## Contents

<table>
<thead>
<tr>
<th>Background and objectives of the study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
</tr>
<tr>
<td>Stage 1</td>
</tr>
<tr>
<td>Development of the cluster alternatives</td>
</tr>
<tr>
<td>Benchmarking of the international clusters</td>
</tr>
<tr>
<td><strong>Stage 2</strong></td>
</tr>
<tr>
<td>Strategically imperative products</td>
</tr>
<tr>
<td>Cluster attributes and key performance criteria</td>
</tr>
<tr>
<td>Cluster land use and logistics</td>
</tr>
<tr>
<td>Cluster marketing strategy</td>
</tr>
<tr>
<td>Conclusions and next steps</td>
</tr>
</tbody>
</table>
Project Goals were formulated to address the major issues

- Develop world-class eco-industrial chemical cluster alternatives for the Greater Edmonton Area

- Leverage Kline’s understanding of the international chemical industry, chemical markets, and the competitive environment to quantify and qualify the potential in the Greater Edmonton Area

- Develop an objective view of Alberta’s potential for the development of a world class chemical cluster in the Greater Edmonton Area

- Benchmark the best in class clusters in order to input key learning’s into the Greater Edmonton Area’s cluster

- Encourage a coordinated, integrated cluster development strategy for the Greater Edmonton Area

- Evaluate the strategic and economic impact of the cluster alternatives, with a view to eliminating associated risks

- Set a clear path to action and results
Adding value downstream: Convincing the international oil refining and chemical industry to invest downstream is the key challenge.
Stage 1 Provided the Platform for Action – Stage 2 Addressed the Action

**Stage 1: Developing the Cluster Alternatives**

1. Lay the Groundwork
   - Build understanding of the potential with the regional players at Stakeholder leader and working group levels
   - Lay a solid foundation for the project in terms of process, team interactions, communications and knowledge base

2. Define the Context and Develop Concept
   - Develop the integration opportunities based on Value Chain analysis
   - Evaluate the Market opportunities
   - Benchmark against best practice clusters
   - Develop alternative cluster concepts
   - Review cluster alternatives with Steering Group and Stakeholder groups
   - Recommend cluster alternative

**Stage 2: Selection, Promotion and Acquisition Strategies**

3. Cluster Marketing Strategy and Investor Acquisition Strategy
   - Develop the Cluster Key Attributes and Key Performance Criteria to ensure it is “Investor Ready”
   - Select cluster alternative
   - Prioritize Products for investment
   - Identify target investor groups
   - Review/ provide key inputs to the Steering Group on the marketing and promotion strategy
   - Develop investment acquisition strategy

4. Investment Acquisition Support
   - Develop a comprehensive investment acquisition support program to enable Greater Edmonton to implement the Cluster marketing strategy in:
     - Pre-Start Up Phase
     - Start Up Phase
     - Post Start Up Phase
   - Recommend Additional expertise required to fully implement the investment acquisition strategy

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The scope of this study

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Development of the cluster alternatives

Contents

<table>
<thead>
<tr>
<th>Summary Stage 1</th>
<th>Development of the cluster alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background and objectives of the study</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategically imperative products</td>
</tr>
<tr>
<td>Cluster attributes and key performance criteria</td>
</tr>
<tr>
<td>Cluster land use and logistics</td>
</tr>
<tr>
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</tr>
<tr>
<td>Conclusions and next steps</td>
</tr>
</tbody>
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Key Underlying Assumptions: The development of the Cluster Alternatives are based on several key assumptions (1/2)

- Bitumen Upgrading will exceed 3.0 million BBL/day by 2020 and Upgrader bottoms production will exceed demand for:
  - Energy generation in the region (as bottoms or coke)
  - Energy generation in export markets (as coke)

- **Outcome:** this will result in 300 000*- 750 000 BBL/day “Stranded Upgrader Bottoms” in Alberta

* Coke

**Whilst this appears to be a problem - this is the key opportunity for Alberta to become the leading Syngas production region in the world**

This is the underlying opportunity
Key Underlying Assumptions: The development of the Cluster Alternatives are based on several key assumptions (2/2)

