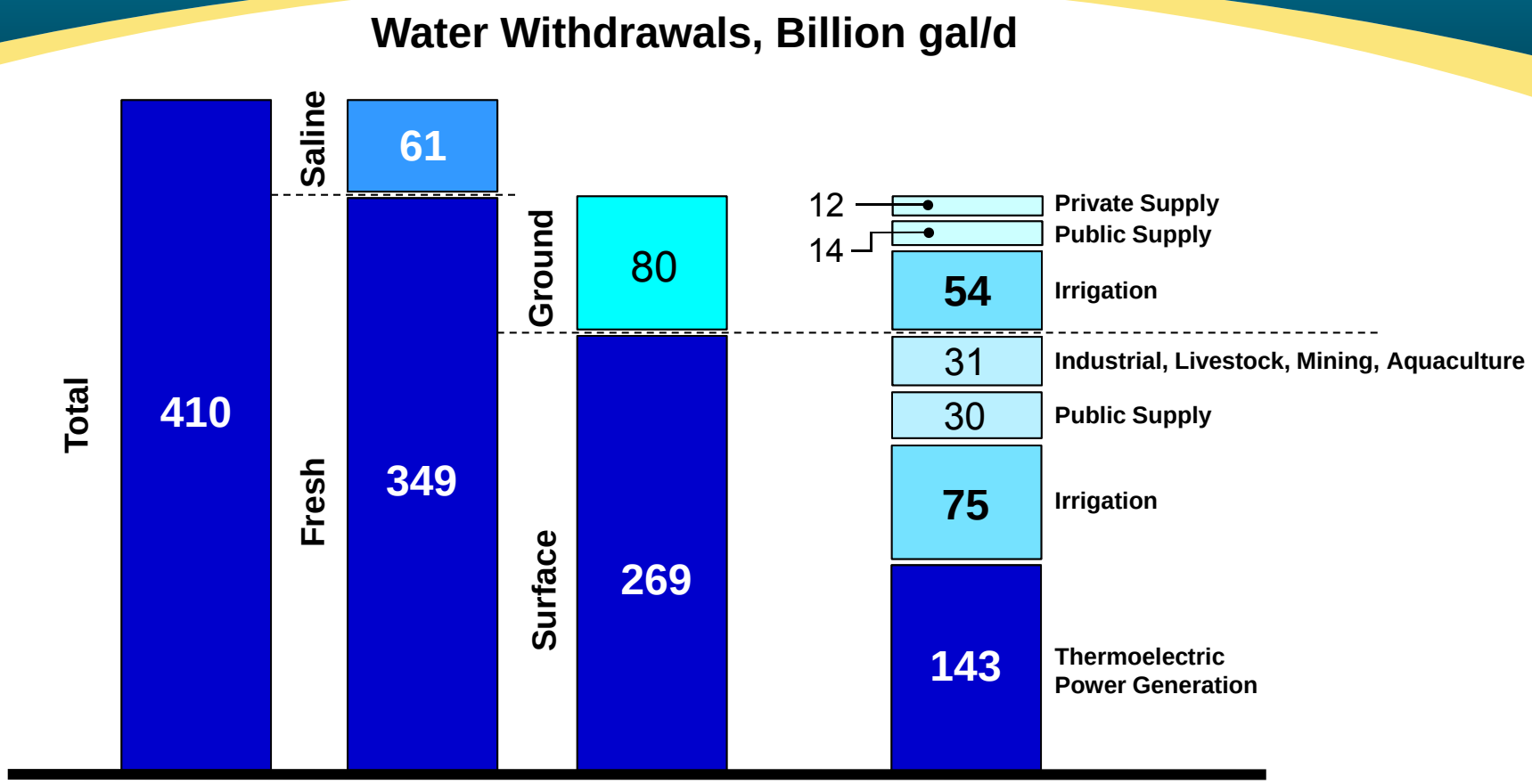
37 measures

18 in agriculture

12 depend on Water Reuse

Source: 2030 Water Resources Group (2009)

