Petroleum Industry: Adaptation to Projected Impacts of Climate Change

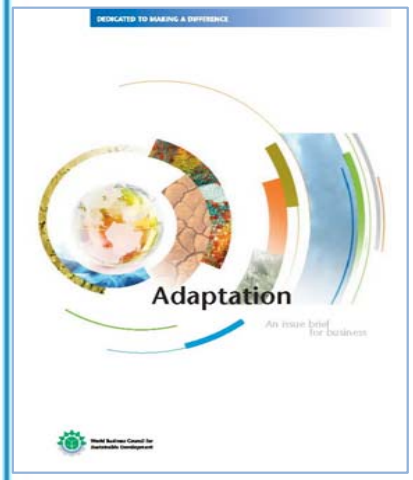
Jan Dell

Presentation to IEA Workshop

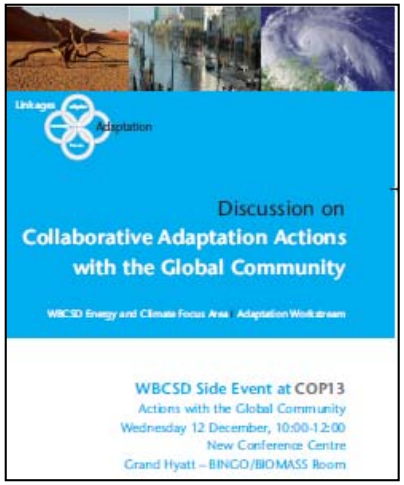
November 13, 2013

The Road to Resilience

2007: First Business Adaptation WBCSD Publication

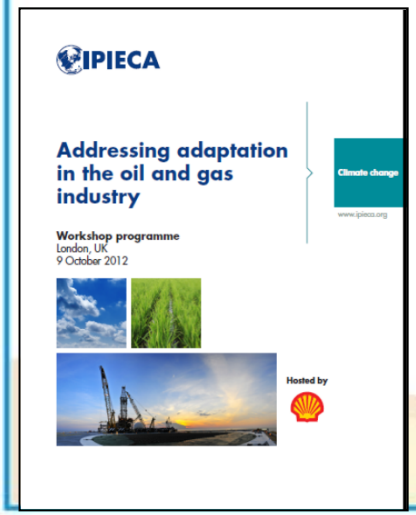


2007: First Business Adaptation COP13 Side Event in Bali



2009: Oil/Gas Industry Consortium Adaptation Workshops

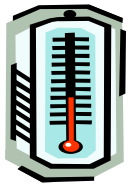
2011: World Petroleum Congress



2012: IPIECA Adaptation Workshop

2013: US National Climate Assessment

Why should Oil/Gas Industry be concerned about projected physical impacts?

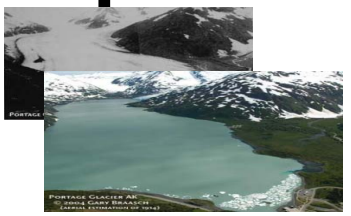


Temp Increase

Droughts & Floods

Storm Events

Rising Sea Level



Snow Cover Shrinking: Less Storage

Ocean Acidification

Because we have many projects and operations:

- In regions of greatest temperature rise and impact (arctic)

- Affected by sea level rise and ocean acidification

- Affected by shrinking snow cover (water supply variability)

- That require significant amounts of fresh water to operate

THE WALL STREET JOURNAL. Thursday, March 26, 2009 A3

U.S. NEWS

Water Worries Shape Local Energy Decisions

Scarcity Forces Electricity Companies to Rethink Power-Plant Plans, Providing an Opening for Renewable Sources

BY REBECCA SMITH

Last month, Tri-State Generation and Transmission Association, a utility that provides power to mostly rural areas agreed to

ber of the Lassen County Board of Supervisors.

Sempra pulled the plug on the project in late 2006, citing, among other things, water use. Since then, another big energy proposal has surfaced, but it hasn't kicked up much opposition: A dozen companies are considering building hundreds of wind turbines along Lassen County ridgelines. So far, 17 meteorological towers have been erected to verify wind speeds.

