Glimpsing the future(s): Transformation in the chemicals industry

Customer needs drive a new innovation age where chemical supply chains and materials respond to downstream developments.

Feedstock playing fields level out, and regional production hubs proliferate.

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In 2000, few would have predicted a US shale oil and gas boom disrupting global energy markets and making the US one of the world’s most attractive locales for petrochemicals production. Indeed, the next ten to 15 years could very well usher in further disruptions. Considering alternative future scenarios is the first step in deciding which strategies and investments to bet on in order to make disruptions work to one’s advantage. It’s especially important in the chemicals industry, where today’s decisions can have long-lasting implications.

The global chemicals market looks to grow robustly over the next decade, but we could certainly see a surprisingly different kind of growth for the industry looking ahead. What if we were to challenge commonly held assumptions and truisms about how the industry will grow—and turn conventional wisdom on its head? Of course, myriad scenarios could unfold, from the predictable and likely to the improbable...or even altogether unthinkable.

To discern what sorts of futures could potentially create disruption in the industry, we at PwC culled insights from our subject matter specialists across geographical and professional boundaries. Our pursuit was not to build a catalogue of alternative futures, but rather to take a close look at key uncertainties which could shape plausible yet highly disruptive future scenarios.

The two key uncertainties we examine here are a world in which:

1. **The customer forces a new innovation age**
   
   Downstream end-customer needs change manufacturing as we know it which, in turn, “pressure up” to upstream chemicals producers. This triggers a new golden age of materials innovation and reconfigured supply chains as chemical producers respond to meet those needs.

2. **Feedstock playing fields level out**
   
   No one region holds a decided energy/feedstock cost and supply advantage, in contrast to today’s dominance of a few regional suppliers. This opens the door to new entrants and more localized production globally.

Separately, either of these scenarios could trigger disruptions to the industry, even if not realized to the full extent. But, if both scenarios were to play out, the disruption could be compounded for all players in the chemicals industry—and their customers.
Key uncertainty 1: The customer forces a new innovation age

Signposts:

• Just as the baby-boomer generation sparked a movement for greener products, the millennial generation holds even higher demands and expectations for eco-friendly products—with over half of millennials globally willing to pay a premium for sustainable products. A product’s sustainability affects their purchasing decisions.1 Meanwhile, developing economies are moving to mitigate pollution and waste, making consumer-driven sustainability more of a global societal imperative. The significant changes we’ve already seen in the production of environmentally friendly products and services are just the beginning. We might see even heightened demand for materials that are part of the solution, not the problem.

• Technology advancements such as 3D printing, collaborative robots, and Industrie 4.0 are opening new possibilities for manufacturers to pursue small-batch, customized or “micro” manufacturing. Just consider that two-thirds of US manufacturers now adopt 3D printing in some way, and that 27% of global CEOs across industries agreed that 3D printing was “strategically important” to their organizations.2,3 These manufacturers are also looking to chemicals producers for new materials that lend themselves to these burgeoning technologies.

• Chemicals companies are, in turn, responding to the changing needs of their customers (e.g., the manufacturing and agriculture industries) and are pushing toward higher-margin products and after-sales services. Take chemicals giant Solvay Group, which is introducing 3D technology to Brazil’s automotive industry to ramp up the use of the technology to produce plastic auto parts with higher thermal and mechanical resistance.4 Promising efforts are also underway, for example, to bring the production of nanomaterials, such as graphene, up to commercial scale which could hold enormous potential for materials producers.5

For decades, the chemicals industry has largely moved in the direction of large, centralized, economies-of-scale production. But in the future, chemicals producers could compete more on how closely they collaborate with customers’ (and customers’ customers) needs for products that meet new preferences and values. In this scenario, then, will chemical companies need to pursue a business-to-consumer strategy? For example, if 3D printers become as commonplace as personal computers in the average household, could those consumers be purchasing their “inks” directly from large chemical suppliers? So, if one were to believe in such a future, most chemicals companies shift from being principally suppliers of product to collaborators in innovation with their customers. This is a path some companies, indeed, are already on.

Think of it as the downstream “pressuring up” to the upstream. Consider the growing societal preference and demand for smarter and greener products (affecting a wide swath of industries from retail and consumer, food and beverage, construction to automotive) which, in turn, places an

Who’s willing to pay extra for eco-products?