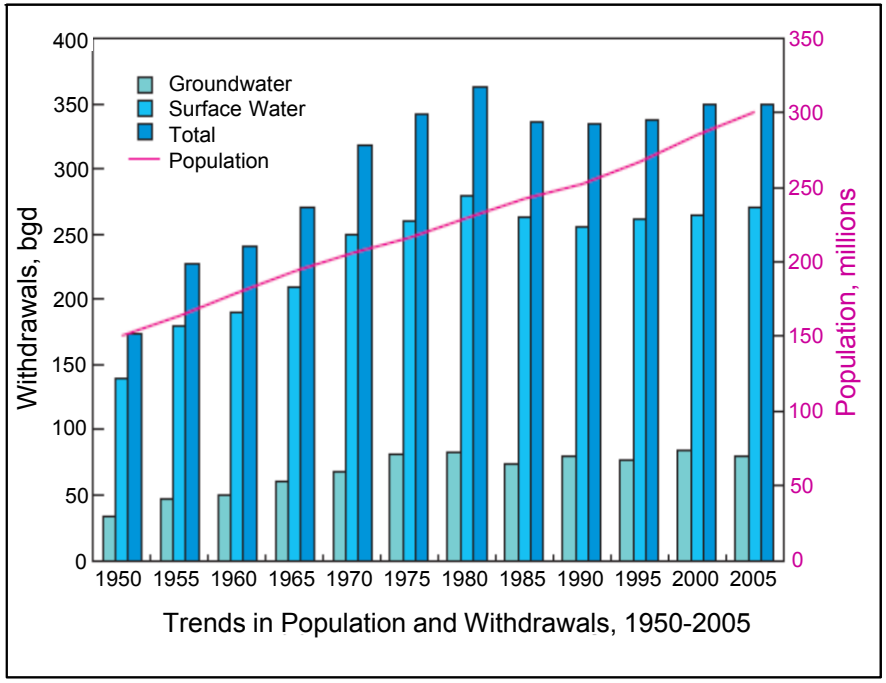
Annual US Water Consumption

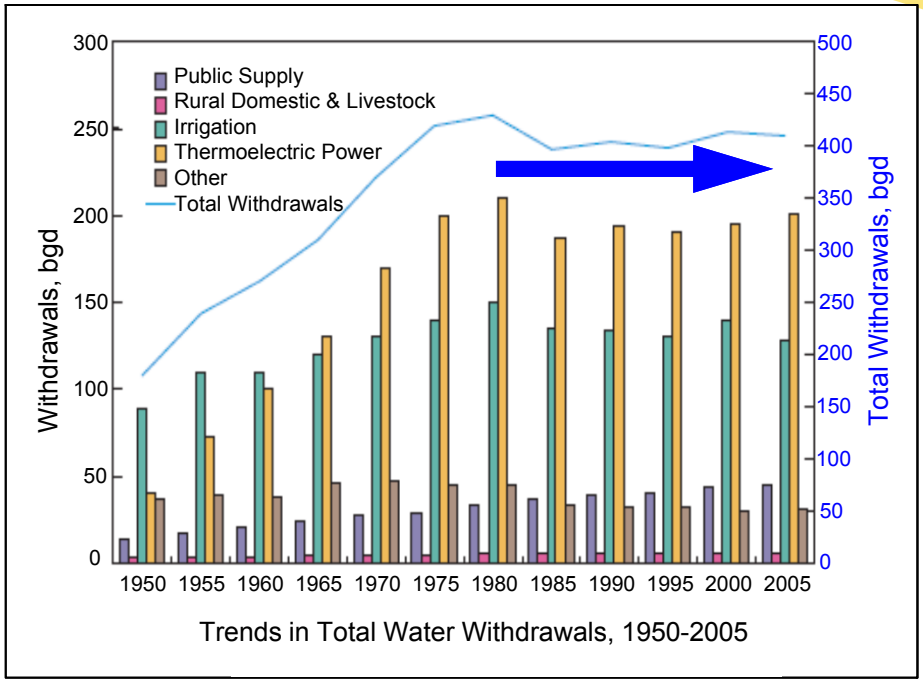


Estimated reliable water storage in US is 475 trillion gallons

Source: *Estimated Use of Water is the US in 2005*
Circular 1344USGS (2009);
2030 Water Resources Group (2009)

Annual Water Consumption Trends in US





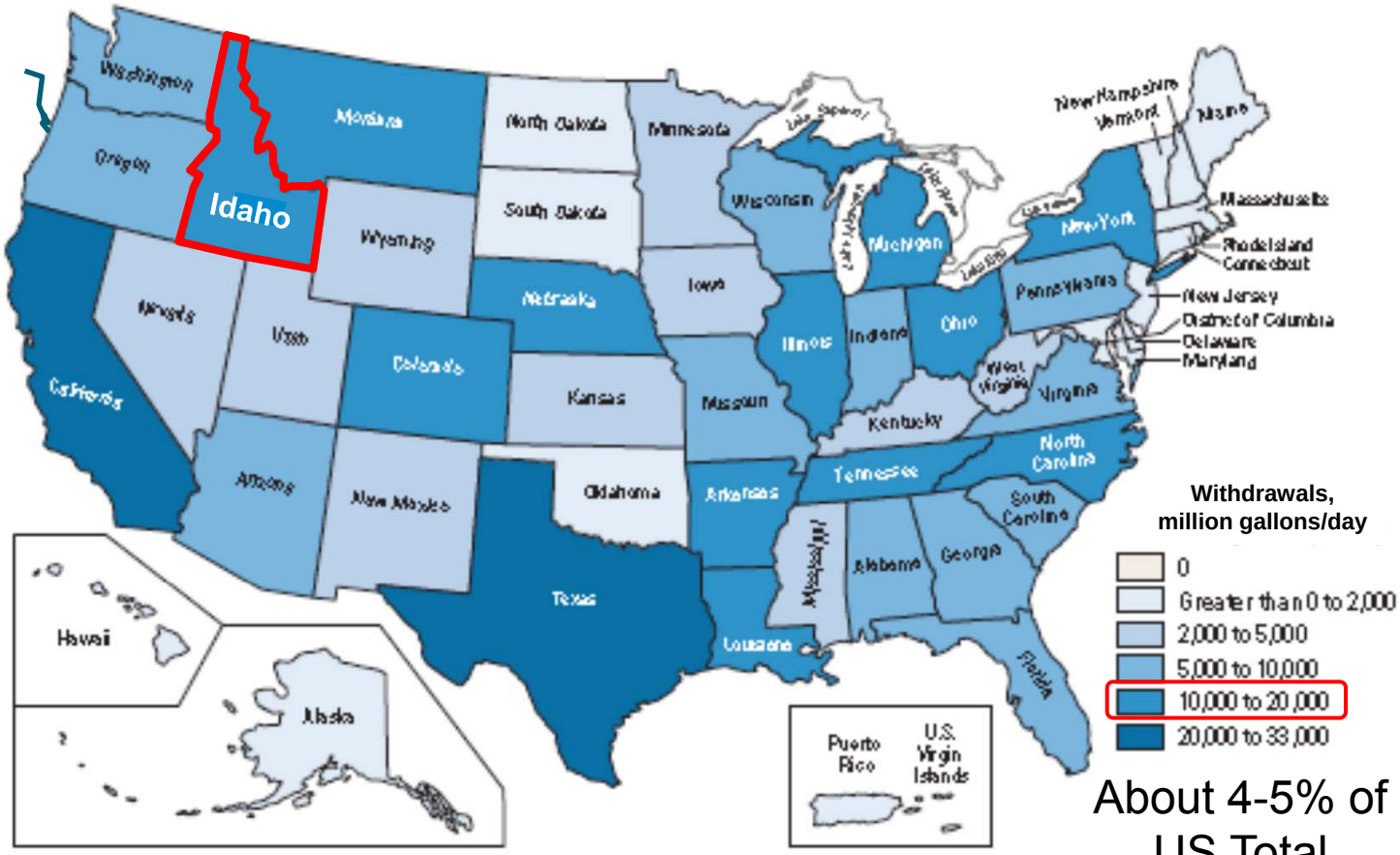
Americans are:

