



Energy & Water

Roland L. Moreau – ExxonMobil Upstream Research Company

NSF Energy-Water Nexus Workshop

June 10-11, 2013 – Alexandria, VA

ExxonMobil

Taking on the world's toughest energy challenges.™

Agenda



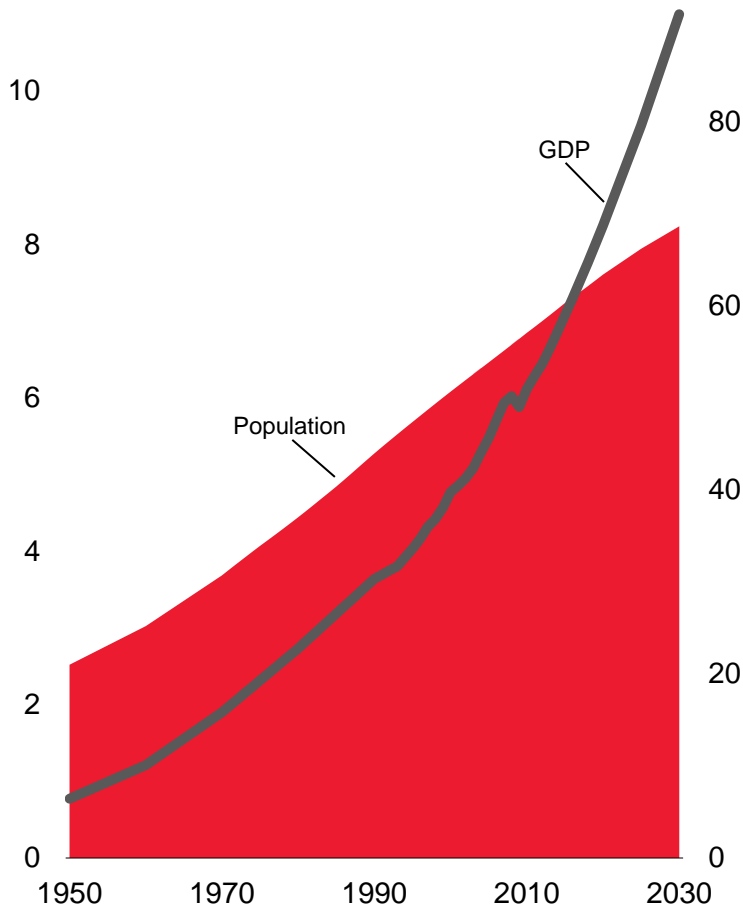
- **Overview of global water cycle & demand**
- **Water Use in Oil & Gas Industry**
- **Unconventional Energy Challenges**
- **Key Points**



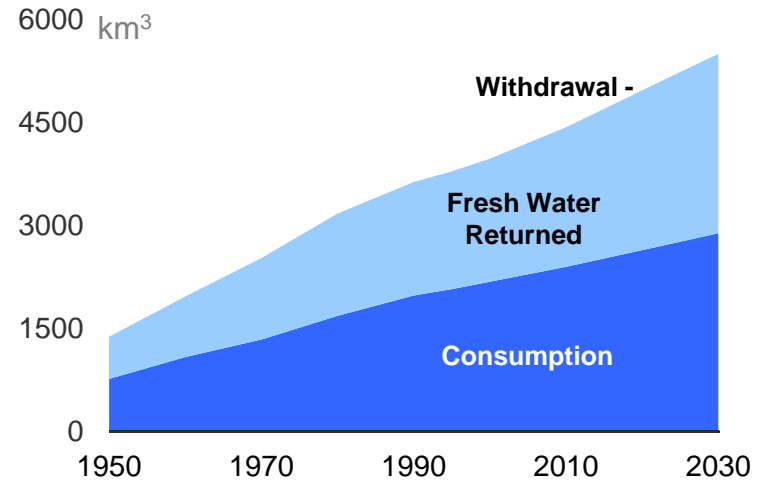
Population & Economic Growth Drive Demand for Water & Energy