Percentage of each global demographic willing to pay a premium for sustainable products and services

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Willing to Pay Extra (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation Z (20 and under)</td>
<td>9%</td>
</tr>
<tr>
<td>Millennials (age 21-34)</td>
<td>51%</td>
</tr>
<tr>
<td>GenExers (age 35-49)</td>
<td>25%</td>
</tr>
<tr>
<td>Baby Boomers (age 50-64)</td>
<td>12%</td>
</tr>
<tr>
<td>Silent Generation (65+)</td>
<td>3%</td>
</tr>
</tbody>
</table>

Source: Investing in the future: Millennials are willing to pay extra for a good cause Nielsen company website, Nielsen, June 23, 2014.

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1 Investing in the future: Millennials are willing to pay extra for a good cause Nielsen company website, Nielsen, June 23, 2014.
2 3D printing and the new shape of industrial manufacturing, PwC, 2014.
4 Brazil’s plastics sector bets on innovation to overcome economic slump, Plastics News, May 19, 2015.
5 ORNL demonstrates first large-scale graphene composite fabrication, Oak Ridge National Laboratory, May 19, 2015.
Key Uncertainty 1: The customer forces a new innovation age

The customer forces a new innovation age upon chemicals companies to respond to—or, better, anticipate—demand for new materials, solutions, and applications. Also, disruptions in customers’ industries (Internet of Things, Industrie 4.0, 3D printing, to name a few) likewise exert pressure upstream, resulting in disruptions flowing up to the chemicals suppliers.

For instance, what if 3D printing were mainstreamed in Moore’s Law fashion—the way the slow, expensive oddity of the 1970s personal computer morphed into a quarter of the world carrying a computer (smart phone) in their pocket? To get to that future, 3D printers would need to work faster, be less expensive, improve resolution, improve mechanical quality and accept a far wider variety of materials beyond plastics—such as more metals, ceramics, nanoparticles, and “bio-inks”. If, say, “printing” human parts becomes a common practice, will it be the chemicals industry—or some other new entrant—collaborating with bio-medical researchers to make that happen?

How could this disrupt the chemicals industry? First, it would stand to reason that the industry would need to design a much more distributed supply chain to get materials to a new breed of customers—from industrial (3D printing “farms”), commercial (local post office, library, or drug store) to residential (hobbyist or do-it-yourself homeowner). Those chemicals suppliers anticipating and satisfying the needs in a world of ubiquitous 3D-printing manufacturing would naturally be best positioned to monetize such a disruption, instead of being left flat-footed or even displaced. Perhaps, the future is already upon us. Nearly four in ten US manufacturers believe it is likely that 3D printing will be used for high-volume production in the next five years, according to a recent PwC survey. If this is the case, then those manufacturers will need chemicals companies to supply the “inks” for that production.

Adding on to the global 3D printing market

Estimated global 3D printer industry

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>$4.1 bn</td>
</tr>
<tr>
<td>2016</td>
<td>$7.3 bn</td>
</tr>
<tr>
<td>2018</td>
<td>$12.7 bn</td>
</tr>
<tr>
<td>2020</td>
<td>$21.2 bn</td>
</tr>
</tbody>
</table>

Source: The 3D printing boom continues Manufacturer’s Monthly, May 15, 2015 (Note: figures cited from Wohlers Associates).

Note: The 3D printing industry includes the value of shipments of a range of printer market segments—from consumer desktop printers to industrial production-level printers.

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6 The role materials play in powering the 3-D printing revolution, PwC Technology Forecast, The future of 3-D printing, Issue 2, 2014, PwC.
7 3D printing and the new shape of industrial manufacturing, PwC June 2014.
So, in the context of this uncertainty, **the chemicals industry changes not only in innovative product, but also in innovative manufacturing.** Flexible manufacturing, for example, becomes a key differentiator, with modular, mobile production (“pop-up factories”) enabling swift pivots from one region to another, with fast turnaround of small-batch, “bespoke” products. Chinese appliance maker Haier, for example, recently opened its first “online factory” (in Qingdo) which links customers and the factory via the Internet to fulfill orders for customized washing machines. Taken a step further, DIY manufacturing (3D printing and robotics may be just the beginning of a massive “maker movement”) that could alter how, what, and where consumers buy. It follows, then, that chemicals companies most competitive in this scenario are those that prove most adaptable to their customers’ needs and have expansive geographical footprints while being flexible and innovative.

