China Advanced Coal Chemical Dynamics
Risks & Opportunities in Established Petro-Chemical

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Presentation to Olefins Asia 2014 – Exploiting opportunities in alternative feedstock
Agenda

1. Deloitte Chemical Credentials in China
2. China Advanced Coal Chemical Dynamics
3. Deloitte Chemical Team on the Call
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Note Monitor Deloitte China = Deloitte Strategy & Operation Consulting China
Deloitte Consulting has continuously analyzed both Global and China Chemical industry dynamics and regularly published corresponding reports (1/2)

Deloitte Chemical – Industry reports related to Global Chemicals 2020 report series

**Reigniting growth:**
Advanced Materials Systems

**End market alchemy:**
Expanding perspectives to drive growth in the global chemical industry

**The chemical multiverse:**
Preparing for quantum changes in the global chemical industry

**The decade ahead:**
Preparing for an unpredictable future in the global chemical industry

Source: Deloitte Consulting
Deloitte Consulting has continuously analyzed both Global and China Chemical industry dynamics and regularly published corresponding reports (2/2)

Energy & Chemical Industry viewpoint from Monitor Deloitte

Chemical Quarterly - All quarterly articles are supported by slide presentations available to clients upon request

Methanol (2011) ; China Chemical Industry 2.0, Industrial and specialty gas (2012) ; Fertilizer (2013); Special edition on environmental science in 2012 (Solid waste treatment, Water treatment); Special edition on oil & gas in 2013 (Shale gas, petrochemicals…)

Source: Monitor Deloitte
Agenda

1  Deloitte Chemical Credentials in China

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This paper focuses on established chemicals that leverages the coal gasification route so called advanced coal chemical by NDRC (CTO/MTO and CEG)

China coal chemical technology map (2012)

Coal-to-fertilizer (via synthetic ammonia) is considered as a traditional coal-to-chemical, experiencing already high over-capacity in China and got de-prioritized by the Chinese administration / regulator

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO
A broad range of players are trying to enter China's advanced coal-chemicals, but based on which fundamentals and other specific business rationales?

Executive summary – China Advanced Coal Chemical (2013)

**Driving forces**

- **Dependence**: China decided to exploit rich coal resource for Chemicals as part of its multi-feedstock approach and to reduce the NOC dominance that could limit material input for the downstream sectors
- **Import**: China has experienced a structural supply / demand unbalance and has kept increasing import volume of major olefin derivatives (PE, PP and EG) – identified as market opportunities
- **Supply**: Chinese CTX technologies have improved dramatically via increasing popularity and investments, with interest from all industry stakeholders (Oil, Coal, Power and Chemical player)

**Structural challenges**

- **Competition**: Chinese NOC have taken a clear positioning on advanced coal chemical: Sinopec (CTO/CEG), CNOOC (SNG) and Petrochina (recently on synthetic fuel ethanol)
- **Overcapacity**: The biggest challenge in China [coal-] chemical sector is shorter window of opportunities leading to overcapacity risks, especially in commodity segments
- **Environment**: CTO is pushed by the China administration in an structured approach by setting some barriers to ensure asset efficiency and environmental protection

**Evolving performance**

- **Profitability**: levels of advanced coal chemicals look highly attractive at first, but the journey to reach them is long and their sustainability can be challenged (coal and oil price, carbon tax…)
- **Operation**: Past projects typically had a long time to ramp up before being fully operational, with low to medium utilization rate in the first years
- **Quality**: Chinese coal-chemical technology have reached a certain level of maturity in polyolefin commodities, but still need to catch up on EG and polyolefin specialties

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO, Monitor Deloitte analysis
Considering huge energy demand to support GDP growth, China decided to exploit rich coal resource for Chemicals as part of its multi-feedstock approach.

China energy consumption and global oil price

China energy mix (2012)

- **Coal**: 69%
- **Oil**: 18%
- **Natural gas**: 5%
- **Others**: 9%

100% = ~ 3,620 MTCE (Million Ton Coal Equivalent)

- **Source**: Deloitte Chemical Quarterly 2012 Q4 China CTO

Global crude oil price evolution* (2009–2013)

- Oil price increased dramatically between 2009 and 2011, and has kept fluctuating since then, with import still represents >50% of China oil demand.