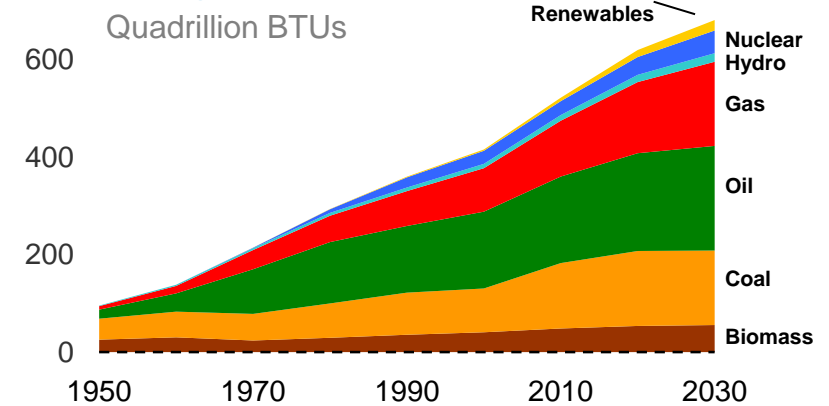
Population
Billion People



Freshwater Use



Energy Demand



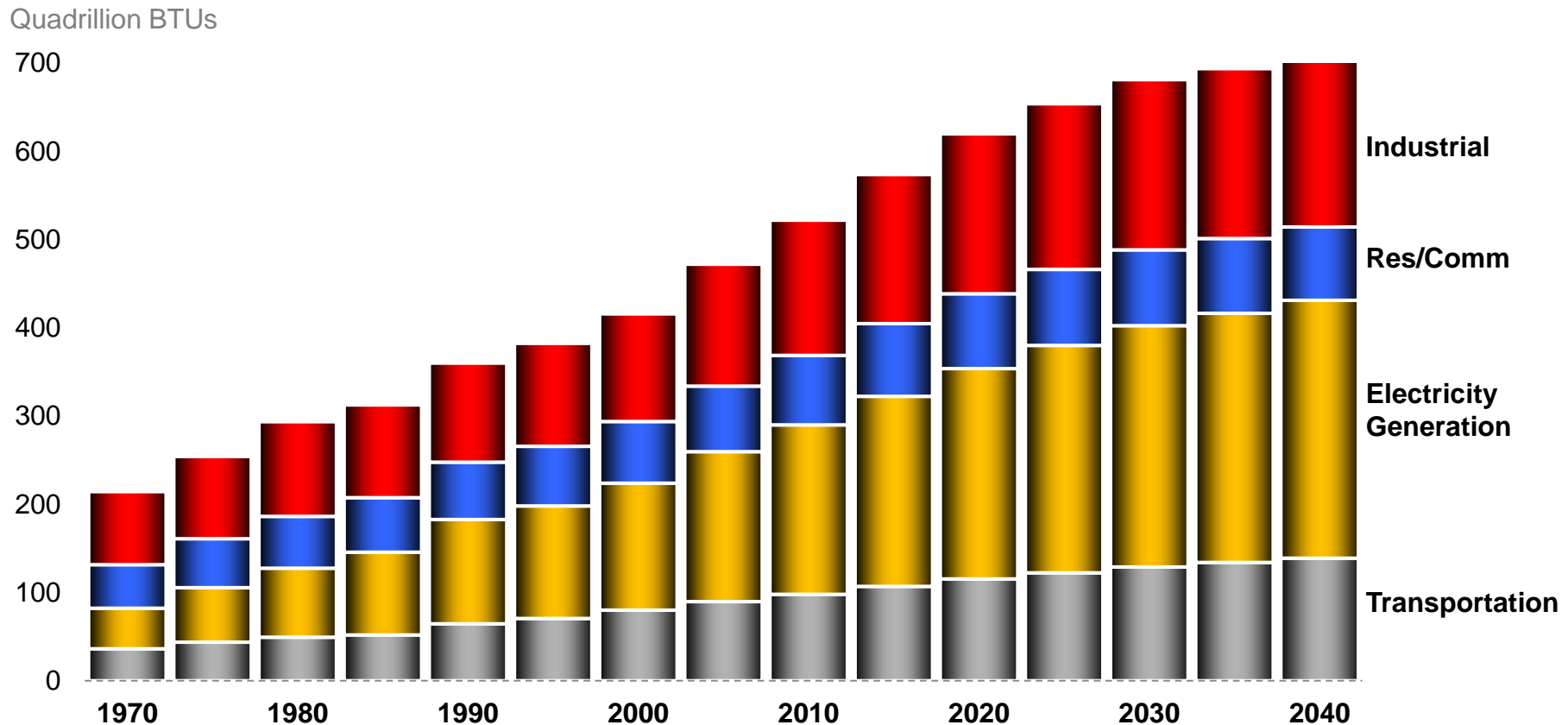
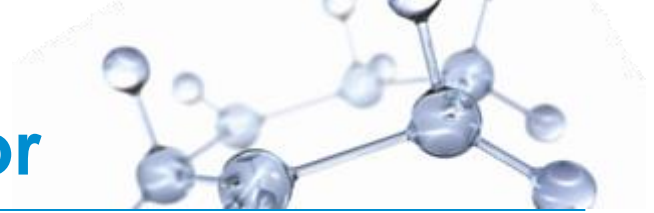
Population, GDP and Energy Demand from ExxonMobil 2013 Outlook for Energy,