In this way, **a second golden age in chemical engineering opens.** The end customers set the pace for the development of next-gen blockbuster petro- and agro-chemical products, cheaper and more diverse portfolios of 3D inks, smart packaging, adaptive materials, and after-sales services. For example, advancements in “light-weighting” of auto and aircraft parts, and greater demand for environmentally safe products (e.g., lowered carbon footprint and biodegradable products) redoubles the mandate of chemicals producers to offer new solutions. This scenario also assumes an acceleration of “dematerialization,” with manufacturers working more closely with materials suppliers to help them make more with less. Just consider that in 1981 the personal computer weighed 1 kilogram with 16 KB computing power; by 2011, it shed its materials weight by 68%, yet grew in processing power by a multiple of 39 million. Furthermore, the demand accelerates for polymers and carbon composites used as “inks” for 3D printing or 4D reactive and adaptive materials.

To realize these changes, chemicals companies move to collaborate more tightly with a wide group of players—from downstream manufacturers to tech start-ups to academic research teams. A new set of players—offering a portfolio of solutions, intermediating between suppliers and end users—could emerge as well, further disrupting the industry.

**A few critical questions to consider…**

- **How far downstream do you need to participate to ensure you have right customer intelligence and touch points to preserve optionality / shape future?**
- **How are you expanding your capabilities around new services, solutions, and know-how (e.g., de-coupling knowledge from product, alliances)?**
- **How deeply is your R&D embedded into that of your customers to enable joint development of new products and services?**

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10 Stuff: when less is more, Harvard Business Review, March 2015 issue.
**Key uncertainty 2:**
**Feedstock playing fields level out**

**Signposts:**
- The 2014–2015 oil price fall has reduced the cost advantage of natural gas based petrochemicals production in the US.
- Some early pushback on shale in the US includes a NY State ban, plus bans or moratoria on hydraulic fracturing in municipalities and communities in other US states, including Colorado and California.
- Other economies are on path to develop their own shale—and non-shale—feedstock technologies, such as the promising coal-to-olefins technology in China and new “on-purpose” technologies for using heavy feedstocks.
- Some early success in alternative bio-based feedstock production (e.g., sugarcane, starch crops, vegetable oils) opens prospects for more diverse sourcing of feedstocks beyond fossil fuels. A new breed of start-ups further develops this technology; take the example of Renmatix, a small Philadelphia firm developing “renewable” biochemicals and fuel from hardwoods.\(^\text{11}\)

How many of us foresaw ten years ago that shale gas and oil activity in North America would hand local ethylene producers such a strong home-court cost advantage over their Asian and European counterparts? The US shale gale has resulted in massive cost savings for US manufacturers, with the chemicals industry a chief beneficiary.\(^\text{12}\)

Now that natural gas costs in the US are less than half of those in Europe and about one-quarter of those in Japan,\(^\text{13,14}\) much is being planned around the current state of affairs. PwC’s Strategy\& estimates US ethane feedstock and ethylene production could rise by 45% through 2025.\(^\text{15}\)

**Peak Fracking?**

15.3 million

Number of Americans living within one mile of a hydraulic fracturing well


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\(^{11}\) ICIS launches chemical industry Innovation Awards for 2014, ICIS News, April 22, 2014.


\(^{13}\) First Research Industry Profile, October 13, 2014.

\(^{14}\) Note: As of October 2014, Henry Hub Natural Gas Spot Price was $3.77 MBTU; Europe Natural Gas Import Price was $9.77 MBTU and Japan Liquefied Natural Gas Import Price was $17.77 MBTU. Source: World Bank, Commodity Market Report Index, October 2014. http://www.worldbank.org/content/dam/Worldbank/GEP/GEPCOMMODITIES/commodity_market_outlook_2014_october.pdf.

\(^{15}\) Global Petrochemical feedstock developments: implications for GCC players, Strategy\&/ PwC, 2011.
But, what if all this were surprisingly short-lived? If, for example, a balancing of global energy/feedstock costs unfolds in the wake of numerous events: successful coal-to-olefins development in China; a greater viability of bio-based feedstock such as sugarcane in Brazil; shale gas and oil being embraced in western Europe and exploited in Asia Pacific for lower-cost ethylene production in those regions; prolonged period of low oil prices? Such a scenario would erase or at least erode cost advantages for US-based chemicals companies, and possibly derail planned expansions in chemical production in the US and the Middle East.

Meanwhile, the feedstock playing field is further leveled through technology advancements to enable deployment of viable “on purpose” technologies to produce non-ethylene petrochemicals (propylene, butadiene, and benzene).

