The energy industry is at a historical turning point that is analogous to when a global flurry of discoveries at the turn of the 19th century ushered in the modern energy industry. An outbreak of energy-related entrepreneurial innovations worldwide is unleashing a raft of new opportunities and risks that will once again remap the energy sector.

Flip through to see how these shifts will impact not just the energy industry but also every company and person that depends on it.
THE MAJORITY OF GROWTH IN HYDROCARBON SUPPLY IS SHIFTING TO COMPLEX RESOURCES...

CUMULATIVE FORECASTED GROWTH IN SUPPLY OF LIQUID HYDROCARBONS
IN MILLION BARRELS PER DAY, 2010–2025

72% of growth will come from complex resources
28% of growth will come from conventional resources

- Development of new conventional reserves (Iraq, KSA, CIS)
- Deepwater shelf
- Tight oil reservoirs and shale oil in US
- Heavy Venezuelan oil, Canadian sands
- Natural gas liquids
- Biofuels
- Coal to liquids/Gas to liquids
- Cumulative growth in supply (2010-25)

OVERALL PROJECTS BY SIZE
NUMBER OF PROJECTS BY OVERALL PROJECT SPEND, 2012

- Nearly 200 projects have budgets over $5 billion, representing 33% of total spend
- Hundreds of projects >60% of spend

PROJECT SPEND

Source: IEA, IHS CERA, IHS Herold, Oliver Wyman analysis.
NATIONAL OIL COMPANIES INVEST MORE IN RESEARCH AND DEVELOPMENT, BUT ISSUE FEWER PATENTS THAN PUBLICLY TRADED FIRMS

Source: FactSet, Energy Evolution, company reports, Oliver Wyman analysis.
TRADING MARKETS MATURE

SOME COMMODITIES TRADED MOST PROFITABLY BY INDEPENDENT TRADERS ARE MOVING OUT OF THE “SWEET SPOT”

TRADING ATTRACTIVENESS (MARGIN AND VOLUME CONSIDERATIONS)

ILLIQUID – NOT TRADED
- Difficult to enter and exit, potentially high margins
- Natural playing ground of asset-backed traders and marketing units
- Met coal slowly developing into a commodity

SEMI-LIQUID
- Attractive for traders who are able to secure structural longs and build network
- Iron ore slowly joining metal concentrates activities
- LNG becoming more and more liquid and accessible, still high margin

LIQUID
- Liquidly traded, often the sweet spot for commodity traders because of high margins and big volumes

NEARLY PERFECT MARKETS
- Decreasing margins, but high volumes. High barriers for new entrants
- Dominated by established players

Source: Oliver Wyman analysis.
HOMOGENIZATION OF MARKET PLAYER STRUCTURE

Market structures across commodities will further harmonize, leading to a three-tier model.

Potential trend in player structure:

- **Fragmented Market Structure**
  - Oil and gas
  - Power
  - With 20+ significant players

  Scale-driven consolidation

- **Concentrated Market Structure**
  - Metals and minerals
  - Softs
  - With 3-5 significant players

  Value-driven trading build-out

- **Trend to Homogeneous Player Structure**
  - Few significant players on long and short side
  - 2-3 independent players per asset class

Source: Oliver Wyman analysis.
COMPRESSED MARGINS

STANDARD TRADING PLAYS WILL BECOME SIGNIFICANTLY LESS ATTRACTIVE IF TRADERS ARE CHARGED MORE FOR WORKING CAPITAL

IMPACT OF A CHANGE IN WORKING CAPITAL COST ACROSS STANDARD DEAL TYPES

Source: Oliver Wyman analysis.
LOW VOLATILITY

VOLATILITY IS CURRENTLY AT HISTORIC LOWS

AVERAGE ROLLING 60 DAYS IMPLIED VOLATILITY FOR KEY ENERGY FUTURES* (PERCENT YEARLY STANDARD DEVIATION)

Source: Reuters, Oliver Wyman analysis.
* Average includes: Brent, WTI, ICE Gasoil, RBOB, ULSD, NatGas HH, Nat Gas NBP.
## THREE KEY MARKET SCENARIOS