Freshwater Use from UNESCO & State Hydrological Institute, St. Petersburg (Shiklomanov)

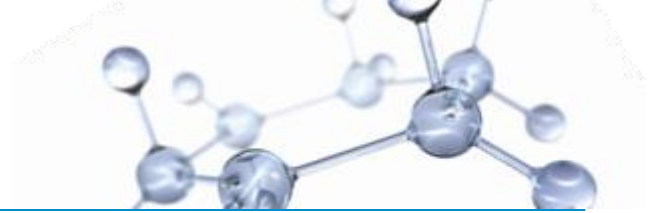


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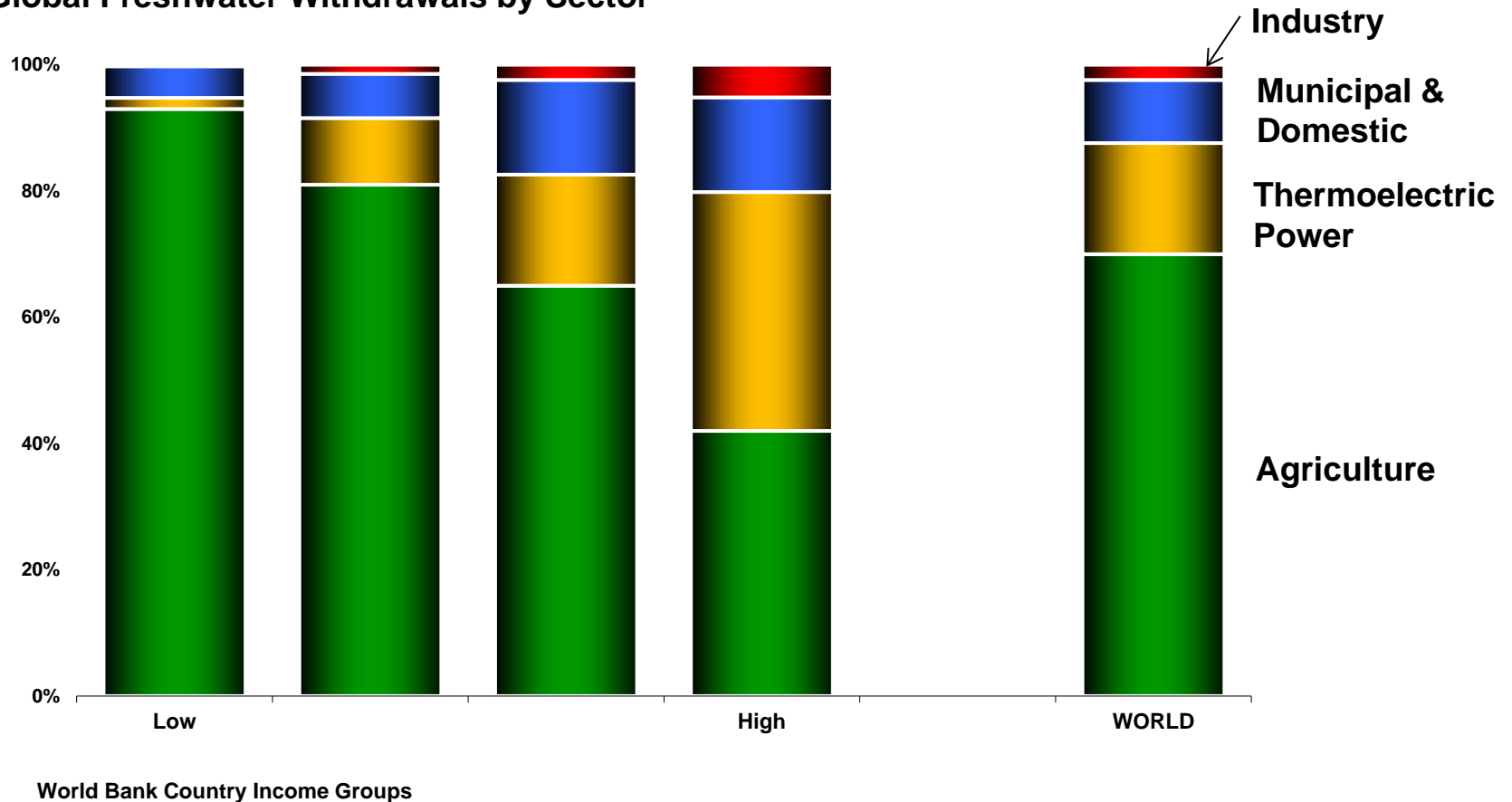
Global Energy Demand by Sector