1) Using less water
2) Being more productive with the water being used
3) Power generation and irrigation dominant all uses

Source: *Estimated Use of Water is the US in 2005*
Circular 1344USGS (2009)

Annual Water Withdrawals in US

Freshwater Withdrawals

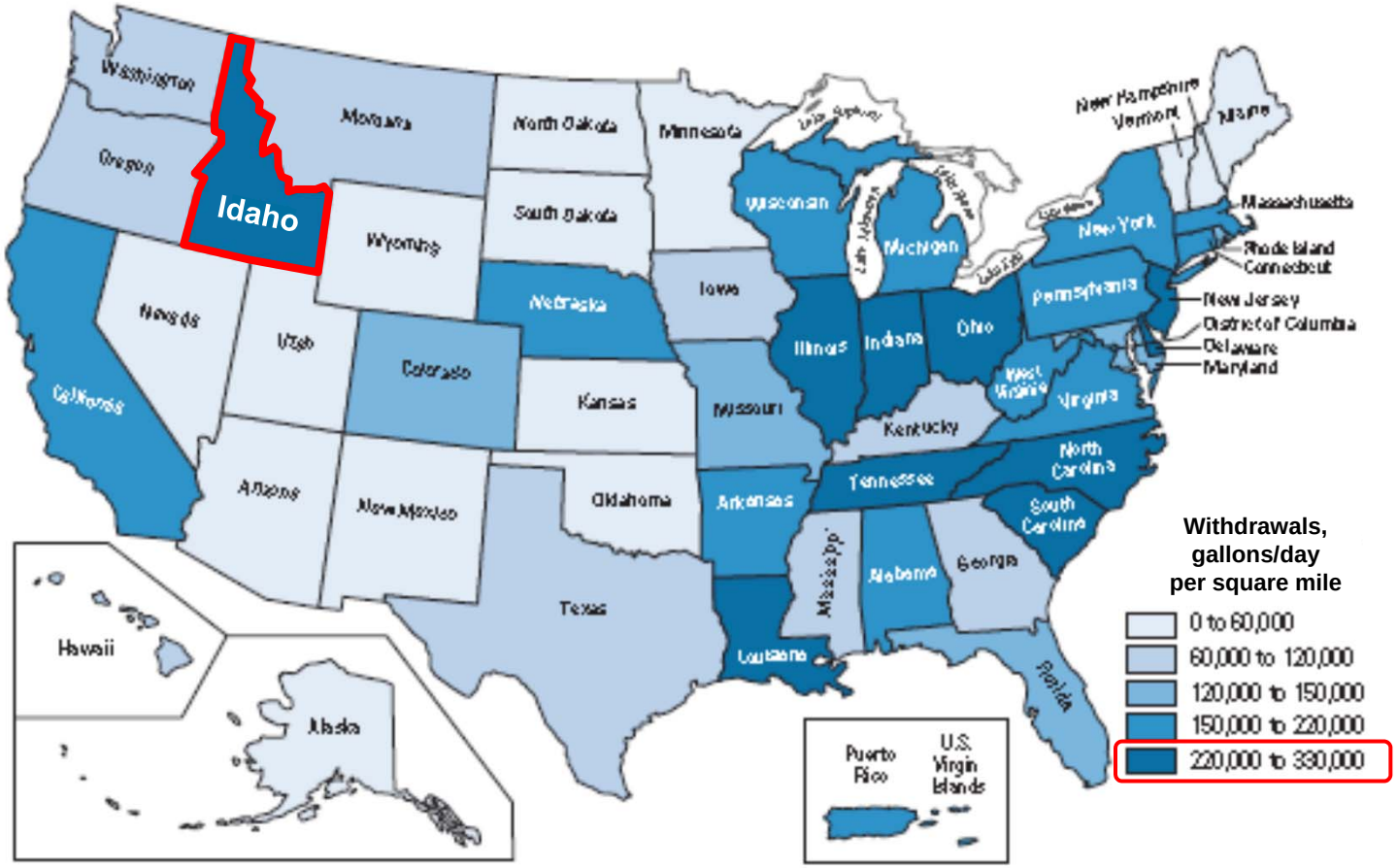


About 4-5% of US Total

Source: *Estimated Use of Water is the US in 2005*
Circular 1344USGS (2009)

