The New Oil World: Is it real?

- There is no Peak Oil. The shale-gas revolution in America has been as “sudden and startling as a supertanker performing a handbrake turn.”

- 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.

- U.S. Steel Chairman, John Surma stated, “Development of our Nation’s recoverable oil and natural gas resources has the potential to be the once-in-a-lifetime economic engine that coal was 200 years ago.”

- And now what? The price of oil has dropped precipitously in the last 2 weeks as Saudi Arabia, Kuwait and others indicate they are ready to accept oil even as low as $80 a Barrel for up to a year or two. This is a major change in policy for Riyadh!

- Energy stock prices have plummeted and all new projects are being re-evaluated. There will be a major shift in E&P spending globally.

Can this oil and gas bonanza sustain itself and how does water impact growth and opportunities?
Water Availability Limits Economic Growth

• Freshwater is finite.

• Demand is outstripping supply as global economies grow with all use categories competing for the same resource.

• We are at a tipping point where the available freshwater supply cannot support continued growth globally.

• Global water withdrawals by 2050 to increase by 55%:
  • Manufacturing – 400%
  • Thermal Electricity Generation – 140%
  • Domestic Use – 130%

10 Year Outlook – Bleak

- Water is by its nature a geographically local resource with global implications. The 10 year outlook stretches available resources beyond capacity. By 2025:
  - **1.8 Billion** – will be living in regions with absolute water scarcity, and 75% of the world population could be under stress conditions; this is both Physical Water Scarcity and Economic Water Scarcity
  - **Water Withdrawals** – will increase in developed nations by 18% and in developing countries by 50%
  - **Energy** – energy needs dependent on availability of water may not be met:
    - 40% increase in energy demand would imply an related increase in water demand of 165%

The Upstream Industry gets most of the negative attention when it comes to competing for water and is held to a higher standard of use.

Source: U.N. Water For Energy, 2014; World Economic Forum
The projections for 2035 are dire! There will not be enough freshwater to support expected growth projections.

- **Population Growth** – from 6.8 Billion today to 8 Billion people

- **Urbanization** – 75% of the global population will live in cities

- **Food** – Production will have to increase by 70-100%; a 30% shortfall in global grain production will be caused by water scarcity

- **Energy** – Production will have to increase by at least 40%, needing a 75% expansion of existing energy infrastructure.

- There will be a projected 40% global shortfall between forecast demand for water and available supply of water by 2030.

The Energy Industry cannot assume it will have a secure supply of water to support its growth!
Water – Energy – Food Nexus

% Increase in demand by 2030

FOOD transports (virtual) water

WATER is needed to grow food

WATER is needed to generate energy

ENERGY is needed to clean and transport water

WATER
+30% DEMAND

ENERGY
+40% DEMAND

FOOD
+50% DEMAND

Source: Shell
The Competition Nexus

**Action Fields**

**Society**
Accelerating access, integrating the bottom of the pyramid

**Economy**
Creating more with less

**Environment**
Investing to sustain ecosystem services

**Finance**

**Governance**
Enabling factors/incentives

**Innovation**

**To promote:**
- Water/energy/food security for all
- Equitable & sustainable growth
- Resilient, productive environment

**Water supply security**

**Food security**

**Energy security**

**Available water resources**

**Nexus perspective**

**Global trends**
- Urbanisation
- Population growth
- Climate change

Source: World Economic Forum (WEF)
Water Use by Energy Source

Water use for primary energy production

- Conventional gas
- Coal
- Shale gas
- Refined oil (conventional)*
- Refined oil (oil sands)**
- Gas-to-liquids
- Coal-to-liquids
- Refined oil (EOR)***
- Lignocellulosic ethanol****
- Palm oil biodiesel
- Rapeseed biodiesel
- Soybean biodiesel
- Corn ethanol
- Sugarcane ethanol

Liters per toe
Toe - ton of oil equivalent (1toe = 41.868 gigajoule)

* The minimum is for primary recovery; the maximum is for secondary recovery.

** The minimum is for in-situ production; the maximum is for surface mining.

*** Includes CO₂ injection, steam injection and alkaline injection and in-situ combustion.

**** Excludes water use for crop residues allocated to food production.

Overall Industry Water Use

Water volumes needed for energy to almost double by 2035!

Source: International Energy Agency

This does not account for the rapid growth of the shales

Source: National Geographic
Impact of Climate Change and Locational Water Stress

Shale Plays and Baseline Water Stress in the United States
Global Onshore Water Stress

Distribution of Baseline Water Stress across Shale Plays in the 20 Countries with the Largest Technically Recoverable Shale Gas Resources

Note: Countries arranged from most arid or highest water stress on the left, to lowest water stress on the right.
Sources: Location of world's shale plays from West Virginia University and The National Energy Technology Laboratory. Estimates of total technically recoverable shale gas resources from the U.S. Energy Information Administration. Estimates of baseline water stress from WRI's Aqueduct Water Risk Atlas.
Water availability is a limiting factor which will drive decisions. “Water risk” and costs will increasingly impact the balance sheet and what projects go forward.

**Water Sourcing Options**

- **Traditional Sources**: Finite and impacted by politics and climate change.
- **Conservation**: Has to be incentivized.
- **Reuse**: Need for widespread adoption.
- **Desalination**: Only new sustainable source of supply.
A primary goal of the Industry is to minimize water use and the disposal of Produced Water and move toward re-use. Produced Water will always be a primary source of water for reinjection and Enhanced Oil Recovery (EOR).
Environmental regulations are becoming increasingly stringent and there is an aggressive push toward recycling.

Technology is NOT the barrier, but cost is!

Cost-effective water treatment solutions are essential to not only meet environmental regulations but to also increase production and extend field life.