Freshwater Use by Sector

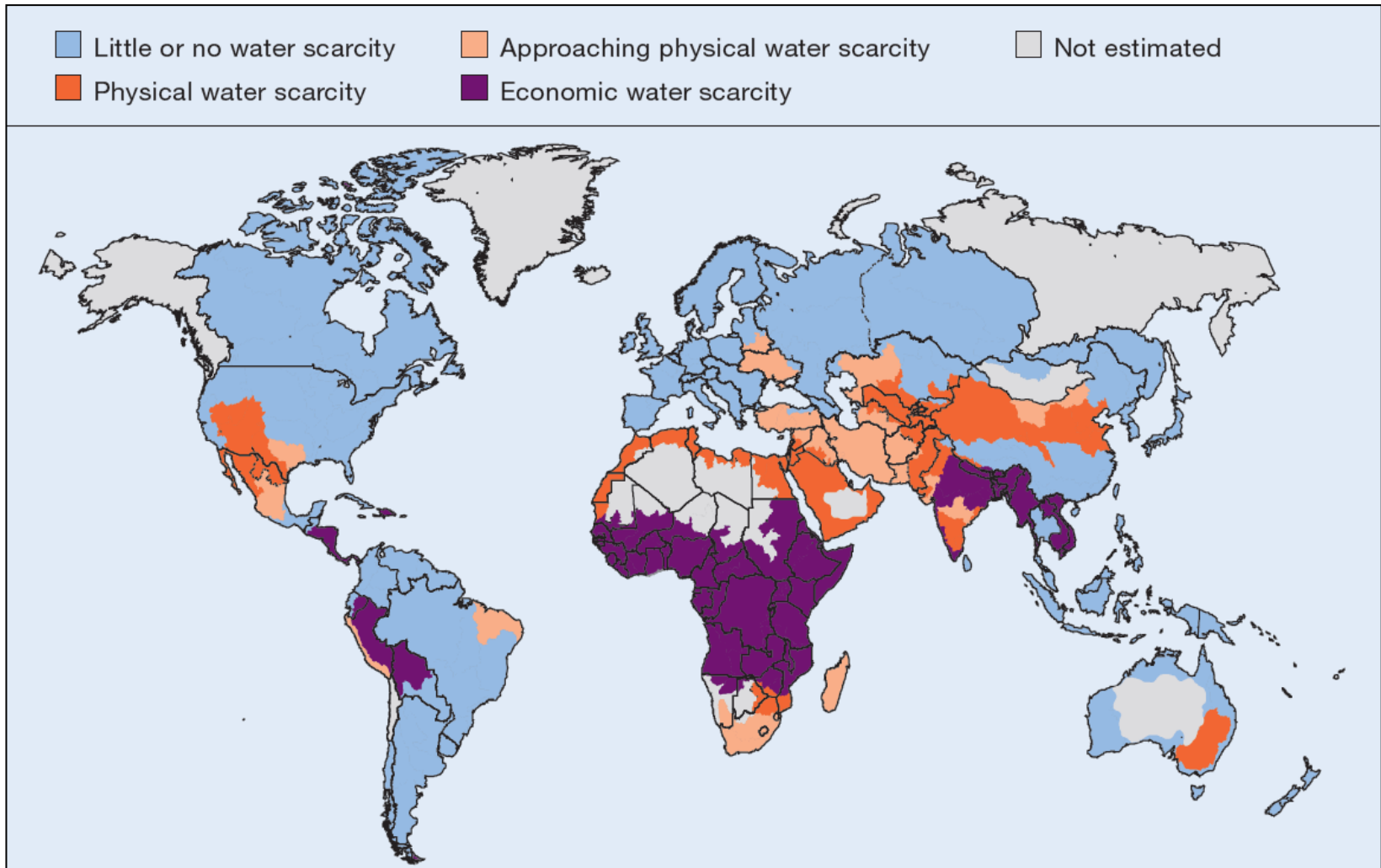


Global Freshwater Withdrawals by Sector



Source (left): *after* World Bank 2011 World Development Indicators
 Source (right): Brown, T. C. (2000), Projecting U.S. freshwater withdrawals, *Water Resour. Res.*, 36(3), 769–780, doi:10.1029/1999WR900284.

Physical & Economic Water Scarcity



Source: International Water Management Institute (2007)