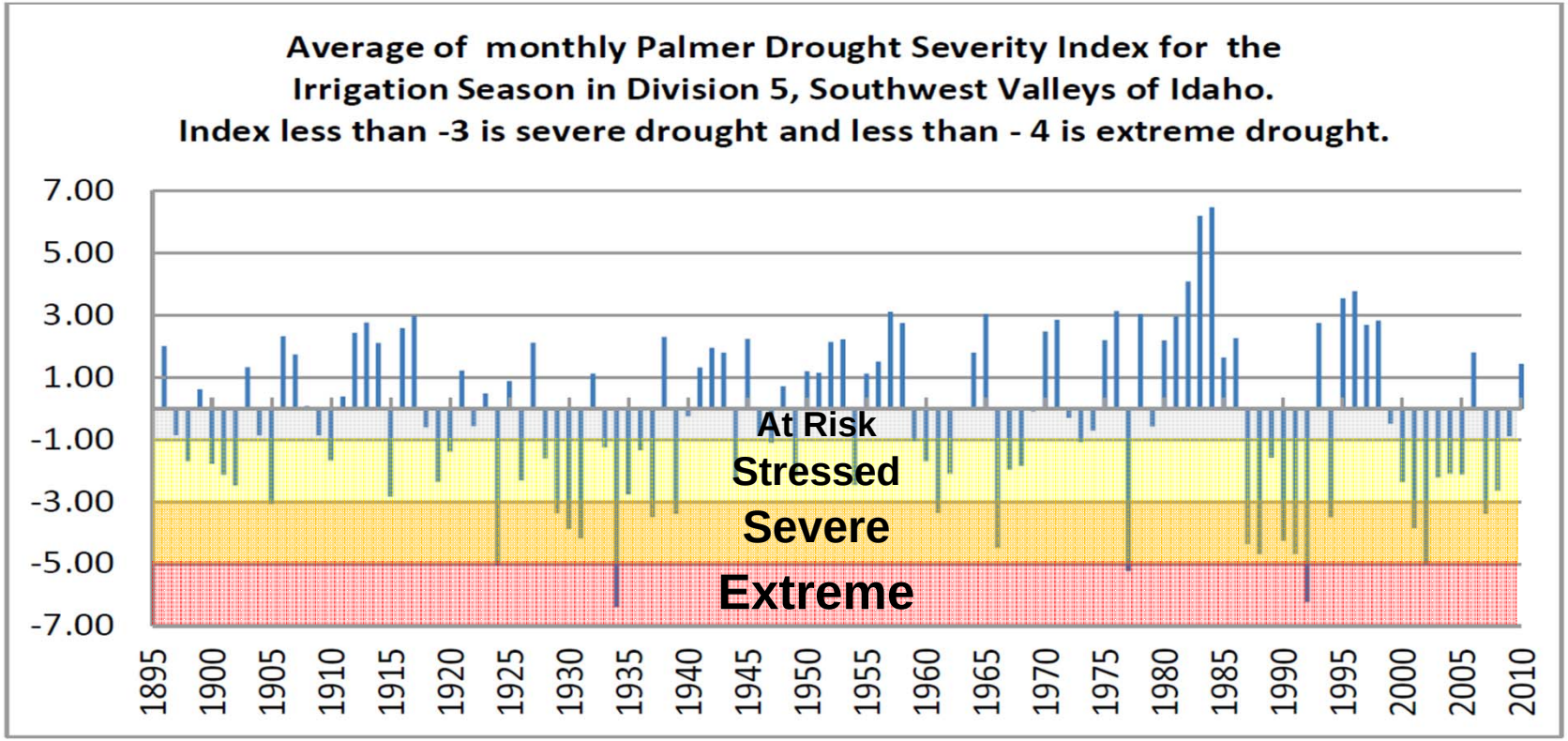
Intensity of Water Withdrawals in US

Freshwater Withdrawals



Source: *Estimated Use of Water is the US in 2005*
Circular 1344USGS (2009)

Drought is NOT Uncommon in Idaho



56% in negative balance condition

Source: TVCAMP, 2012; NOAA; NCDC 2012

How much water do we need for sustainable living?

Sufficient: > 450,000 gpy
Stress: 265,000 – 450,000
Scarcity: 132,000 – 265,000
Extreme Scarcity < 132,000

USA ≈ 437,000 gpy (1,200 gpd)

Limit ≈ 396,000 gpy (1080 gpd)