- **Additional refinery capacity** will be added in Alberta, serving export markets
- **Pipeline infrastructure** will be expanded to include clean products and possibly olefins
- **Upgrader and refinery off-gases** will become increasingly important sources of petrochemical feedstock
- **Gasoil** and possibly Naphtha will become feedstocks of choice for crackers in North America due to dwindling economic supplies of Ethane
- **Methane** will be an increasingly uneconomic source of hydrogen for Upgraders, Refineries and Petrochemical producers

Unlocking Alberta’s Downstream chemical potential requires the industry to recognize the opportunities that “unconventional” raw materials and feedstocks provide.
## Product Flows from Primary Raw Materials (generic)

<table>
<thead>
<tr>
<th>RAW MATERIALS</th>
<th>FEEDSTOCKS</th>
<th>BUILDING BLOCKS</th>
<th>COMMODITIES</th>
<th>INTERMEDIATES</th>
<th>FINAL PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas / Crude Oil / Bitumen / Condensate</td>
<td>C1</td>
<td>Methane / refinery residue</td>
<td>Synthesis Gas</td>
<td>Methanol, Ammonia, Formaldehyde</td>
<td>Glues, Resins, Polymers</td>
</tr>
<tr>
<td>Natural Gas / Crude Oil / Bitumen / Condensate</td>
<td>C2</td>
<td>C2-C3 / Naphtha</td>
<td>Ethylene</td>
<td>EDC, VCM, Ethylene oxide, PVC</td>
<td>Polymers, Copolymers, Polyols</td>
</tr>
<tr>
<td>Natural Gas / Crude Oil / Bitumen / Condensate</td>
<td>C3</td>
<td>C2-C3 / Naphtha</td>
<td>Propylene, propane</td>
<td>Polypropylene Oxide, Butanols</td>
<td>Polymers e.g. Polyurethane</td>
</tr>
<tr>
<td>Crude Oil / Bitumen</td>
<td>C4</td>
<td>Refinery off-gas / Naphtha</td>
<td>Mixed C4</td>
<td>Butadiene</td>
<td>Butadiene, Styrene</td>
</tr>
<tr>
<td>Crude Oil / Bitumen</td>
<td>C6</td>
<td>Naphtha</td>
<td>Benzene, Toluene</td>
<td>Ethyl Benzene, Styrene, BPA, Polybutadiene</td>
<td>Epoxies, Polyurethane</td>
</tr>
<tr>
<td>Crude Oil / Bitumen</td>
<td>C7,8</td>
<td>Naphtha</td>
<td>Mixed Xylenes</td>
<td>O, P-Xylene, PA, PTA</td>
<td>PET</td>
</tr>
<tr>
<td>Sea water / Brine</td>
<td>CI</td>
<td>Chlorine, NaOH</td>
<td>EDC, MDA</td>
<td>VCM, MDI</td>
<td>PVC, Polyurethane Chlorides</td>
</tr>
</tbody>
</table>

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We arrived to 77 products from initial 140 after three consecutive screens focusing on different set of criteria.

Initial universe of over 140 potential products

1st Screen selection (110 products still under consideration)

2nd screen selection (90 products)

Final screen & Kline recommendation (77** products)

** Of 77 chemicals selected, 18 are already made in Alberta

Most Viable Growth Options, Strategically Imperative Products

Detailed product analysis

NEXT STEPS
- Further investigation
- Feasibility studies

DESIRED ATTRIBUTES
- Profitable
- Technology available

DESIRED ATTRIBUTES
- Clear growth drivers
- No excess capacity in the US
- Good cluster Integration potential

MUST HAVE ATTRIBUTES
- Scale
- Domestic market critical mass
- Demand Growth rate
- Import substitution potential US
## Contents

<table>
<thead>
<tr>
<th>Summary Stage 1</th>
<th>Development of the cluster alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benchmarking of the international clusters</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategically imperative products</td>
<td></td>
</tr>
<tr>
<td>Cluster attributes and key performance criteria</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Conclusions and next steps</td>
<td></td>
</tr>
</tbody>
</table>
A Cluster benchmarking study was performed to provide “key learnings” for Greater Edmonton