In turn, conventional power plants are turning to technology that aggressively cuts water use as they weigh the costs of installing more complicated cooling sys-

practice violates the Clean Water Act because it harms aquatic life and fails to utilize the best technology available, a requirement of the federal act.

The case, now before the U.S. Supreme Court, stands to test how water-use issues will determine which power plants continue to operate as well as what kind of plants are built.

Nuclear plants face particular scrutiny, since they require more water than any other form of steam generation. Virginia Power, a unit of **Dominion Resources**, is facing a legal challenge over its right to draw one million gallons of water a minute

Drought raising water costs, scarcity concerns for shale plays

Stakeholder Interest in Company Assessments

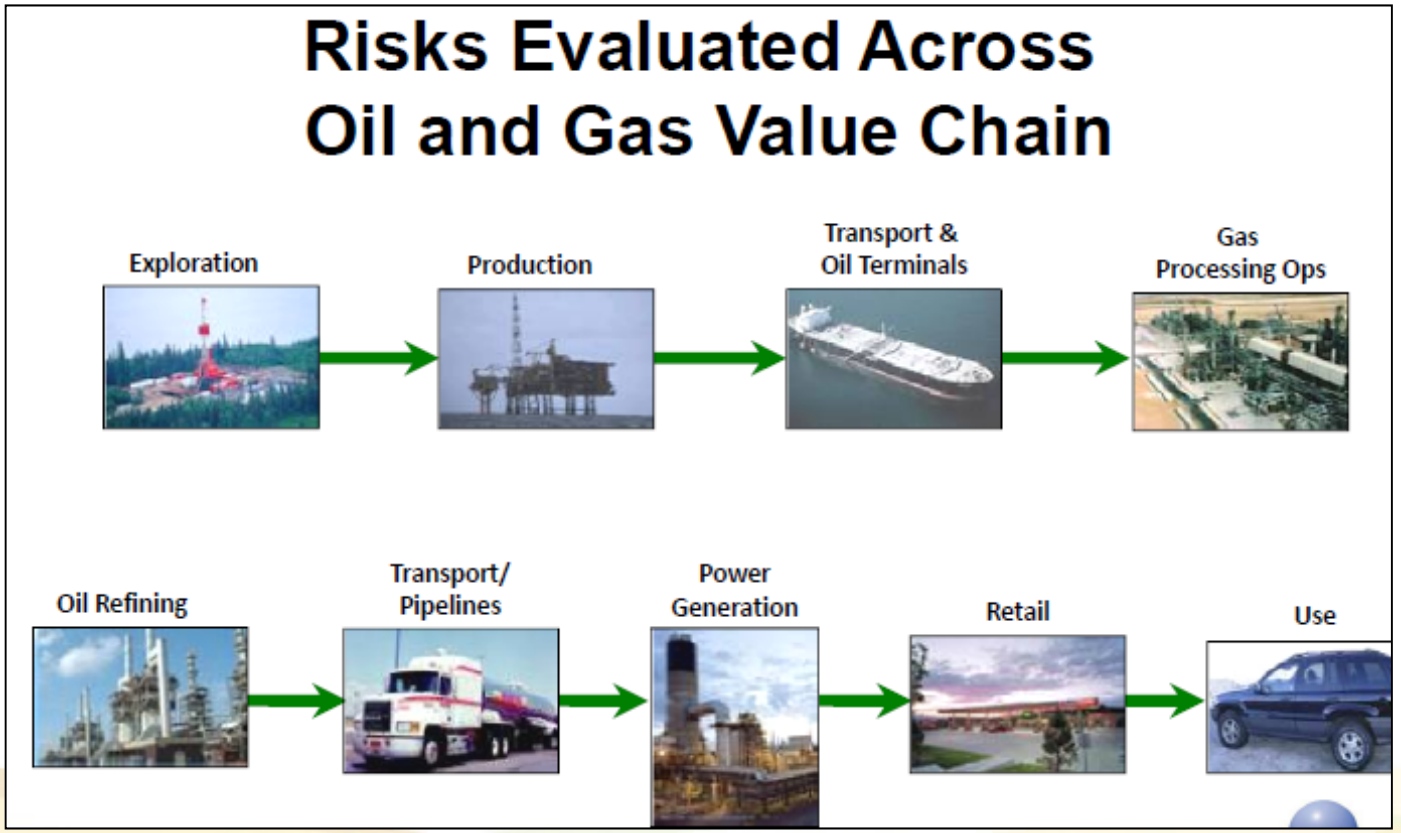
February 8, 2010: SEC Releases Interpretive Guidance