- **Source**: Deloitte Chemical Quarterly 2012 Q4 China CTO
China olefin sector is highly consolidated and dominated by 2 NOCs (Sinopec / CNPC) that could limit material input for the overall downstream industries.

### China olefin (ethylene + propylene)

#### Consumption value (2005-2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>Net import (billion RMB)</th>
<th>Production (billion RMB)</th>
<th>Total (billion RMB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>1%</td>
<td>99%</td>
<td>107</td>
</tr>
<tr>
<td>2010</td>
<td>9%</td>
<td>91%</td>
<td>240</td>
</tr>
</tbody>
</table>

CAGR +17%

#### Capacity breakdown (2010)

<table>
<thead>
<tr>
<th>Share</th>
<th>Capacity (100% = ~ 29 mta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinopec</td>
<td>55%</td>
</tr>
<tr>
<td>CNPC</td>
<td>26%</td>
</tr>
<tr>
<td>CNOOC</td>
<td>8%</td>
</tr>
<tr>
<td>Shenhua</td>
<td>3%</td>
</tr>
<tr>
<td>Other domestic players</td>
<td>5%</td>
</tr>
<tr>
<td>Foreign share (JV)</td>
<td>~2%</td>
</tr>
</tbody>
</table>

Note: Ethylene (~15mn tons) and Propylene (~14mn tons) comprise the overall capacity.

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO
China has experienced a structural supply / demand unbalance and has kept increasing import volume of major olefin derivatives (PE, PP and EG)

### China consumption volume of olefin derivatives (2005–2010)

<table>
<thead>
<tr>
<th></th>
<th>Polyethylene</th>
<th>Polypropylene</th>
<th>Ethylene Glycol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit:</strong> million Tons</td>
<td><strong>Unit:</strong> million Tons</td>
<td><strong>Unit:</strong> million Tons</td>
<td></td>
</tr>
<tr>
<td><strong>2005</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td>50%</td>
<td>37%</td>
<td>78%</td>
</tr>
<tr>
<td><strong>Net import</strong></td>
<td>50%</td>
<td>63%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>2010</strong></td>
<td>59%</td>
<td>70%</td>
<td>73%</td>
</tr>
</tbody>
</table>

CAGR +11%  
CAGR +9%  
CAGR +12%

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO
CTO/MTO has shown interest across different industry stakeholders (Oil, Coal, and Chemical) with players participating on a stand-alone basis or via co-operation.

China CTO industry mapping considering sector of origin (2012, non-exhaustive list of players)

- CTO has shown interest across different industry stakeholders (Oil, Coal, and Chemical)
  - Coal players: leverage their own abundant coal feedstock eg Shenhua, Huating and Huaihua
  - Power players with solid presence in coal mine willing to get into deregulated sectors – follow the coal player pattern eg Datang [top 5 coal power player in China] and Luneng
  - Oil players to secure presence in alternative energy: leverage existing olefin sales channel
  - Chemical players [with coal related business already] eg Jiutai chemical (DME from coal via Methanol)
- All those players participate in CTO projects on a stand-alone basis or via co-operation to leverage resources & capabilities across parties and share large-size investment
  - Coal/Oil: China Coal and ShaanXi YanChang ; CPI ([Coal] power) and Total, using Total MTO tech. that has been in pilot in Belgium
  - Coal/Chemical: Shenhua and DOW, using DOW UNIPOL polypropylene technology, currently on stand-by due to other priority investments for Dow

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO
The biggest challenge in China [coal-] chemical sector is shorter window of opportunities leading to overcapacity risks, especially in commodity segments

Coal-based [petro]chemicals – China capacity dynamics (2010-2015)

- China demand growth for overall chemicals will continue at a slower pace than in the past (>25% p.a.), but the growth will be still sizeable in absolute value (+USD 130-160 bn annually in nominal value)…
  - There will be growth, but opportunities will not be as easily found as before…
  - …with emerging structural imbalance of some domestic production though selective

- China olefin industry may face already some overcapacity by 2015 due to heavy investments in petro & coal route (CTO), that could be worsened by MTO & PDH projects (PDH seems less of a threat in the short term since feedstock access a key constraint)…
  - In a first approach the 2015 utilization rate of the China olefin industry (86%-93%) seems to be manageable (90% average target for a cracker), but a lot of assumptions are optimistic
  - Upside is that most if not all CTO/MTO projects are forward integrated into polyolefin where import ratio is extremely high (requirements for Chinese players is to be competitive as compared to Middle-Eastern)

