Interdependencies In Aerospace, Energy, And Oil & Gas Markets

Implications For Advanced Materials Suppliers

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Key Trends In Aerospace, Oil & Gas, and Energy

Interdependencies & Implications
In Aerospace, Aircraft Production Is Projected To Reach 5,000 Units By 2017; Aeroengine Production Will Hit 10,000

Aggregate Production Market
2011-2021, By Market Segment

Aero-Engine Production Market*
2011-2021, By OEM

Source: ICF SH&E
Aerospace Raw Material Demand Will Ramp Up With Production

Aerospace Raw Material Demand Forecast

*Includes aluminum-lithium

Source: ICF SH&E
Consolidation Amongst Tier 4 Material And Process Suppliers Is Also Gaining Momentum

The Aerospace Manufacturing Supply Chain

Source: ICF SH&E Analysis
Aeroengine OEMs Are Making Significant Investments In New Generation Engines To Cope With High Fuel Prices

LEAP-X

- Fuel prices have more than tripled and are now 30-40% of airline cost structures
- CFM International and Pratt & Whitney are in a titanic battle to win orders on future generation single aisle aircraft
- CFM’s Leap-X is emphasizing thermal efficiency through advanced materials – including advanced alloys, ceramic matrix composites, and epoxy matrix composites
- Pratt is betting on enhanced propulsive efficiency through its innovative geared turbofan design
- The new engines are expected to yield ~15% fuel efficiency improvement

Sources: CFM, Pratt & Whitney
In Oil & Gas, Shale Gas Is The Largest Source Of Growth In Unconventional Gas Supplies In The US…

- Shale gas is by far the fastest growing type of unconventional gas production
- ICF expects unconventional gas to reach 77 Bcf/d by 2030

U.S. and Canadian Unconventional Gas Production

Source: ICF International Integrated Energy Outlook
...And In A Bullish Scenario, The Number Of Unconventional Wells Drilled Globally Could Increase 10X....

Under a “Golden Rules” scenario, the number of unconventional wells drilled globally could increase 10X by 2035

...And Could Fundamentally Restructure The Natural Gas Supply Structure...And Geopolitics

- In the IEA’s positive scenario, unconventional sources could be double conventional sources

- China and the US will account for a significant portion of new supply, reducing the importance of The Middle East & Russia

- Russia’s closure of the $15b Shtokman project could be a harbinger of these shifts

Investment In Deepwater Oil Platforms Will Grow Significantly

- Deepwater platforms will be a significant destination for new O&G investment.
- Significant developments are underway in numerous theatres.
- The upshot: deepwater requires ultra-high quality materials and components – especially since the Deepwater Horizon disaster.

Source: World Resources Institute
Falling Natural Gas Prices Are Influencing Energy, Where Coal To Gas Switching Increased Sharply In 2012

- Tumbling natural gas prices due to unconventional production have erased coal’s historical delivered cost advantage in key eastern generation markets
- As a result, U.S. gas-powered power generation increased its market share from 22% to 30% in one year
- The implication: greater industrial gas turbine demand and utilization

Sources: ICF analysis, Bloomberg, EIA
In The US, Natural Gas And Renewables Will Dominate Future Capacity Additions

- In all regions in the US, natural gas and renewables will be the only types of economic builds per ICF’s latest Integrated Energy Outlook.
- ICF does not project that any new nuclear capacity will be developed during the study.
- California will lead renewable growth.

Source: ICF Integrated Energy Outlook 2012

*PJM – regional transmission organization covering 13 states in Mid-Atlantic and Midwest
Globally, Investment In Energy Infrastructure Could Exceed $15 Trillion Through 2035

- The IEA anticipates in excess of $15T in energy infrastructure investment through 2035
- Power generation accounts for over half of the investment – worth $9T
- Much of the investment will be in developing economies

Source: WEO 2011; figures are for New Policies Scenario
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Key Trends In Aerospace, Oil & Gas, And Energy

Interdependencies & Implications
### Market Trends Create Important Implications…