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“TRADING IS NOT WHAT IT USED TO BE”</strong></td>
<td><strong>Banks exiting the commodity trading space</strong></td>
</tr>
<tr>
<td>Trading activity</td>
<td>- Banks leaving the market, no substitution, limited activity of independents, producer and consumer traders</td>
</tr>
<tr>
<td>Today</td>
<td>- Alternative usages for capital preferred</td>
</tr>
<tr>
<td></td>
<td>- Prolonged period of low volatility</td>
</tr>
<tr>
<td></td>
<td><strong>Homogenization of market structure</strong></td>
</tr>
<tr>
<td></td>
<td><strong>“BACK TO NORMAL”</strong></td>
</tr>
<tr>
<td>Trading activity</td>
<td><strong>Pressure on independent trader model</strong></td>
</tr>
<tr>
<td>Today</td>
<td>- Substitution of the banks’ activities through producer/consumer traders</td>
</tr>
<tr>
<td></td>
<td>- Alternative providers established for RM offerings and market liquidity</td>
</tr>
<tr>
<td></td>
<td>- Increase to an average level of market volatility</td>
</tr>
<tr>
<td></td>
<td><strong>Regulator changes (Dodd-Frank, Basel III, IFRS…)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>“THE RETURN OF THE BANKS”</strong></td>
</tr>
<tr>
<td>Trading activity</td>
<td><strong>Commodity market dynamics and oversupplied markets</strong></td>
</tr>
<tr>
<td>Today</td>
<td>- Change in regulation (potential for 3-4 year horizon) and/or engagement of emerging markets banks (BRIC, Singapore, Middle East)</td>
</tr>
<tr>
<td></td>
<td>- Banks in commodities trading supported by consumer/producer traders</td>
</tr>
<tr>
<td></td>
<td>- Increased market volatility</td>
</tr>
<tr>
<td></td>
<td><strong>Maturing across commodity classes</strong></td>
</tr>
</tbody>
</table>

Source: Reuters, Oliver Wyman analysis.
THE OIL MAJORS’ DILEMMA

OIL PRICES HAVE QUADRUPLED...

DOLLARS PER BARREL

2001 2013
$24.5 $25.9 $24.5 $108.6
Europe Brent Spot Price FOB
Cushing, OK WTI Spot Price FOB

...BUT OIL MAJORS’ OPERATING CASH FLOWS HAVE BARELY DOUBLED...

US$ BILLION

2001 2013
$83.7 $189.5

...AND THEIR STOCK MARKET VALUATIONS HAVE LAGGED THE BROADER STOCK MARKET

US$ TRILLION

2001 2013
$1.3 $52.4

Source: Thomson Reuters: Datastream, Oliver Wyman analysis. Calculations reflect the world’s six largest international oil companies.

Source: Thomson Reuters: Datastream, Oliver Wyman analysis.
THE OIL MAJORS’ DILEMMA

THE RELATIONSHIP BETWEEN CAPITAL EXPENDITURES AND DEPRECIATION FOR MOST INTERNATIONAL OIL COMPANIES HAS FUNDAMENTALLY CHANGED...

...AND MANY ARE PAYING DIVIDENDS TO SHAREHOLDERS THAT MEET OR EXCEED THEIR FREE CASH FLOW

Source: Thomson Reuters: Datastream, Oliver Wyman analysis.

Levered free cash flow* for the world’s largest six international oil companies

Source: Thomson Reuters: Datastream, Oliver Wyman analysis.

* Levered free cash flow is defined as the amount of cash left over for stockholders and for investments after all obligations are covered.
NET RISK EXPOSURE OF INDUSTRIAL COMPANIES

Source: Oliver Wyman analysis.
* Net exposure.
MORE ACTIVE PORTFOLIO MANAGEMENT IS NOT A SUBSTITUTE FOR QUALITY INVESTMENT DECISIONS

THE 40 ENERGY COMPANIES IN THE S&P 500 THAT HAVE DEVOTED A LARGER PERCENTAGE OF REVENUES TO CAPITAL EXPENDITURES AND DIVESTITURES ARE UNDERPERFORMING THEIR PEERS...

...BUT THEY CAN IMPROVE THEIR PERFORMANCE BY OPTIMIZING THEIR PORTFOLIO ALONG A “RISK-RETURN EFFICIENT CORPORATE INVESTMENT FRONTIER”

<table>
<thead>
<tr>
<th>COMPANY TYPE</th>
<th>PORTFOLIO ACTIVITY</th>
<th>AVERAGE RETURN ON INVESTED CAPITAL</th>
<th>STANDARD DEVIATION RETURN ON INVESTED CAPITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure play</td>
<td>Less active</td>
<td>16.8%</td>
<td>+/- 5.7%</td>
</tr>
<tr>
<td></td>
<td>More active</td>
<td>17.1%</td>
<td>+/- 4.9%</td>
</tr>
<tr>
<td>Integrated</td>
<td>Less active</td>
<td>16.8%</td>
<td>+/- 5.7%</td>
</tr>
<tr>
<td></td>
<td>More active</td>
<td>17.1%</td>
<td>+/- 4.9%</td>
</tr>
</tbody>
</table>

Source: Oliver Wyman market analysis of industrial companies.
* Invest (or divest) less than 30% of annual revenue.
** Investment (divestment) activity = Balancing activity = [Absolute value (capital expenditures) + absolute value (divestitures)]/Revenue return on invested capital = Earnings before interest and taxes/(Total assets – cash – accounts payable – accounts receivable).