- …but the biggest challenge is lack of awareness from domestic players regarding the industrial project
  - Limited sales & marketing awareness of most of the new entrants (they focuses on manufacturing!)
  - Limited awareness of risks related to methanol imports from SEA or North America (shale gas boom)

- China EG capacity will become more fragmented with coal–based new entrants, with 3.5+ million tons new expected capacity before 2014 – the EG domestic supply demand delta will reduce but still remain
  - Requirements for Chinese players is to be competitive as compared to Middle-Eastern

Source: Deloitte Chemical Webcast 2012 Q3 China Chemical 2.0, Deloitte Chemical Quarterly 2012 Q4 China CTO
China olefin industry may face already some overcapacity by 2015 due to heavy investments in petro & coal route, that could be worsened by MTO & PDH projects

China olefin capacity\(^1\) 2010 vs.2015 (as of Oct 2012)

Unit: mn tons

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity</th>
<th>New capacity</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>31</td>
<td>20</td>
<td>51</td>
</tr>
<tr>
<td>2011-2015</td>
<td>53</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td>53</td>
<td>51</td>
</tr>
</tbody>
</table>

13th 5YP

After 2016

Projects announced
In design or construction

+++

Utilization rate

86%

After 2016

Projects announced
In design

+++ 58

After 2016

Projects announced
In design or construction

1.3

1.3mt under construction and likely to be completed

93%

China olefin industry may face already some overcapacity by 2015 due to heavy investments in petro & coal route, that could be worsened by MTO & PDH projects.

Major uncertainty before 2015: Developments of MTO projects since they are not yet regulated!

Major uncertainty after 2016: Developments of PDH projects ~4.7mta announced (10+ projects)!

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO

Note: 1) Operative capacity with approval of production from regulatory bodies
Even in water-sufficient regions (Guizhou, Xinjiang and Anhui), access can be challenging (Xinjiang water is only rich in Yili area, far away from the coal reserves).

As China’s major coal resources reserve and production base, Ordos (Inner Mongolia) has proven reserves of 150bn tons of coal of fair quality for both power generation and coal gasification. Statistics from Asiachem show that during 2011-2015, the available water capacity in Ordos is about 2.4 billion t/a, which can basically meet the water demand of the local coal chemical projects.

China Coal-to-Olefin – Comparison of coal basic reserve and water supply for selected provinces (2010)

Ordos (Inner Mongolia) a center of gravity for CTX projects (including CTO), due to sufficient water access and abundant coal reserves of fair quality.

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO

**basic reserve refers to the total mine volume of a discovered reserve that is technologically or economically feasible to extract at the given time.

Note: * selected provinces are the 8 provinces with most coal reserve in China.

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The profitability levels of advanced coal chemicals looks highly attractive at first, but the journey to reach them is long and their sustainability can be challenged.

Executive summary – Business profitability of China Advanced Coal Chemical (2013)

**Theoretical superiority**
- In a first approach, China production of established petro-chemicals via the coal route is quite profitable with a better cost position than the naphtha route (15 to 30 pts average delta margin)
  - CTO gross margin: ~35% gross margin 2011 Apr/ 2012 Apr (monthly volatility STD +/-10pts)
  - CEG gross margin: ~48% gross margin 2012 Jan/ 2012 Dec (monthly volatility STD +/-2pts)
- Break-even point (EBIT margin = 0) estimated at USD 80-85 per barrel for the oil price

**Operational challenges**
- Past projects typically had a long time to ramp up before being fully operational, with low to medium utilization rate in the first years:
  - Typically between 40% and 60% the first year
  - Then between 60% and 75% in the following year
  - After 2-3 years, can enter production cruising mode (continuous process)

**Long-term risks**
- The sustainability of China CTO & CEG profitability require to manage uncertainties:
  - Carbon tax (CTO: 7 tons more carbon emission per ton olefin as compared to the petro route)
  - Coal and oil price volatility
  - Competitive imports from countries with low-cost advantages (Middle-East and US)
  - Logistics flow & costs evolution (or not) between coal (feedstock) and chemicals (finished product)

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO, Monitor Deloitte analysis
In a first approach, China CTO seems to display a fair profitability but is highly volatile depending on coal and oil price levels.