- A number of key attributes were identified to characterize the world class clusters
- These attributes are considered as the “Key Performance Drivers” - high scores on these attributes are expected to result in a very successful cluster
- A qualitative rating of these attributes enabled a high level comparison between the clusters
- This provided an understanding of why these clusters are successful
- The following clusters were reviewed in this study:
  - Antwerp, Belgium
  - Houston, Texas, USA
  - Jurong Island, Singapore
  - Tarragona, Spain
  - Chemsite, Ruhrgebiet, Germany
  - Chemelot, Geleen, Netherlands
  - SCIP : Shanghai Chemical Industry park, China
Key insights: The detailed analysis highlighted several important “key insights” for Greater Edmonton

- **Government participation and leadership** helps in the overall growth of the cluster in a phased manner.
- The establishment of a **"cluster promotion body"** can be a **key success factor** (stakeholder representation & strong leadership).
- **Involving global players** early in the cluster development helps in achieving faster cluster growth & stronger integration.
- Better **cluster integration** together with **product diversity** helps increase efficiency in material flow and reduce supply chain costs.
- **Good infrastructure** is common to all world class clusters.
- **Limited cluster scale** (e.g. Tarragona) can be **compensated by a less diversified, yet fully integrated, product range**.
- Most clusters **serve a large geographical area, shipping mostly final products** rather than commodities or intermediates.
- **Most successful clusters are purpose built**.
- All clusters have strengths and weaknesses, the **key is to progressively and consistently focus on the promotion and development of strengths**.
## Contents

<table>
<thead>
<tr>
<th>Summary Stage 1</th>
<th>Development of the cluster alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background and objectives of the study</td>
<td>Benchmarking of the international clusters</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Strategically imperative products</th>
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<td></td>
</tr>
<tr>
<td>Cluster marketing strategy</td>
<td></td>
</tr>
<tr>
<td>Conclusions and next steps</td>
<td></td>
</tr>
</tbody>
</table>
Strategically imperative product selection assumptions

**Scale**
- Sufficient size and potential to support *world-scale investment* either as the basic feedstock and/or as commodity products
- Recognition of the additional potential for development of ‘mega’ investments (Mega Methanol, MTO/MTP)

**Products**
- Selected chemicals may be dependent on the availability of basic feedstock and therefore **not classified as strategically imperative** (high performance polymers, urethanes, polycarbonates, PET, plasticisers)

**Feedstock**
- Gasification of Upgrader Bottoms to syngas
- Refinery *Off-gas* production
- *Naphtha cracking* (from SCO)
- Combined *bitumen upgrading/hydrocracking/hydrotreating and gasification* (potential extension of NorthWestUpgrading type development)

**Technology**
- New technology may produce *alternative routes for commodities*:
  - MTO/MTP for polyethylene(s) and polypropylenes
  - *Reconfiguration of Upgraders* to generate petrochemical feedstock (e.g. syngas)
From the initial screening 31 products can be regarded as “strategically imperative”

<table>
<thead>
<tr>
<th>RAW MATERIALS</th>
<th>FEEDSTOCKS</th>
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</tr>
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<td>Natural Gas/ Crude Oil / Bitumen/ Condensate</td>
<td>C1 Methane/ refinery residue</td>
<td>Syn Gas</td>
<td>Methanol Ammonia</td>
<td>Acetic Acid Urea, AN</td>
<td>VAM UAN</td>
</tr>
<tr>
<td>Natural Gas / Crude Oil / Bitumen/ Condensate</td>
<td>C2 C2-C3/ Naphtha</td>
<td>Ethylene</td>
<td>Ethylene Oxide</td>
<td>EG Polyethylenes**</td>
<td></td>
</tr>
<tr>
<td>Natural Gas / crude Oil / Bitumen Condensate</td>
<td>C3 C2-C3/ Naphtha</td>
<td>Propylene</td>
<td>Propylene Oxide</td>
<td>Polypropylene</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>Crude Oil/Bitumen</td>
<td>C4 Refinery off-gas/ Naphtha</td>
<td>Butanes Butenes</td>
<td>Maleic Anhydride</td>
<td>Glycols</td>
<td></td>
</tr>
<tr>
<td>Crude Oil/Bitumen</td>
<td>C6 Naphtha</td>
<td>Benzene</td>
<td>Cyclohexane Phenol Cumene</td>
<td>BPA</td>
<td></td>
</tr>
<tr>
<td>Crude Oil/Bitumen</td>
<td>C7,8 Naphtha</td>
<td>Toluene</td>
<td>o-Xylene p-Xylene</td>
<td>PTA Phthalic Anhydride</td>
<td></td>
</tr>
</tbody>
</table>