Source: Oliver Wyman market analysis of industrial companies.
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A TALE OF THREE MARKETS

LOCAL UTILITIES ACCOUNT FOR THE MAJORITY OF GERMANY’S INDUSTRY, WHILE THEY REMAIN THE MINORITY IN THE US AND THE UK

PERCENT OF CONNECTED ELECTRICITY CUSTOMERS

Source: Oliver Wyman analysis: EIA, DECC, UKV.
UTILITIES ACQUIRED IN THE PAST FIVE YEARS

DEAL VALUE
US$ BILLION

Source: Dealogic, Oliver Wyman analysis.
* As of October 17, 2014.
POTENTIAL ALTERNATIVE FUELS FOR AVIATION

SHORT-TERM

HEFA PROCESS
(conversion of natural oils and animal fats into hydroprocessed esters and fatty acids)

Advantage: Already used at commercial scale at several biorefineries.

Challenge: Facilities tend to favor biodiesel production for subsidized ground transportation markets. Jet fuels are produced more opportunistically. Need to reduce refining and conversion costs.

FISCHER-TROPSCH PROCESS
(synthetic fuel from biomass or fossil fuels)

Advantage: Used at commercial scale, with coal and natural gas as feedstocks.

Challenge: Has not yet been proven at commercial scale using biomass as a feedstock.

MEDIUM-TERM

ALCOHOL-TO-JET
(jet fuel from alcohols such as ethanol)

Advantage: Feedstocks include corn, sugarcane, wood chips and agricultural waste.

Challenge: First-generation feedstock supply chain is mature. Additional research and development needed to bring to economic viability. May also require sustainability-certified feedstocks in the future.

CRYOGENIC FUELS
(such as liquefied natural gas)

Advantage: Could cut aviation carbon emissions by about 15 percent and reduce nitrogen oxide pollution by 40 percent.

Challenge: Would require new engines and substantial infrastructure upgrades at airports.

LONG-TERM

ELECTRICITY

Advantage: Lower-cost option; could significantly reduce carbon and pollution from planes, depending on the fuel used to generate electricity.

Challenge: Would require development of electric propulsion systems, sufficiently powerful batteries, airport recharging systems.

Source: Oliver Wyman analysis.
For the 23rd edition of The 100 Largest Losses report for the hydrocarbon industry, Marsh, like Oliver Wyman a subsidiary of Marsh & McLennan Companies, examined the property damage losses suffered globally by the energy industry over the past four decades. These pages summarize the results.

Marsh discovered an outsized concentration of incidents resulting in more losses exceeding $130 million after 1999 than in the preceding three decades. Since 2011 alone, eight new losses have entered the 100 largest losses list. Most of the largest losses did not result from so-called “black swan” events, but instead from the failure of prevention and mitigation measures taken to manage operational risks.

Note that the loss values have been adjusted to reflect the equivalent value of the loss at the end of 2013. And yet, they do not reflect the entire cost to a company’s operations, since costs of business interruption, extra expense, employee injuries/fatalities and liability claims are excluded from this analysis.

TOP 20 LOSSES
The call outs on this timeline represent the 20 largest property losses suffered by the hydrocarbon industry since 1974.

Source: The 100 Largest Losses: 23rd edition, Marsh. Marsh, like Oliver Wyman, is a subsidiary of Marsh & McLennan Companies.
PREDICTIVE AND REACTIVE ANALYTICS

Reliability Analytics Engine

Degree of Difficulty

High

Reporting
What happened to specific areas at specific times?

Ad Hoc
What is the correct answer response to inquiries?

Queries
What is the key problem to solve?

Alerts
What actions are needed?

Statistical Analysis
Why is this happening?

Forecasting
What if these trends continue?

Predictive Modeling
What will happen next?

Optimization
What is the best that can happen?