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<th>Market</th>
<th>Trend</th>
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| **Aerospace** | • Large air transport backlog  
• Tier IV consolidation  
• Major investments in new fuel efficient aeroengines | • Larger, more capable suppliers with end-to-end capability  
• New materials and technologies will improve gas turbine efficiency for aero and energy applications |
| **Oil & Gas** | • Growth in unconventional supplies  
• Falling natural gas prices  
• Emphasis on deepwater oil…while improving safety in the post-Deepwater Horizon era | • Significant investment growth in unconventional equipment & infrastructure  
• Need to improve maintenance processes & quality |
| **Energy** | • Natural gas substitution for coal  
• Emphasis on natural gas & renewable for new capacity | • Increased demand for efficient combined cycle IGTs  
• Need for technology to improve efficiency and reduce emissions…at the right price  
• Growing IGT maintenance demand |

Source: ICF SH&E analysis
And Contribute To Interdependencies Between The Three Sectors

- Cutting edge aerospace technologies needed in energy
- Linkage between IGTs and aeroengines
- Massive energy infrastructure investment creates major new market for aerospace suppliers

- Cutting edge aerospace technologies needed in oil & gas
- Aerospace maintenance practices/standards needed by oil & gas
- Major O&G investment creates major new market for aerospace suppliers

Source: ICF SH&E analysis
Gas Turbines Are An Excellent Example Of Linkages Between Aerospace, Energy And O&G…

2011 Global Gas Turbine Production ($B)

Source: ICF SH&E analysis, Forecast International
...And Rolls-Royce Is An Example Of An Aeroengine OEM That Is Diversifying Into Other Markets

- Rolls has increased its business from non-aerospace sectors over the last decade
- In March 2011, Rolls-Royce and Daimler AG acquired Tognum (50-50 joint venture), which makes engines for O&G, mining, marine, power generators, military vehicles and locomotives
- In the same year, Rolls sold its stake in IAE to Pratt & Whitney & MTU; it also agreed to collaborate with Pratt on future geared turbofan designs
- Rolls-Royce is executing a diversification strategy

Source: Rolls-Royce
Allegheny Technologies Is An Example Of A Materials Supplier That Addresses All Three Markets

- ATI is a world-leading mission critical metallic supplier covering Ti, nickel alloys, stainless and exotic alloys
- One of the largest aeroengine and aerospace material suppliers
- Revenues from O&G/Processing and Electrical Energy increased from $1.15 → $1.89 B from 2009 to 2011
  - Growth in natural-gas fired IGTs
  - Increased directional drilling and deepwater exploration
- Created matrix organization to align capabilities and investment with markets

$5.2B revenue

11,500 employees

Other 35%
Aerospace & Defense 29%
Energy 15%
O&G & Processing 21%

Source: ATI
PAS Technologies is a 650 employee firm that has expanded into O&G and energy markets.

- PAS Technologies is an independent maintenance service provider focused on aeroengine parts repair and manufacturing.

- PAS has expanded its business in industrial gas turbine (IGT) and Oil & Gas (O&G) markets considerably in recent years; these markets now account for 30% of its revenue.

- Three factors aided expansion into O&G and energy:
  - Proprietary technology developed for aerospace including coatings in demand in IGT and O&G.
  - Aerospace quality standards is required by some customer segment.
  - Alignment with OEMs – works as partner rather than competitor.

Source: PAS Technologies
# Interdependencies Create Challenges And Opportunities

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<th>Organization</th>
<th>Implications</th>
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| Suppliers      | • Determine implications for strategy – are there opportunities to expand in adjacent markets? What are the implications of competitors that are diversifying?  
• Organize for success – how to best connect technologies with markets? |
| Service companies | • Aerospace-oriented service firms must determine if there are opportunities to take aerospace processes, technologies, and/or value propositions into these markets?  
• Energy and O&G firms: opportunity to play offense and expand into aerospace? How to play defense against new competitors? |
| Customers      | • Understand how interdependencies impact procurement and supply chain strategies – do they create new “pinch points?”  
• Seize opportunity to find new suppliers from adjacent markets  
• Determine how diversification strategies will affect supplier positioning, technology, and financial resources |

Source: ICF SH&E analysis
Thanks and Questions

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