*Derived from initial 77 chemicals selected plus polypropylene

** Includes LDPE, LLDPE and HDPE

Total: 31*
31 strategically imperative products are further prioritised based on a combination of strategic fit to Alberta and ease of implementation.

What is the order of priority among strategically imperative products?

Ability to realize the opportunity

Strategic fit to Alberta

- Derivatization potential
- Integration potential
- Technology availability
- World scale production potential
- Environmental footprint

Timing to realise the opportunity

Ease of Implementation

- Time to set up production
- Ease to deliver the product to market
Prioritisation of strategically imperative products: North American context

Strategically imperative products

Bubbles proportional to estimated market size, 2007
Prioritisation of strategically imperative products: Global context

Strategically imperative products

Bubbles proportional to estimated market size, 2007
The road map envisages a stepwise development with a number of critical investment milestones.
Key building blocks and commodities top the list of priority investment projects

<table>
<thead>
<tr>
<th>Key Investments/Value Chain/Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasification</td>
</tr>
<tr>
<td>Refining</td>
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<tr>
<td>Naphtha Cracking</td>
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<tr>
<td>Refinery Off-gas</td>
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<tr>
<td>C1</td>
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<tr>
<td>C2-C8</td>
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<tr>
<td>C2-C8</td>
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<tr>
<td>C4, C6-C8</td>
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<tr>
<td>Strategically imperative products</td>
</tr>
<tr>
<td>Acetic Acid</td>
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<tr>
<td>Acrylic Acid</td>
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<tr>
<td>Ammonia</td>
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<tr>
<td>Ammonium Nitrate</td>
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<tr>
<td>Benzene</td>
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<tr>
<td>Butanediol (BDO)</td>
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<tr>
<td>BPA</td>
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<tr>
<td>Butenes</td>
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<td>Butanes</td>
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<td>Toluene</td>
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<td>Cumene</td>
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<tr>
<td>Cyclohexane</td>
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<td>Ethylene</td>
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<td>Ethylene Glycol</td>
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<td>Ethylene Oxide</td>
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<tr>
<td>Maleic Anhydride</td>
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<tr>
<td>Methanol</td>
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<td>Polyethylenes</td>
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<td>Polypropylene</td>
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<td>Propylene Oxide</td>
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<td>Propylene Glycol</td>
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<tr>
<td>Phenol</td>
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<td>Phthalic Anhydride</td>
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<tr>
<td>p-Xylene</td>
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<td>UAN</td>
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<tr>
<td>Urea</td>
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<td>VAM</td>
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<tr>
<td>Acetone</td>
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<td>Acrolein</td>
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<tr>
<td>Acrylic acid esters</td>
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<td>Acrylate polymers</td>
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<td>Adiponitrile</td>
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<tr>
<td>Aniline</td>
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<tr>
<td>Bisphenol A</td>
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<td>Butyraldehyde</td>
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<tr>
<td>Di-isooctyl phthalate (DIOP)</td>
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<tr>
<td>Dimethyl carbonate (DMC)</td>
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<td>Dimethyl ether (DME)</td>
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<tr>
<td>Dioctyl phthalate (DOP)</td>
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<td>DPC</td>
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<tr>
<td>2-Ethyl Hexanol (2-EH)</td>
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<td>Ethoxylates</td>
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<td>Ethylene Glycol Ethers</td>
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<tr>
<td>Caprolactam</td>
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<tr>
<td>EVA Copolymers</td>
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<tr>
<td>EVOH</td>
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<tr>
<td>Formaldehyde</td>
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<tr>
<td>Gamma-Butyrolactone</td>
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<tr>
<td>IPA (isopropanol)</td>
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<tr>
<td>Isooctane</td>
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<tr>
<td>Linear Alpha Olefins (LAOs)</td>
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<tr>
<td>Melamine</td>
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<tr>
<td>Melamine resins</td>
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<tr>
<td>Mixed C4 / Butane</td>
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<td>MDI</td>
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<tr>
<td>MMA</td>
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<tr>
<td>Nitrobenzene</td>
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<td>N-Methylpyrrolidone (NMP)</td>
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<td>Nylon-6 (PA -6)</td>
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<td>Nylon-6, 6 (PA- 66)</td>
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<td>PET</td>
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<td>PMMA</td>
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<tr>
<td>Polybutylene terephthalate</td>
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<td>Polycarbonate</td>
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<td>Polyurethanes</td>
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<tr>
<td>PPG</td>
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<tr>
<td>PTMEG</td>
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<tr>
<td>PVA (PVOH)</td>
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<tr>
<td>SAP's</td>
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<tr>
<td>TBA</td>
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<tr>
<td>Tetrahydrofuran (THF)</td>
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<tr>
<td>UPR's</td>
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</tbody>
</table>