The whole water cycle must be better managed; The Industry has to look at the problem holistically and at “Water in and Water out” in order to identify the full potential for cost savings. There are better solutions available than using more chemicals!

In order to become more independent and to de-risk, the Industry focus needs to be on securing alternative sources of water supply that do not compete with existing users and have not been previously allocated.

This means brackish water, desalinated water and produced water.

The Industry needs to become more self-sufficient because it will always be held to a higher standard and its use curtailed early.
Full Water Cycle Management is Critical

As the water treatment market expands, there is an immediate need for cost-effective proven technologies and solutions focused on the entire water cycle: “Water In / Water Out”

Water Standard Primary Capabilities

Water Standard Total Solutions Provider

Where the market is heading
It’s all about reuse and meeting environmental discharge standards

- Regulations are increasingly stringent requiring additional treatment before discharge, and in some cases in an offshore environment, zero discharge.

- Treatment requirements vary by location and unpredictable changes in produced water quality makes PW challenging to manage.

- PW is the highest volume by product associated with oil and gas production, which makes its reuse and safe discharge even more essential; Current global production water volume is estimated at more than 70 billion bbl a year (OGF, 2012).

- The quality of produced water management plays a critical role in the success or failure of an oil production project, along with the selection of the right treatment method.

- Globally only 19% of offshore PW is re-injected and here is another urgent opportunity! Trend is to greater treatment. Norway is already ZLD.

The Industry has to promote cost effective new technologies that can effectively treat a wide range of issues and TDS/TSS
Produced water is already in the control of oil and gas producers and is the largest waste stream in the Industry. It is an immediate, non competitive alternate source of water if it can be cost effectively treated and re-injected.

Source: GWI
Shale Gas Water Management Cost Ranges

- **Costs Drive Choices**
- **Source:** Lance GWI Conference Sep 2013

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**Shale Gas Water Management Cost Ranges**

- **RO**
- **Evaporation**
- **Crystallization**

- **Total Dissolved Solids [mg/L TDS]**
  - 750
  - 3,000
  - 40,000
  - 260,000
  - 1,000,000

- **Treatment for Reuse**
- **No TDS Removal**
- **TDS Removal**

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**Cost per Barrel [$]**

- **Disposal**
  - 0.21
  - 14.28

- **Treatment**
  - 0.04
  - 5.46

- **Transport**
  - 1.05
  - 19.95

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**Source:** IHS White Paper, Water Management in Shale Gas Plays 8/2012
Why Water-Based EOR

“Resource holders will demand getting every barrel we can out of every reservoir, even the difficult ones.”

Shell estimates global water-based EOR potential is estimated at 750 billion barrels.

“Well Recovered” Shell (2009)

MARKET DRIVERS FOR EOR

- Increased cost of finding new reserves; get more oil where you have already found it
- Increased recovery with proven cost-effective technology
- Maturing reservoirs with production declines
- High costs of decommissioning
- Current commodity price environment

WATERFLOOD

Incremental 5 – 15%

Low Salinity: 5 – 15%
Polymer Flooding: 5 – 20%
ASP Flooding: 15 – 30%

WATER-BASED EOR

Incremental 5 – 30%

Primary

Range 10 – 30%

% Original Oil in Place (OOIP)
With a global average of only 33% primary recovery, EOR is the biggest source of oil on the planet with the 2013 EOR market valued at $101.52B in revenue (market share for top 20 EOR companies).

From 2009 to 2015 global EOR production growth will be dramatic and is estimated to grow to 12.1B bbl or 34% of global market share. This includes conventional water flooding and CO2.

BP intends to apply LoSal EOR technology to all candidate reservoirs going forward. Full implementation across BP’s portfolio could increase net recovery by up to 700 million barrels. “Genuine game-changing technology does not happen overnight and does not occur frequently in our industry but we believe we have such a winner in LoSal EOR.”

Source: PennEnergy Research / Oil & Gas News – Hilal Publishing and Marketing Group
BP.com/EOR, The Third Trillion
Shell’s View of Next Generation Solutions

ENHANCED RECOVERY HISTORY AND NEW HORIZONS


- Steam trials
- Thermal EOR pilots
- Full scale CO₂ floods
- CO₂/thermal optimisation
- Low-salinity waterflooding
- Smart surveillance
- Chemical rebirth
- Unconventional heavy oil
- Next generation CO₂ solutions
- Innovative solvents
- Offshore EOR

1930:
- Gas injection
- Oil saturation measurement

1940:
- First commercial steam drive
- First successful CO₂ field test

1950:
- Permian CO₂ boom
- Chemical trials

1960:
- Smart fields
- Oil sands

1970:

1980:

1990:

2000:

2000+:

Source: Shell Oil
Pelican Lake Technology Development Yields Improved Recovery

2P recovery factor (% OIIP)

Oil Recovery Factor in Developed Regions

Primary
Primary/Waterflood
Primary/Polymerflood

Primary | Waterflood | Polymerflood

Note: Average recovery factor booked for 2P reserves in developed regions.

Four Fold Increase in Recovery Factor

CNQ Slide 22
• In an era of increasing drought cycles and climate change, effective water management is critical to the success of onshore oil & gas production.

• Growth in this Sector will be in recycling and reuse, PW treatment and brackish water for conventional and unconventional production.

• Finding more oil where you have already found it and use produced water or brackish water for EOR will be critical developments.

• Globally we will see the emergence of technologies reducing water usage and enabling more cost effective treatment.

• If water needs and water management are not managed effectively, water availability and use will severely limit future Industry growth.

The Industry must become more self-sufficient and not compete for dwindling supplies as the last player at an already crowded table.
Remember Elephants are in the Room and are an Endangered Species
Redefining Water Treatment for the Oil and Gas Industry

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