The SEC highlighted four areas for companies to consider when assessing whether climate-related disclosure is required under its rules and regulations:

- **the impact of legislation and regulations, such as laws requiring companies to install pollution control equipment,**
- **the impact of international climate change accords, such as the Kyoto Protocol,**
- **indirect consequences of regulation, such as decreased demand for carbon-intensive products and**
- **physical risks of floods, hurricanes and other natural disasters that may result from climate change.**

2009: Consortium O/G Group Workshops

Goal: to perform an assessment of the global oil and gas value chain to enable companies to plan for the projected impacts of climate change and build resiliency into their long-term business models.



2009: Consortium O/G Group Workshops Regions Reviewed

Arctic

60 to 90 N Lat

US and Canada (non-arctic)

West North America: 30N, 50E TO 75N, 100E

Central North America: 30N, 103W TO 50N, 85W

East North America: 25N, 85W TO 50N, 50W

Europe

Northern Europe: 48N, 10W to 75N, 40E

Southern Europe: 30N, 10W to 48N, 40E

MENA

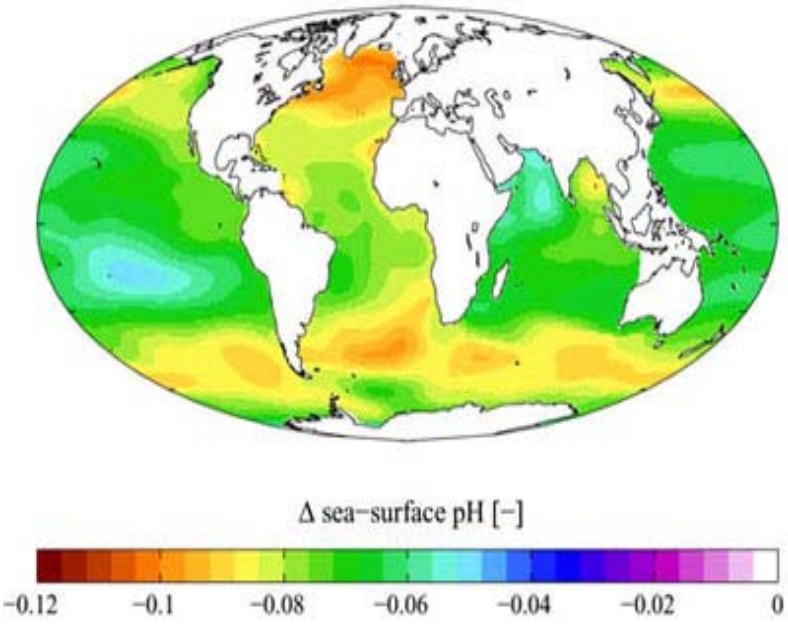
Australia

N. Australia: 30S, 110E to 11S, 155E

S. Australia: 45S, 110E to 30S, 155E

2009: Consortium O/G Group Workshops

Impact Categories Evaluated:



Global:

1) Sea Level Rise (SLR)
2) Ocean pH

Regional:

1) Ambient Warming
2) Summer Season Length
3) Sea Ice Thickness and Coverage
4) Snow Depth and Coverage
5) Coastal Erosion Rates
6) Land Condition (Permafrost, Semi-Permafrost, Non-Permafrost)
7) Disease Vector and Species Migration
8) Local Precipitation
9) Storm Frequency and Strength and Wind Speeds
10) Wildfires