Water Use in the Oil & Gas Industry



Water Use



Upstream

- Exploration and production
- Modest water use during hydrocarbon extraction, but can be material local user

Downstream & Petrochemicals

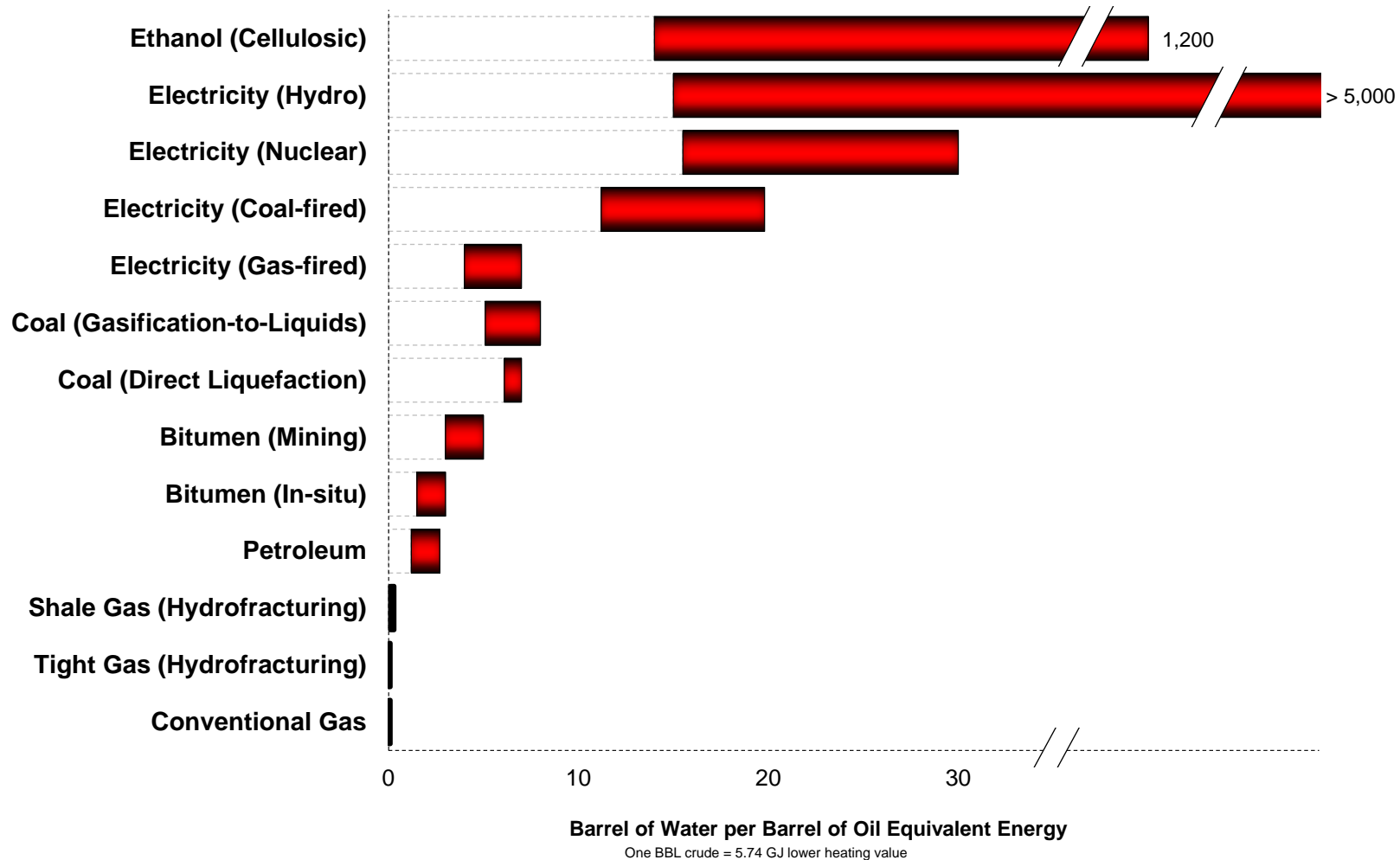
- Conversion of oil & gas to fuels and chemical base stocks
- Refining is the largest energy-related water consumer after electricity