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The Economic Rational for Investment in the Strategically Imperative Products in the GEA was Examined in Detail

- Key global players expect **access to advantaged feedstock** as one of the major drivers behind their location decisions.

- We need to demonstrate that **Alberta’s economics based on upgrader bottoms as a source of feedstock is better** than production based on other feedstock types.

- We have developed several business cases based on different feedstock scenarios **to compare how different feedstock sources and their prices affect the economics of Methanol and Ammonia.**
Does syngas produced from upgrader bottoms provide a viable and sustainable competitive position based on potential market futures?

Methodology:
- Upgrader-based syngas to methanol and ammonia economics competitive cash cost comparison
  - Alternative stranded feedstock basis: natural gas, coal
  - Location: Alberta, Middle East, Caribbean, USGC
  - Financials: Acceptable ROI, global scale and cost position
  - Sensitivity analysis: feedstock and capital
  - Assumption: further C1 downstream investment will not be considered unless gasification represents a significant advantage over current or alternative routes
- Scenario analysis has been used to test the economic robustness under different competitive environments of feedstock pricing and capital expenditure
The robustness of potential gasification investment has been considered under different scenarios for methanol and ammonia.

### Drivers
- Oil Price
- Natural gas prices
- Process Technology
- Feedstock availability
- Emission and carbon values

### Scenarios
- Natural gas price levels: $4 – 20 / MMBtu
- Upgrader bottom price levels: $0 – 40 per tonne
- Coal and Petroleum Coke price levels: $0 – 60/ST
- Capital: 80 - 150% world scale
- Locations: USGC, Caribbean, Middle East, Russia

### Key Sensitivities
- Natural gas prices: will natural gas prices remain at a high enough level such that gasification-based economics are sufficiently advantaged?
- Capital investment levels: will escalating capital investment costs make the investment unprofitable?
- Product pricing: will product pricing remain at profitable levels looking forward?
- Feedstock competition: does an upgrader have a sufficient cost advantage over petroleum coke and coal to engage in aggressive price based competition?
The global methanol price setting mechanism is determined by USGC natural gas price levels

- Variable cost component essentially drives overall cost of production
- Global business based on stranded natural gas developments
  - Key locations: Trinidad, Chile, Middle East, New Zealand
  - US ‘high cost, natural gas’ plants setting overall pricing mechanism
  - USGC Cost of Production = FOB price
  - Trend to higher natural gas prices will initiate further closures of laggard units
- Evidence that alternative energy options, e.g. LNG, is drawing feedstock away from petrochemicals
- China production increasingly met from coal based feedstock although logistic disadvantages
  - Potential upside in demand from DME for fuels
- Significant US demand being met by increasing levels of imports
Long term methanol pricing reflects changes in natural gas scenarios