Results Detailed in SPE Paper 126307

Climate Change Adaptation in Oil/Gas Value Chain: Opportunities and Risks
Workshop Outcomes - April 28, 2009

Climate Change Impact	Business Operation				
	Overall Oil and Gas Industry	Exploration and Production Specific	Pipelines, Transport & Oil Terminals	Refining	Communities - External Stakeholders Issues
					
Ambient Warming: Temperature Increase	Risks: • Air quality degradation could lead to increased regulation or more stringent permit limits • Health & Safety: Shortened work days and increased hardships in hot climates • Logistics/Planning:Moving goods and people impacted by hot temperatures in hot climates and reduced ice roads in arctic • Water Supply: higher evaporation rates from surface ponds and open tanks could lead to higher water use • Cooling Capacity: increased ambient temperature will lower capacity of existing cooling systems • Regulatory: increased water body temperatures could lead to increased regulation or more stringent water discharge permit limits (quality, temp, pH)		Risks: • Design/Logistics: Decreased capacity of gas pipelines • Logistics/Planning: Congested Right of Ways for gas pipelines due to encroaching communities and increased pipeline construction		Risks: • Health and Safety: Increased heat waves • Regulatory: Air quality degradation could lead to increased regulation or more stringent permit limits
Length of Summer Season	Opportunities: • Logistics/Planning:Longer summer work season in temperate climate zones • Design: Increased summer demand for cooling by consumers (increased electricity and natural gas demand)	Opportunities: • Design: Offshore: Instead of ice-based construction, lower cost conventional construction could be employed		Opportunities/Risks: • Logistics/Planning:Shift in seasonal demand cycle for products	Opportunities: • Communities/Water Supply: Increased growing seasons in some climates impacting Food Sources and Security Risks: • Communities/Water Supply: Decreased growing seasons in some climates. Concerns of food sources and security could put pressure on water rights and land use.
Sea Ice Thickness and Coverage	Opportunities: • Logistics/Planning:New shipping routes which could decrease shipping costs or eliminate need for pipelines Risks:	Opportunities: • Logistics/Planning: Longer drilling season • Logistics/Planning: New areas open for exploration and production Risks:	Opportunities: • Logistics/Planning:Longer Open water season • Regulatory/Logistics: New shipping routes through the Arctic regions Risks:		
Storm Frequency and Strength Wind Speed	• Design: Increased wave loading • Logistics/Planning:More frequent evacuations • Design: Power outages in facilities due to storm damage and icing • Design: Increased ice accretion should be factored into new designs		• Logistics/Planning:More frequent shipment interruptions or delays. • Logistics/Planning:Increased costs from stronger protection in loading facilities • Logistics/Planning:Increased frequency of supply route disruptions (e.g. port closings)	• Logistics/Planning:Increased frequency of outages • Logistics/Planning:Increased repair costs from storm damage • Design/Logistics: Decreased overall power grid reliability	may increase. • Design: Storm preparedness and retrofit of infrastructure design will increase costs
Coastal Erosion	Risks: • Design: Degradation of coastal barriers • Logistics/Planning:Damage to and possible relocation of facilities • Communities: Relocation of fence line communities and increased stakeholder pressure	Risks: • Design: Damage to pads • Technology: Increased complexity in new drilling	Risks: • Design: Damage to existing terminals and shore transition pipes • Design: Damage to existing infrastructure, roads, pads	Risks: • Design: Increased road damage • Design: Increased costs from deeper road and rail setbacks required	Risks: • Communities: Communities may require relocation • Design/Communities: Damage to public and private facilities and infrastructure
Wildfires	Risks: • Logistics/Planning:Increased production interruptions • Health and Safety: Human exposure risks • Logistics/Planning:Curtailed operations in 'high risk' seasons • Design: Increased lightning frequency • Logistics/Planning:Increased frequency of evacuations		Risks: • Design/Health and Safety:Pipeline compressor stations: increased interruptions and evacuations		Risks: • Logistics/Planning:Increased frequency of evacuations • Design/Planning:Increased frequency of power outages • Design: Damage to public and private facilities and infrastructure
	Risks:	Risks:	Risks:		Risks:
General and Political					• Regulatory: Communities may encroach on oil/gas sites as their land is impacted. • Planning/Logistics: Pipeline ROWs will become more congested. • Regulatory: Legal action regarding climate impacts • Communities: Cultural/historical sites and customs could be impacted.