Diet: Vegetarian
Theoretical = 66,000 gal/yr
Actual ≈ 198,100 gal/yr

Diet: 20% Meat
Theoretical = 180,000 gal/yr
Actual ≈ 356,600 gal/yr

Falkemark & Widstrand, 1992; Zehnder, 2008

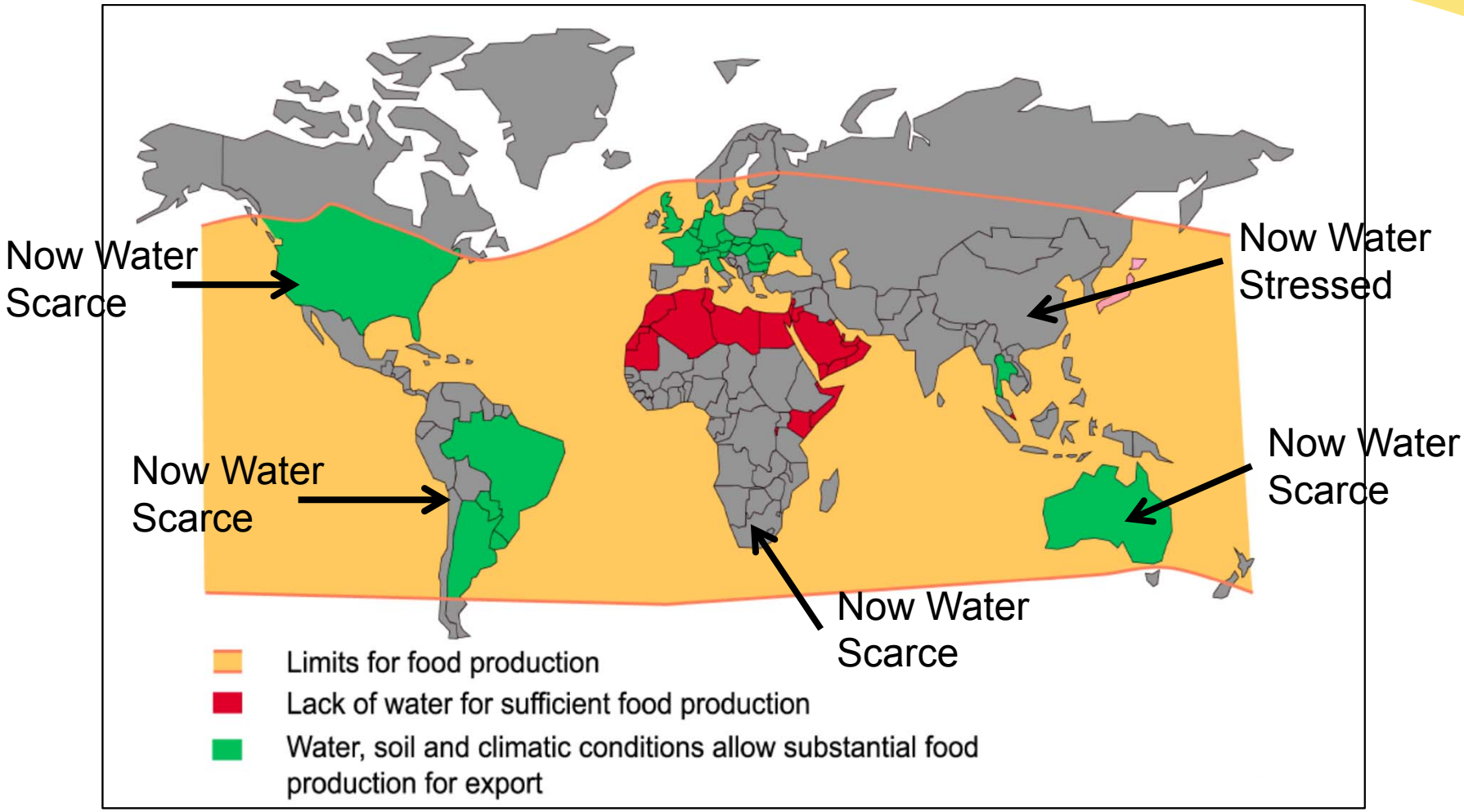
Part of the Solution: "Virtual Water"

- Virtual Water (or hidden water) refers, in the context of trade, to the water used in the production of a good or service.

"Virtual water has major impacts on global trade policy… especially in water-scarce regions… Nations such as the US, Argentina and Brazil 'export' billions of litres of water each year, while others like Japan, Egypt and Italy 'import' billions, the virtual water concept has opened the door to more productive water use."