Methanol Price Outlook

- Assumption is that long term pricing will revert to traditional methanol/natural gas price spread
  - Current price volatility function of supply/demand imbalances and manufacturing outages
- Upside in demand from new applications in fuel related sectors especially in China

Source: Methanex
Syngas is traditionally produced from coal or petroleum coke and economics reflect capital cost

- Feedstock, either coal, petroleum coke or upgrader bottoms, relative small component of overall total production materials costs
- Significant capital expenditure for gasification, typically in region $1-1.5+billion
  - Major redundancy built-in to ensure continuous availability of syngas
  - Manpower intensive
- Critical aspects: Cost and availability of power, steam and water, by-product credits
- Technology: Introduction of alternative gasification options (e.g. partial oxidation, POX)
- China leading proponent of coal gasification. Eastman in US
Coal gasification versus Partial oxidation (POX) process

**Coal Gasification**
- Feedstock is either coal or petcoke
- Raw material costs is relatively small component of the total variable cost and total production cost
- Significant capital expenditure for gasification is in the range of
  - $3600/kW upwards in IGCC setup
  - $0.13 million per million Nm3 of syngas produced for non-integrated gasification plants
  - Typical plant size: 6500 mn Nm3 of syngas
  - Manpower intensive
- Critical aspects: Cost and availability of power, steam and water, by-product credits

**Partial oxidation**
- Feedstock is upgrader bottoms
- Feedstock consumption per kg of syngas produced in POX is higher as compared to feedstock consumption in gasification
- Sulphur is removed early in the process thereby reducing very high investment in corrosion resistant equipment throughout the plant
  - $0.206 million per million Nm3 of syngas produced
  - Typical plant size: 2500 mn Nm3 of syngas
- By-product credit (for hydrogen, as fuel or as chemical feedstock) compensates for increased capital and high utility consumption
Gasification is capital expensive compared to traditional routes but can still remain attractive.

- Assumption is for world-scale integrated gasification/methanol investment with a base CAPEX of $1.1 bn and high capital sensitivity of $1.69bn
  - Indicative coal or petroleum coke price of $20/ST
Coal gasification is attractive with natural gas above $6/MMBTU

- Long term coal and petroleum coke prices are forecast to remain essentially flat with regional and quality variations
  - Albertan sources may be considered as stranded with limited markets; prices of order $20-30/T
Syngas from gasification of stranded upgrader bottoms will be highly competitive given no alternative value

Comparison of Syngas Economics
Residues Bottoms and Coal

- Stranded location with no alternate option suggests a nil or negative value for Upgrader bottoms
- Gasification of Upgrader bottoms (liquids) is less capital intense than coal or petroleum coke gasification (solids) but is still considerable
- Economics are capex dependent but there are a number of caveats which need to be considered
  - Consideration of by-product credits, hydrogen (assumed as fuel) is a key issue
- The availability (volumes and timing) of Upgrader bottoms and any associated legislation, environmental considerations, etc, is still to be determined.
Stranded economics are potentially highly attractive

- Syngas production is more attractive from upgrader bottoms than either coal or petroleum coke.
- At nil value for residues methanol economics will be of similar order to the existing ‘low cost’ sources in Middle East and Trinidad.
- Current USGC spot prices of $520/t reflect natural gas levels of $12/MMBTU.
Upgrader bottoms gasification gives leading economics

- Syngas production is more attractive from upgrader bottoms than either coal or petroleum coke.
- At nil value for residues ammonia economics will be of similar order to the existing ‘low cost’ sources in Middle East, Russia and Trinidad.
- Current USGC spot prices of $550/t reflect natural gas levels of $12/MMBTU.
Adapting the upgrader configuration could provide a step change to naphtha for petrochemicals*

The potential for upgrading bitumen blend feedstock to condensate, naphtha and vacuum gas oil provides the ability to manufacture petrochemicals through traditional cracking routes. Provides access to C1 value chains without standalone gasification of upgrader bottoms. Provision of low cost, highly competitive naphtha based products without SCO refining.