China CTO profitability analysis (DMTO–II technology, 85% utilization, 0.7 mta capacity)

Gross margin PROFORMA

<table>
<thead>
<tr>
<th>Unit: RMB/ton, price excluding VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>~35% gross margin 2011 Apr/ 2012 Apr (monthly volatility STD +/-10pts)</td>
</tr>
</tbody>
</table>

Considered drivers: Olefin price, Coal price and by–product price

EBIT margin sensitivity analysis

<table>
<thead>
<tr>
<th>Oil price USD/Barrel</th>
<th>80</th>
<th>100</th>
<th>120</th>
<th>140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal price RMB/Ton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>–3%</td>
<td>26%</td>
<td>41%</td>
<td>51%</td>
</tr>
<tr>
<td>500</td>
<td>–11%</td>
<td>20%</td>
<td>37%</td>
<td>48%</td>
</tr>
<tr>
<td>600</td>
<td>–19%</td>
<td>14%</td>
<td>33%</td>
<td>44%</td>
</tr>
<tr>
<td>700</td>
<td>–28%</td>
<td>9%</td>
<td>28%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Note: Production cost is net of by–product sales; Use Anthracite coal price in Tianjin port (price shown includes VAT)

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO
Access to the railway capacity and associated freight prices are key drivers to understand in the transportation challenges of coal chemicals in China

China planned railway system during the 12th 5-Year-Plan Period (2013)

- Currently China has the 2nd longest railway system in the world and plans to further increase logistics capacity
  - 98,000 km railways in 2012, planned to reach 120,000 km by 2015
- Government investment is the major driver for the drastic expansion of railway system
  - From 2002 to 2012, the fixed asset investment for railway has been growing at a CAGR of 25%
- China's railways are concentrated in coal production centers in North China
  - In Shanxi, Shaanxi and Inner Mongolia, there are 15 trunk railway lines across the 3 provinces
- The construction of High Speed Rail will greatly release freight logistics capacity of existing railway ways
  - The completion of “4 Vertical and 4 Horizontal High Speed Railway Lines” will release 500 mn ton logistics capacity

In central China (North West), Chemical logistics offering is currently under capacity with several providers investing heavily to build truck fleets – while some coal chemical players have in-house logistic capabilities (network breadth), and expands with warehouses (network depth) in Eastern China

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO
Chinese coal-chemical technology seems to have reached a certain maturity level in polyolefin commodities, but still need to catch up on EG & polyolefin specialties

Coal-based petrochemicals – Process technology (2013)

China polyolefin (PE+PP)  
- DICP Commodity (2013)
- DICP Specialty (2013)
- KBR (2013)

China MEG  
- KBR (Olefin)
- Japan High Chem tech (2013)
- Danhua (2013)

Technology Progress

Time/Cumulative Effort

Embryonic  Growth  Mature  Ageing

Coal route (MTO)

Coal route (DMO)

Oil route

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO, Monitor Deloitte analysis
A broad range of players are trying to enter China's advanced coal-chemicals, but urgent need to carefully review all the dimensions of their investments

Executive summary – China Advanced Coal Chemical (2013)

- China advanced coal chemical industry for established petro-chemical products has already started and will sustain in the long run as part of the multi-feedstock approach
  - To reduce dependence and ensure material input for the downstream sectors

- China is pushing for the development of this sector in an structured approach…
  - By setting some barriers to ensure asset efficiency and environmental protection

- …and its development will be closely monitored and adjusted from an olefin perspective
  - But the development will not be at the expense of the traditional petrochemical where the past (and future) investments are significant [long-term asset exposure]

- Expect to have winners and losers in China coal chemical sector in the mid /long-term
  - Any existing players and new entrants will need to carefully review all the dimensions of their investments and search for any sustainable competitive advantage(s) considering various uncertainties (coal and oil price, carbon tax, transportation, etc)

Source: Deloitte Chemical Quarterly 2012 Q4 China CTO, Monitor Deloitte analysis
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For any further questions, Please contact the Deloitte Chemicals team!

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