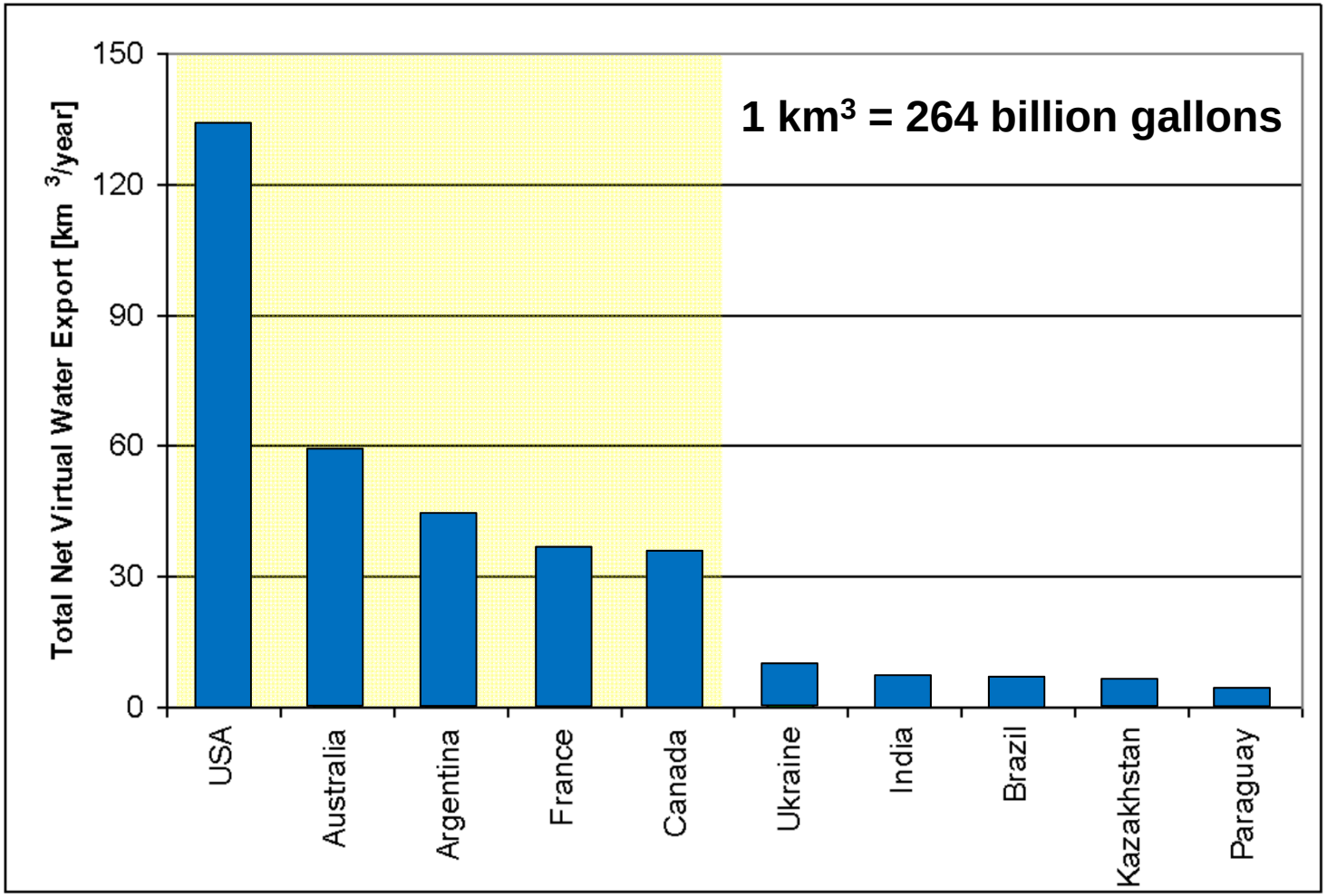
– John Anthony Allen - 2008

Global Food Production Regions



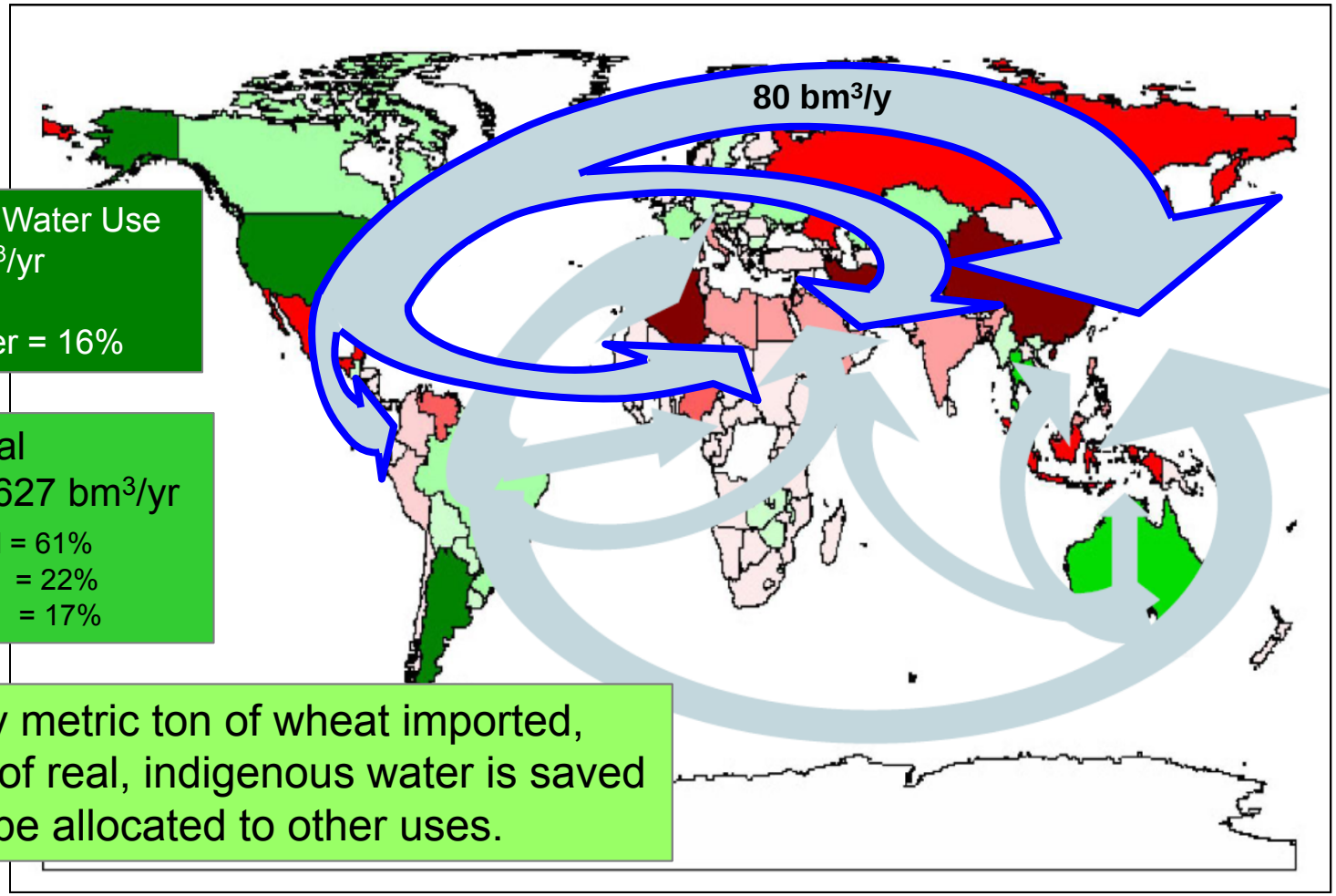
Zehnder, 2002

The Food Exporters are the Virtual Water Exporters



Liu, *et al.*, 2010