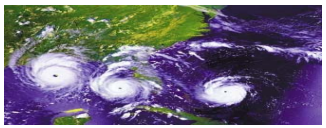
Detailed Value Chain Analysis of Climate Change Impacts was performed to identify Opportunities and Risks in Oil and Gas Operations

Conclusion: Adaptation planning identifies "no regrets" actions and promotes cost-effective resiliency in operations.

Summary of Impacts

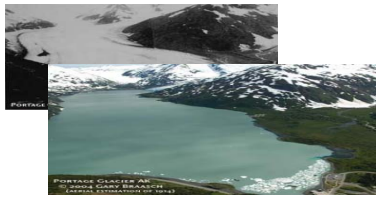
Temp Increase

Droughts & Floods



Storm Events

Rising Sea Level



Snow Cover Shrinking

Ocean Acidification

Impacts on…

Exploration

- Subsidence
- Increased wave loading
- Loss of surface water access
- Sound impacts on sea mammals
- Delays due to Species migration

Production

- Early season delays
- Pad damage
- Loss of surface water access
- Production interruptions
- Ice road – decreased tundra travel

Transport & Terminals

- Increased ice-load variation
- Damage to coastal facilities
- Increased shipment interruptions
- Improved or reduced shipping lanes or seasons

Pipelines

- Thaw subsidence and frost jacking
- Increased setbacks
- Loss of capacity in existing pipelines
- Wildfires

Refining & Processing

- Loss of access to water
- Interruptions from flooding
- Loss of peak cooling capacity

Neighboring Communities

- Weather-related mortality
- Infectious diseases
- Air-quality respiratory illnesses
- Loss of species and habitat
- Water

Physical Impacts are Local, Projects are Unique: Adaptation assessments must be performed at site level to identify design and operational actions

Step 1. Identify Future Projected Physical Impacts in a specific area over time range of interest