Thus, an altogether different energy landscape takes shape. The US and the Middle East lose their energy/feedstock cost advantage, with light and heavy feedstock prices balancing globally. This could come about through a combination of a few unfolding conditions: unconventional hydrocarbon drilling technologies could become successfully adopted in regions such as Europe, Asia, and Latin America; “petro-states,” notably Russia and Saudi Arabia, could alter global supply to depress oil prices, causing a pull-back from shale oil and gas drilling in North America as a result of it becoming less economically attractive.

Some 250 new US-based chemical projects valued at over $135 billion announced as of early 2015 from foreign companies.

Foreign companies had invested more in the US chemicals industry by the end of 2013 than in any other industrial sector—for the first time since 1997.\textsuperscript{16,17}

Map of basins with assessed shale oil and shale gas formations, as of May 2013

Source: United States basins from US Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.

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\textsuperscript{16} Year-end 2014 Chemical Industry Situation and Outlook, American Chemistry Council, December 2014.

\textsuperscript{17} R&A Briefing, PwC, March 2014.
Quite simply, the era of large geographical hubs and regional energy/feedstock cost advantages ends as the chemicals and energy industries become less inextricably linked. The result? Regions gain a greater degree of energy/feedstock independence and embark to build out domestic chemical manufacturing hubs unencumbered by cost disadvantages and supply constraints.

A highly competitive global race ensues to gain footholds in high-growth regions of developing Asia-Pacific, Africa, and Latin America, while US-based companies and Middle East producers reset strategies to compete. Local players, with access to affordable energy/feedstocks, ramp up their domestic chemicals industries. This scenario leaves unprepared US and European chemical suppliers then flat-footed in attempts to enter fast-growing regions in Asia and Latin America—after having made substantial investment in North America when feedstock cost advantages existed.

Succeeding in the context of this uncertainty will require close collaboration, localization and geographic segmentation, with a greater push by incumbents for new partnerships, alliances and M&A activity in Asia and Latin America, for example. Given the very high level of partnering, intellectual property protection becomes an increasingly important issue.

A few critical questions to consider...

- How aligned is your current footprint with feedstock advantaged regions?
- How diversified is your feedstock mix to preserve optionality for the future?
- How are you expanding your capabilities (M&A capabilities, manufacturing scale, flexibility, tailored supply chains etc.) to remain competitive in the future world?
- How are you positioned to scale up your regional footprints to become a local leader?
Thus far, we have explored two key uncertainties which could usher in disruptions in the global chemicals industry—feedstock costs and availability and customer pressures. These uncertainties can yield four distinct scenarios as summarized in the matrix, below:

**Plausible scenarios**

**Scenario 1: New Dawn for Chemicals**
- Material science revolution ushers in new golden age of chemical engineering
- Sustainable products capture significant share in most chemicals value chains
- Level playing fields for feedstock costs and availability invite new players focused on application know-how
- Impact on industry structure: value of integration diminishes
- Primary basis for competition: new solutions and services

**Scenario 2: Complex World**
- Selective penetration of sustainable products due to cost competitiveness issues
- Middle East and US maintain feedstock advantage
- Impact on industry structure: emergence of pure-play downstream focused players, value of integration remains but only for undifferentiated products
- Primary basis for competition: managing complexity (applications and supply chain)

**Scenario 3: Regionalized Industry**
- Limited pull for innovation either for novel materials or distributed supply chain
- Regionalized chemical industry based on locally competitive feedstock
- Sustainable products gain foothold in those regions where advantaged bio-feedstock allows cost-competitive substitutes to hydrocarbon
- Primary basis for competition: economies of scale and scope within the context of a regionalized industry

**Scenario 4: Status Quo**
- Limited pull for innovation for novel materials or distributed supply chain
- Global, integrated players dominate; specialties fragment
- Limited penetration of non-petroleum based chemicals
- Primary basis for competition: economies of scale and integrated value chain
How would your chemicals business flourish in alternative futures?

In an era of more frequent disruptions triggered by unprecedented societal and technological change, it is becoming more important for companies to imagine the unimaginable, to think through alternate futures. This thinking helps prevent companies from being surprised by disruptive developments and helps them take advantage instead of being blindsided.

We have painted a plausible future where the world would look quite different for chemical industry from today. There are, naturally, myriad additional futures to glimpse. Take, for example, the recent rise of shareholder activism in the chemicals industry: what kinds of futures is this portending? Could hedge funds, as with customers, “pressure up” to force change on chemicals companies? And, if so, what should companies do now if they believe that will lie in store in the future?

Considering plausible scenarios of the future may reveal what bets are the right ones to make today.
To have a deeper conversation about how this subject may affect your business, please contact:

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