Virtual Water Flows by Regions (average over 1997 – 2001)



Total World Water Use = 7,451 bm^3/yr

Virtual Water = 16%

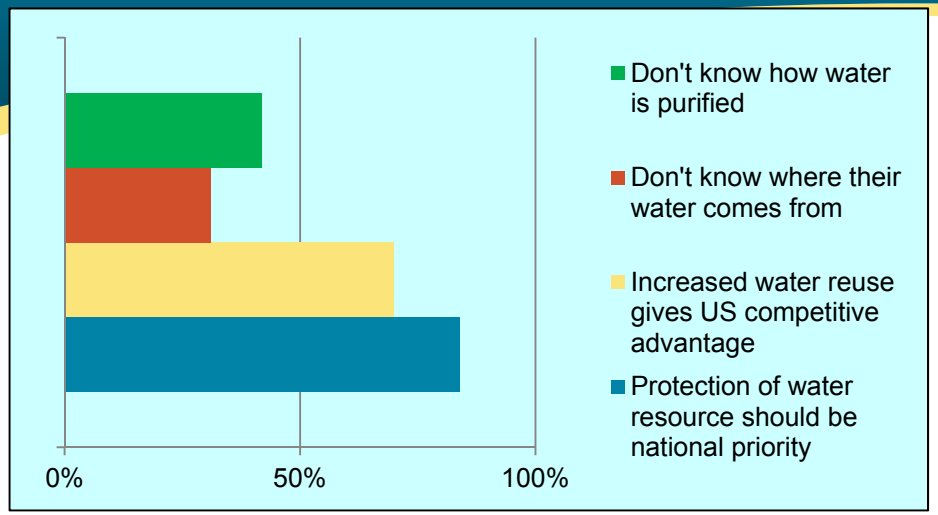
Total Virtual Water =1,627 bm^3/yr

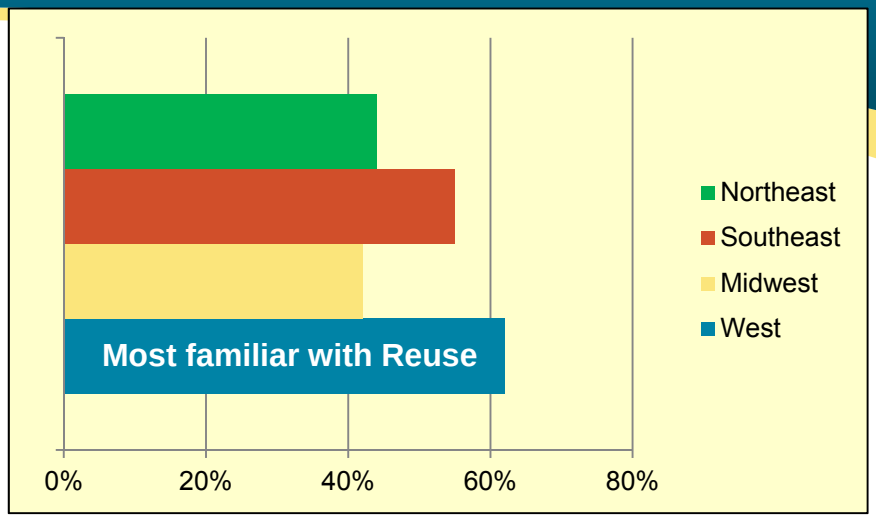
Agricultural = 61%
Industrial = 22%
Livestock = 17%