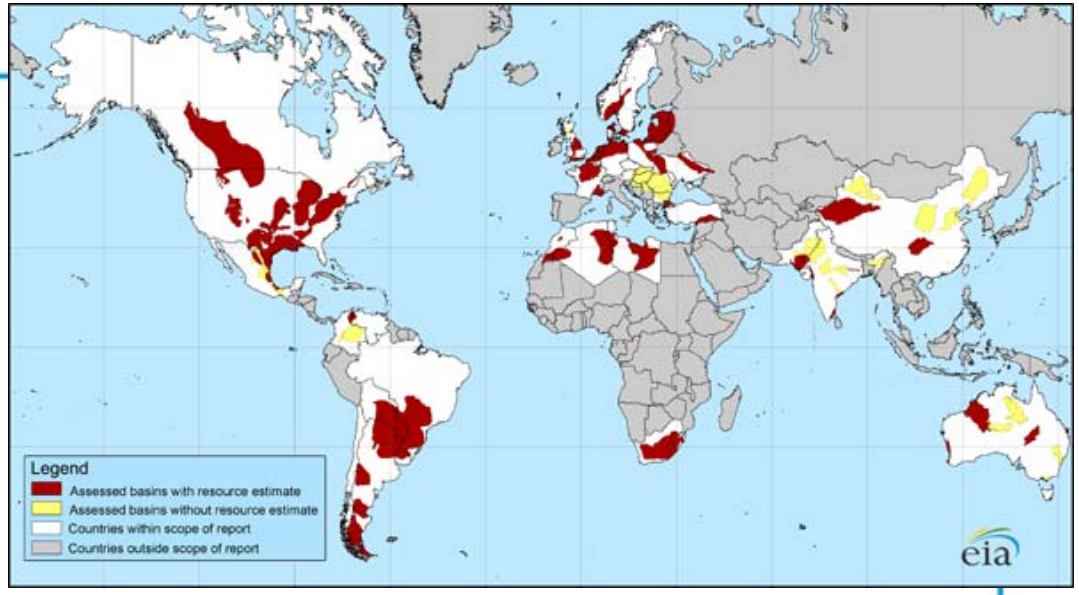
In-Land West Texas	Reference/Citation			
26 to 37 degrees north -98 to -102 degrees west	Executive Summary Projected Physical Impacts	Summary Impact (synthesized from all sources)	IPCC Predicted (2007) http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml	Texas Climate
2) Land and Vegetation Condition	Land and vegetation conditions are not predicted by global climate change models. Based on the predictions of an increase in temperature and no change in precipitation, there is an increased potential for: 1) vegetation die-off during summer months 2) less growth of grass due to shifts in seasonal rain patterns 3) creation of dust bowls from extended droughts	With an increase in temperature and no change in precipitation, species could move as a unit to the northeast, however global climate models do not provide the precision needed to project the local duration, frequency, or seasonality of precipitation. Prolonged drought periods (multi-month and multi-year) in the southwestern states (including West Texas) can reduce vegetative ground cover. This loss of vegetation, coupled with more frequent and intense continental storm systems, could lead to increased dust storm frequency and intensity.	No specifics.	Seasonality of rainfall relative to the growing vegetational changes in the Chihuahuan Des shrubs as a result of changes in the season reduce proliferation of grasses. Shrubs can However, grasses do not grow during wint summer. The ability of species to respond to change of remaining ecological communities results regarding human impact on landscape: (1) t dispersal across gaps between fragments vegetation become smaller and discontinuo
3) Disease Vector and Species Migration	Pests and diseases are increasing in West Texas because warmer winters reduce die-off and parasite development rates and infectivity increase with temperature. This trend is predicted to continue through 2040.	Pests and diseases are increasing in range because warmer winters reduce die-off and parasite development rates and infectivity increase with temperature. An estimated 6,186 cases of Dengue Fever were reported between 1995-2005, most of these in the dengue-vulnerable Texas-Mexico border region. 110 Texas counties have mosquitoes that can transmit the virus (as of 2005). 2,175 cases	No specifics.	Increased risk (heat wave deaths, waterborn With an increase in temperature and no chang climate models do not provide the precision ne Therefore, ecologists currently do not have th

Step 2. Evaluate Risks to Specific Assets (Oil and Gas Production and Processing, Pipelines, Refineries, Chemical Plants, Staff Offices), Critical Infrastructure and Communities

Value Chain Summary	Executive Summary Projected Physical Impacts for West Texas Climate Zone	Most Significant COP Design/Operation and Community Impact Risks and Opportunities for Period to 2040	Impact Risks and Opportunities Common to All Operations	Natural Gas Production Field / Natural Gas Processing Plant
Climate Change Impact (2040)	26 to 37 degrees north -98 to -102 degrees west			
1) Ambient Warming	The mean annual temperature in West Texas area is predicted to rise by +3 to +5 F by 2040.	COP: • **Cooling Capacity:** increased ambient temperature will lower capacity of existing cooling systems Communities: • Health and Safety: increased heat waves	Risks: • **Air quality** degradation could lead to increased regulation or more stringent permit limits • **Water Supply**: higher evaporation rates from surface ponds and open tanks could lead to higher water use • **Regulatory**: increased water body temperatures could lead to increased regulation or more stringent water discharge permit limits (quality, temp, pH) • **Equipment failures** could result from design spec exceedances - particularly sensitive electronics • **Cooling Capacity**: increased ambient temperature will lower capacity of existing cooling systems	Risks: • Decreased capacity of gas pipelines
	The growing season length in West Texas is predicted to	COP and Communities:	Opportunities: • **Design:** increased summer demand for cooling by consumers (increased electricity and natural gas demand) Risks: • **Health & Safety:** increased heat stress to workers in summer months	Risks: • Decreased capacity of gas pipelines

or

Impacts Should be Assessed for Risk/Opportunity Significance: Likelihood of Physical Impact and Magnitude of Consequence