End Use

- Electricity generation is the most significant energy-related water consumer
- Overall modest water consumption by other end users

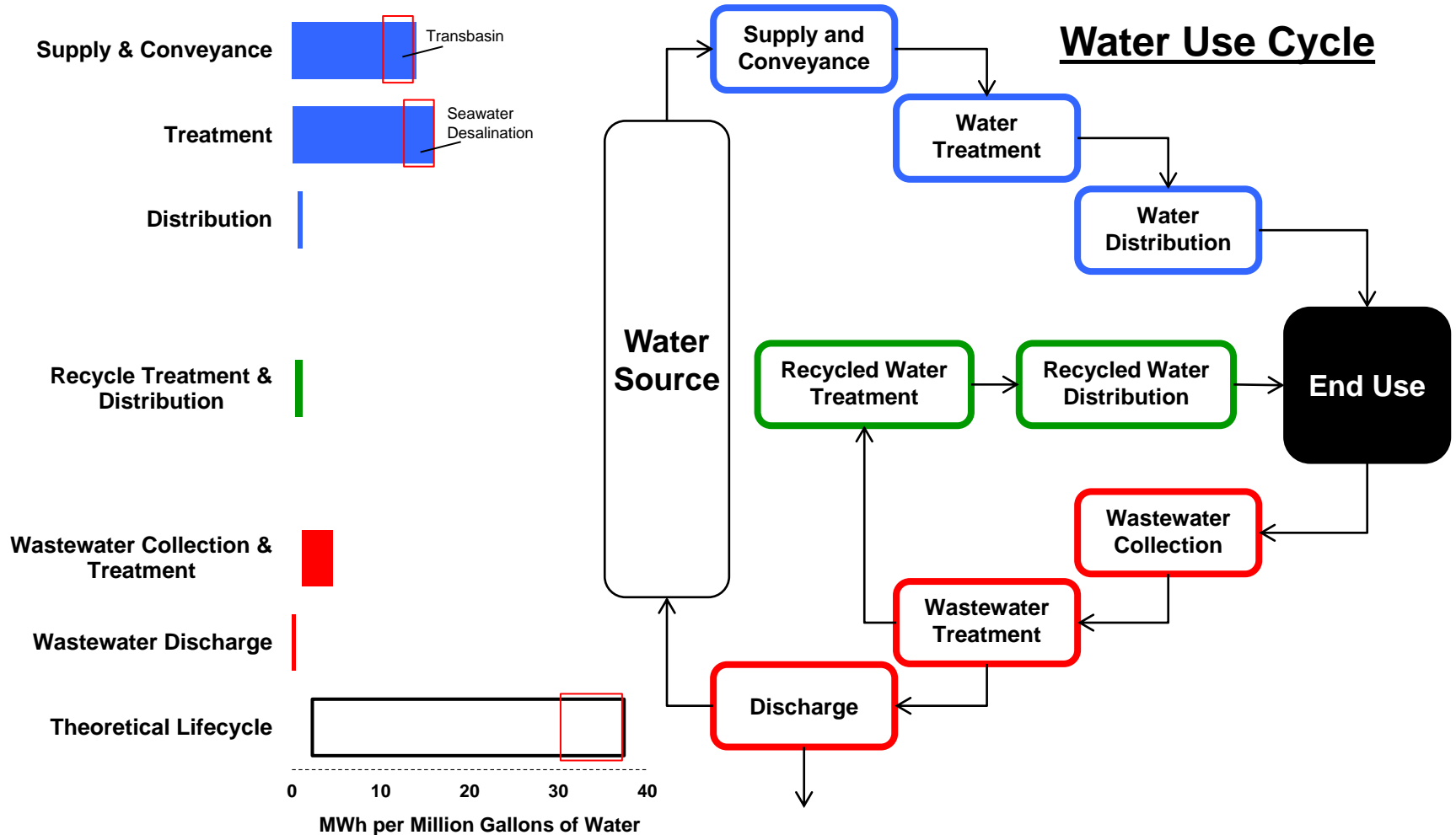
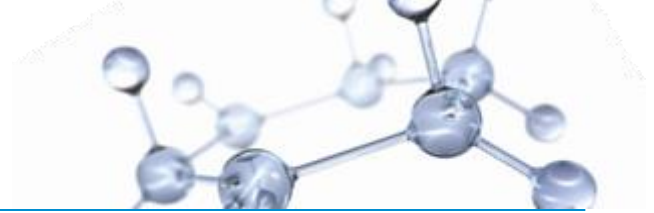
Graphic is slightly modified from API source
<http://www.api.org/aboutoilgas/>