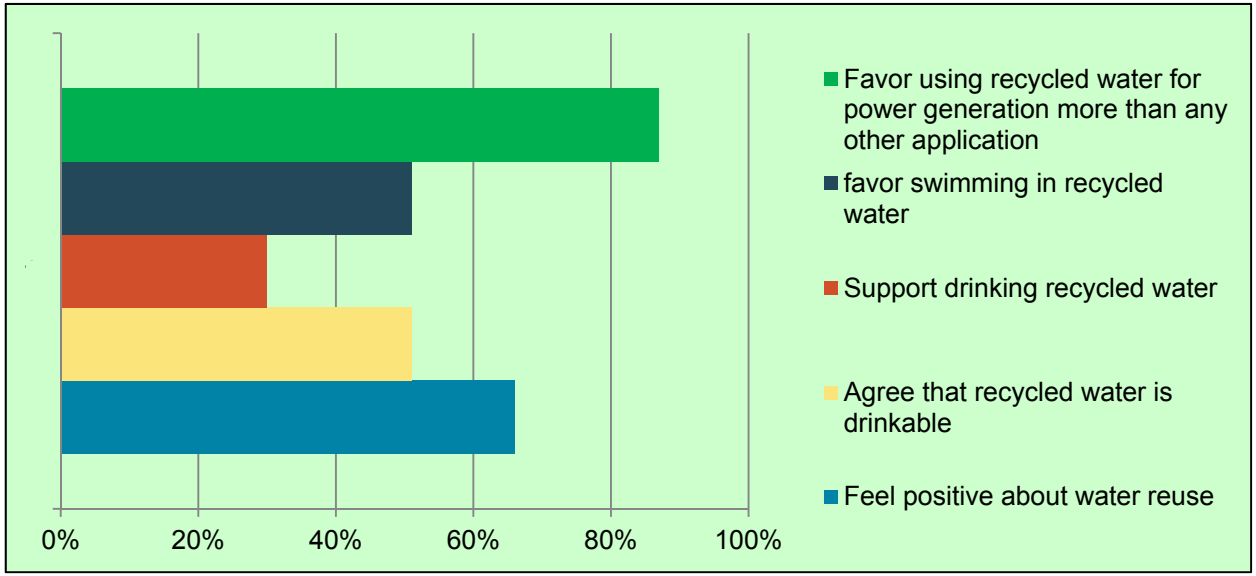
For every metric ton of wheat imported, 1300 m^3 of real, indigenous water is saved and can be allocated to other uses.

Yang, *et al.*, 2006; Chapagain & Hoekstra, A, 2008

Americans and Our Opinions on Water







Source: Exton, R., GE Power; 2013; MOE 3.1% at 95th confidence interval

Summary

- Multiple nexus; energy and water at the core – each linked to climate change
- Move to avoid consequences we cannot manage; learn to manage those effects we cannot avoid
- Focus must be on reducing demand
- Are energy policies that promote low carbon and low water footprints really possible?
- For Energy – it's about conservation
- For Water – it's about reuse and virtual water
- Reuse is about perception: where do you stand?

Thank you!!

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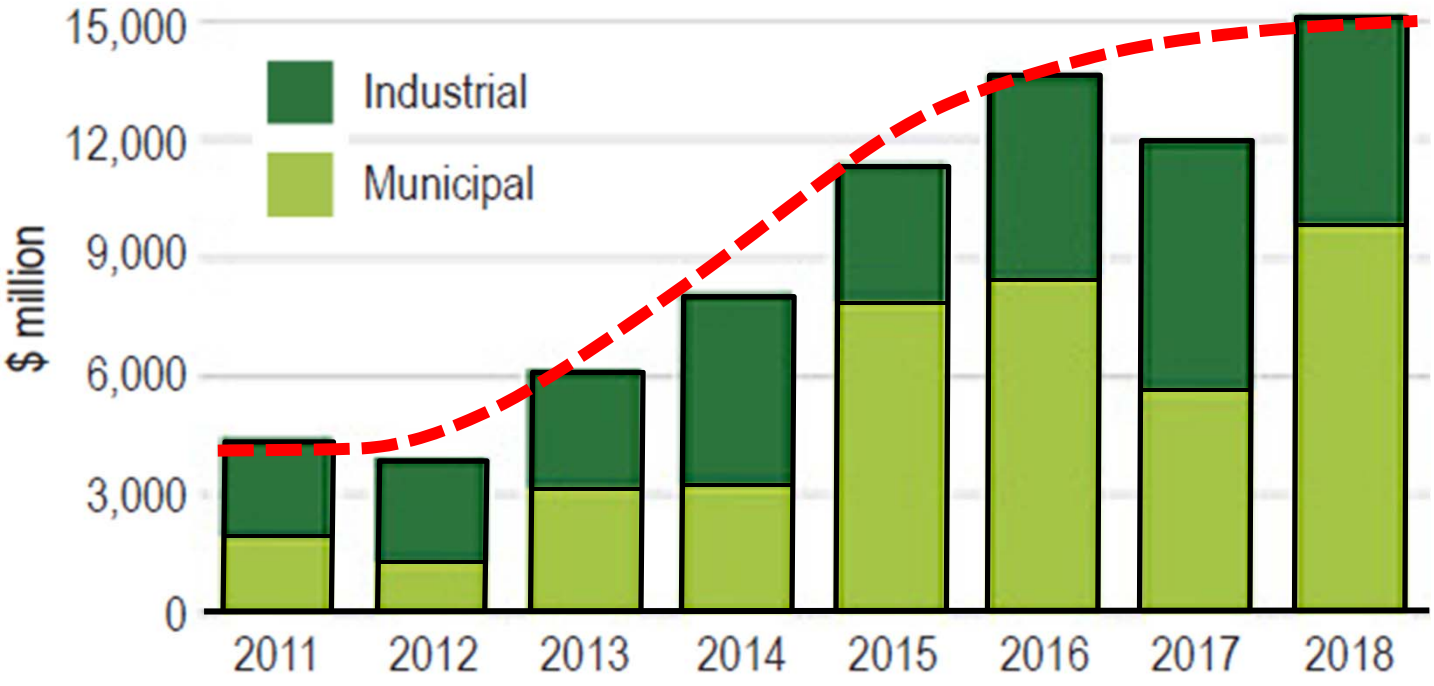
Growth of Desalination Market Slowing



Global Seawater and Brackish Desal Market