Benefits of Shale Gas Production

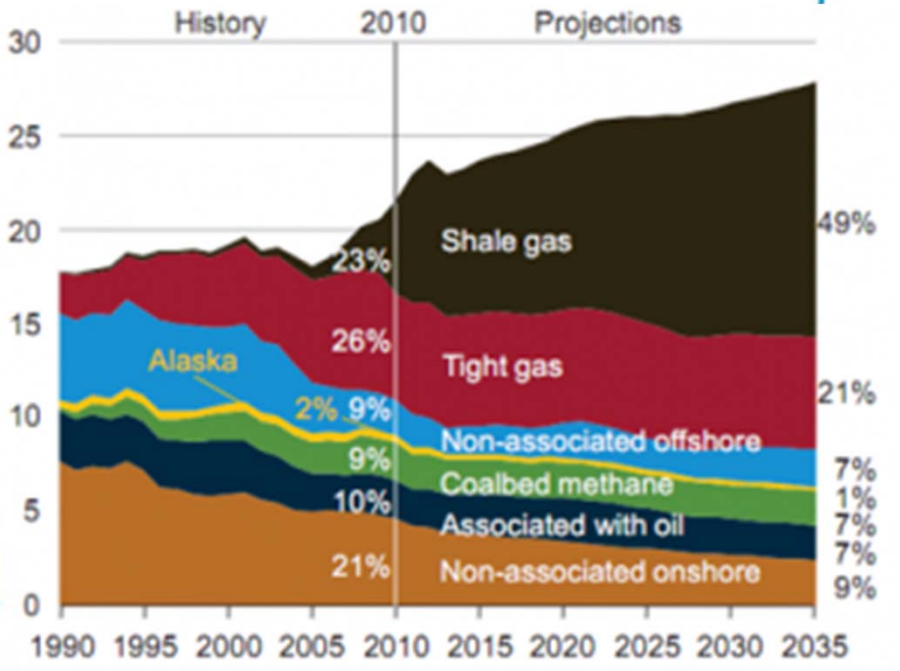
- Sources: Diversification away from coastal/offshore sources

US: 2005 GOM = 20% gas, 27% oil prod

US: 2012 GOM = 7% gas, 23% oil prod

- Power Plant Retrofits: move to gas combustion from coal lowers water intensity in power plants
- New Gas Power Plants: move to dry cooling and use of municipal effluent.

US EIA Data and Projections



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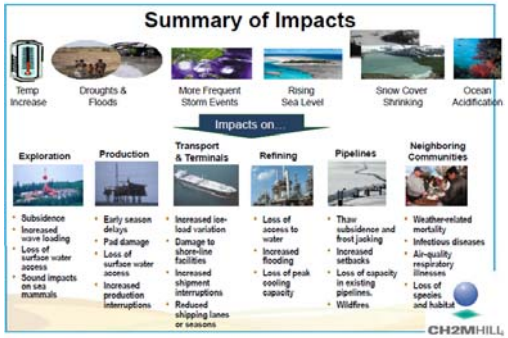
BUSINESS | September 21, 2012, 6:55 p.m. ET

Power Plants Aim to Curb Their Thirst

Remember on the Road to



Oil and gas Industry faces a range of risks and opportunities

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U.S. NEWS

Water Worries Shape Local Energy Decisions

Scarcity Forces Electricity Companies to Rethink Power-Plant Plans, Providing an Opening for Renewable Sources

By Rebecca Smith

Steady-State is Out-of-Date: Water availability and variability are increasing concerns

GEMI®
Local Water Tool™ (LWT)
for Oil and Gas

<u>Local</u> assessments can best identify low cost "no regrets" actions to design resiliency into new projects and existing operations