Freshwater Intensity of Energy Production



Source: internal & external reports

Energy Intensity of Water Use

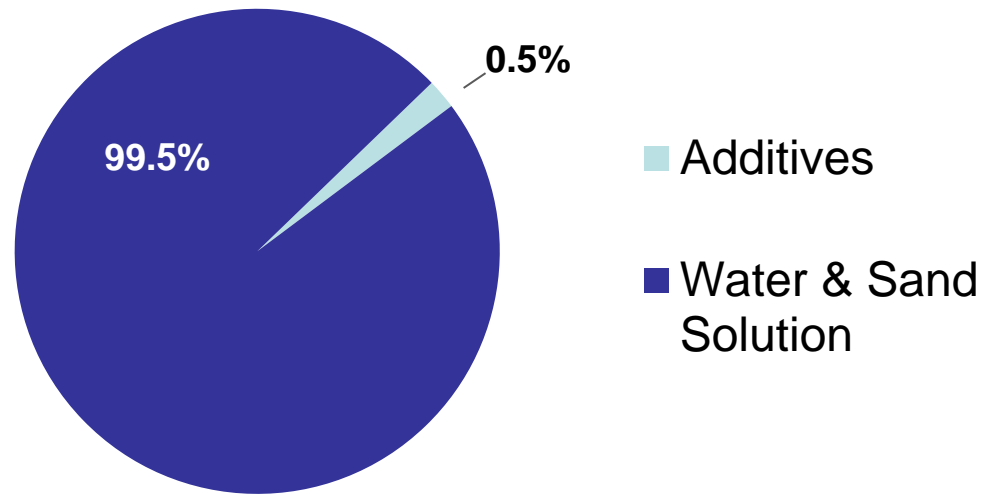


Source: CA Energy Commission 2005, Tech. Rep. CEC-700-2005-011-SF

Elements of Hydraulic Fracturing Fluid



- What is hydraulic fracturing fluid?
 - The vast majority of fracturing fluid is water and sand.
 - The small fraction of remaining ingredients are other additives often found in common household goods.