Degree of Insight

Low

High

Source: Oliver Wyman analysis.
THE OIL AND GAS TALENT GAP

Mercer, like Oliver Wyman a subsidiary of Marsh & McLennan Companies, recently conducted a landmark study of the talent outlook and workforce practices in the oil and gas industry. Mercer’s study showed that the industry is confronting a chronic, global talent shortfall, especially among the more experienced workers. To fill that gap, many companies plan to recruit workers away from their competitors. But it is unlikely that this approach will be sufficient to meet demand. Not only is the strategy impossible to sustain, but oil and gas is in competition for the same pool of talent with other industries.

Addressing the talent gap will require industrywide solutions that start with companies understanding the internal and external market forces at work. To that end, these pages summarize the results of the survey that consisted of 126 participants from 112 organizations with more than one million employees, representing a cross-section of company types in 50 countries.

SKILLS GAPS IN EXISTING WORKFORCE
Percentage of respondents facing a gap in the skill set identified

- Technical skills/Knowledge: 74%
- Leadership skills: 59%
- Communication skills: 46%
- Teamwork skills: 20%
- Supervisory/management skills: 65%
- Project management skills: 48%
- Risk management/quality assurance: 20%
- Supervisory/management skills: 65%
- Project management skills: 48%
- Risk management/quality assurance: 20%

TOP TALENT MANAGEMENT INITIATIVES UNDERWAY
Percentage of respondents selecting initiative

- Training & development: 31%
- Talent management & succession planning: 16%
- Workforce planning: 11%
- Retention: 10%
- Performance management: 10%
- Other: 8%
- Compensatory & incentives: 6%

PERCENTAGE OF COMPANIES ANTICIPATING A TALENT GAP
Industry perception of pending talent gaps across occupational groups

- Petroleum Engineers: 65%
- Plant/Operations Engineers: 61%
- Plant/Operations Managers: 55%
- Plant/Operations Technicians: 53%
- Geoscientists: 50%
- Upstream Project Managers (large-scale projects): 49%
- Upstream Technicians: 42%
- Finance Managers: 32%
- Sales and Traders: 31%
- Shipping/Maritime Leaders: 18%

Source: Mercer’s Global Oil and Gas Talent Outlook and Workforce Practices Survey. Mercer, like Oliver Wyman, is a subsidiary of Marsh & McLennan Companies.
# BLOWOUTS IN TEXAS

Texas has more blowouts in shale versus conventional operations...

<table>
<thead>
<tr>
<th>Year</th>
<th>Conventional Oil</th>
<th>Conventional Gas</th>
<th>Unconventional Oil</th>
<th>Shale Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>3</td>
<td>4</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>2</td>
<td>5</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>1</td>
<td>6</td>
<td>29</td>
<td>0</td>
</tr>
</tbody>
</table>

...and the number of blowouts is dramatically increasing.

Total blowout incidents in Texas...

- **2009**: 16
- **2010**: 18
- **2011**: 20
- **2012**: 11
- **2013**: 29

How much the number of blowout incidents in Texas increased from 2012 to 2013:

2.6x

Source: Railroad Commission of Texas, EIA, Oliver Wyman analysis.
INVESTMENTS REQUIRED FOR GERMANY’S ENERGY TRANSITION

RANGES FOR INFRASTRUCTURE, RENEWABLE POWER AND CONVENTIONAL POWER AND STORAGE, REFLECTING MULTIPLE SCENARIOS MODELED BY OLIVER WYMAN

ESTIMATED COSTS BY INVESTMENT AREA IN BILLIONS OF DOLLARS

Source: Network development plan 2013, 2nd draft, DENA distribution network study, Fraunhofer study “Electricity production costs of renewable energies” (2012), Oliver Wyman analysis.
Likely core investors for each technology based on their risk profiles

Actual vs. required return (WACC) in percent

Source: Dealogic, Oliver Wyman analysis.

* Mean of the risk-return profile, investments in higher risk (offshore wind) as well as lower returns (distribution network) are common.
## Estimated Financing Gaps for Germany’s Energy Transition

### Emerging Financing Gaps

**US$Billion**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Situation Until 2023</th>
<th>Situation Until 2033</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission Network</td>
<td>29.0</td>
<td>37.4</td>
</tr>
<tr>
<td>Conventional Generation and Storage</td>
<td>44.8</td>
<td>55.5</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>45.3</td>
<td>73.4</td>
</tr>
</tbody>
</table>

**Legend**
- Investment needed
- Cost recovery
- Financing gap

Source: Oliver Wyman analysis.
MEETING THE WORLD’S ENERGY FINANCING NEEDS

THE WORLD NEEDS $48.2 TRILLION IN ENERGY INVESTMENTS BY 2035
INVESTMENT NEEDED BY REGION
US$TRILLION