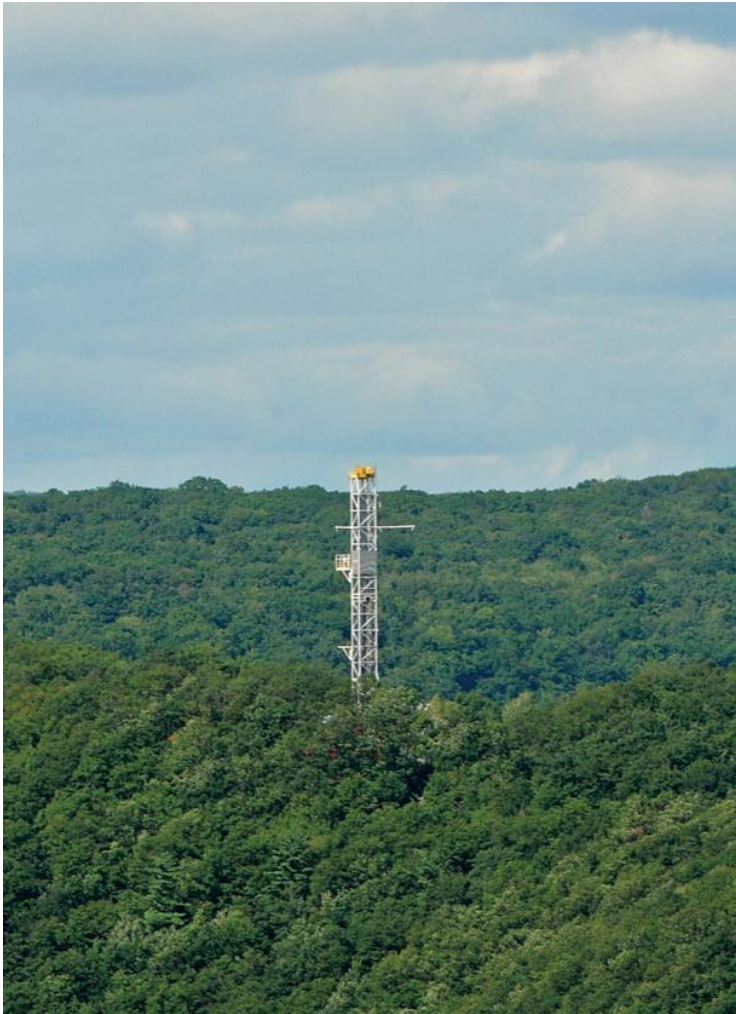


Safe Treatment of Water After Use



- What happens to the hydraulic fracturing fluid?
 - Recycled by treating and mixing with freshwater for re-use in future operations
 - Sent to an industrial wastewater treatment plant
 - Injected underground in properly permitted wells for disposal

Water Use – Marcellus Shale Region



- Susquehanna and Delaware River Basin Commissions employ strict siting and surface water management requirements
- Industry will use far less than 1% of water flow in both Basins

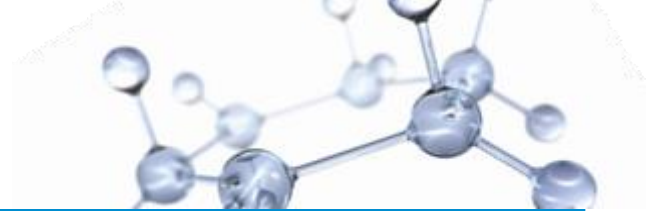
Water Use – Barnett Shale Region



- Water managed by multiple water management districts and municipalities
- Industry uses less than 2% of total surface water in Fort Worth Basin



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HYDRAULIC FRACTURING
HOW IT WORKS

GROUNDWATER
PROTECTION

CHEMICAL
USE

REGULATIONS
BY STATE

FIND A WELL
BY STATE

FREQUENT
QUESTIONS

WELCOME

Welcome to FracFocus, the hydraulic fracturing chemical registry website. This website is a joint project of the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission.

On this site you can search for information about the chemicals used in the hydraulic fracturing of oil and gas wells. You will also find educational materials designed to help you put this information to use.

[LEARN MORE >](#)

Looking for information about a well site near you?



Search for nearby well sites that have been hydraulically fractured to see what chemicals were used in the process.

In Summary ...



- **Water and energy are interrelated, and both are vitally important for society and economic development**
- **Population and economic growth drive water and energy demand**
- **Water scarcity is regional and can vary over time**
- **Water issues are most effectively addressed with local, watershed-scale solutions**
- **All stakeholders (industry, government, academia) have a valuable role to play in sustainable water solutions**
- **Petroleum industry is not an intensive freshwater user, but can be a material local water user**
- **Conduct research and operational analyses to support improvement of water-related technologies, practices, and performance**