* With permission from North West Upgrading
Conclusion: GEA – highly competitive petrochemical source!

- Syngas production based on gasification of upgrader bottoms offers a **highly attractive route to globally competitive methanol and ammonia** together with associated derivatives.
- Given the stranded nature of the residues and the potential significant volumes arising gasification provides a straightforward route for the GEA to develop as a **leading global centre for C1 petrochemicals**.
- Given a nil or negative value of residues will provide the **basis of competing against other global advantaged locations**, especially the Middle East and Trinidad.
- Production of naphtha, condensate and vacuum gas oil direct from bitumen feedstock may offer a **highly competitive alternative**.

<table>
<thead>
<tr>
<th>Indicative Price Upgrader Bottoms $/t</th>
<th>Syngas $/MMBtu</th>
<th>Methanol GEA Cost of Production $/t</th>
<th>Cost advantage* $/t</th>
<th>Ammonia GEA Cost of Production $/t</th>
<th>Cost advantage* $/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>0.19</td>
<td>91</td>
<td>310-430</td>
<td>81</td>
<td>310-420</td>
</tr>
<tr>
<td>0</td>
<td>2.12</td>
<td>139</td>
<td>260-380</td>
<td>140</td>
<td>250-360</td>
</tr>
<tr>
<td>20</td>
<td>5.99</td>
<td>235</td>
<td>160-280</td>
<td>254</td>
<td>140-250</td>
</tr>
</tbody>
</table>

*Cost advantage: difference between forecast USGC FOB prices and cost of production + 10%ROCE in GEA
Basis: NG $8.5 and 12.0/MMBtu (Current spot prices May 2008: Methanol $ 449/t, Ammonia $ 507/t fob Black Sea*
GEA has the potential to develop a globally competitive cluster and create significant added-value

- Development in parallel with growth in Oil Sands investment
- Access to plentiful and increasing supply of stranded residues
  - No real alternative outlet given scale of development
  - Upgrader bottoms will have nil or negative value and this will not change
  - Opportunity to negate potential high environmental impact of stranded coke
- GEA competitiveness benefiting from the increasing differential forecast between oil, natural gas and stranded upgrader residues
- Economics to compete with the leading locations based on ‘cheap’ natural gas
- Gasification will provide access to methanol and the fertiliser value chains
- Opportunity for SCO as feedstock for refining and naphtha-based chemicals
  - Associated investments in refining and naphtha cracking will lever further added-value and investment across other value chains rather than as direct sale to export markets
- Support throughout from national, regional and local government

A global opportunity for GEA to develop over the next 25 years
### Contents

#### Stage 1
- Background and objectives of the study
- Development of the cluster alternatives
- Benchmarking of the international clusters

#### Stage 2
- Strategically imperative products
- Cluster attributes and key performance criteria
- Cluster land use and logistics
- Cluster marketing strategy
- Conclusions and next steps
### What are the major drivers for new clusters? Typically who is involved?

<table>
<thead>
<tr>
<th>Major Attributes</th>
<th>Characteristics</th>
<th>Leading Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refinery/petrochemical integration</td>
<td>General trend</td>
<td>ExxonMobil, Shell, CPChem, Total, Sinopec, Reliance</td>
</tr>
<tr>
<td></td>
<td>Most oil companies</td>
<td></td>
</tr>
<tr>
<td>Operational excellence</td>
<td>General trend</td>
<td>ExxonMobil</td>
</tr>
<tr>
<td>Scale of operations</td>
<td>Trend, most new and green field investments</td>
<td>Dow, Nova, SABIC, BASF, NPC, Reliance, MEGlobal</td>
</tr>
<tr>
<td>Regional market share</td>
<td>Traditional regional and state enterprises</td>
<td></td>
</tr>
<tr>
<td>Global market share</td>
<td>Few majors</td>
<td>Dow, SABIC, MEGlobal, BasellLyondell</td>
</tr>
<tr>
<td>Technology - licensing</td>
<td>Readily available</td>
<td>Shell/SD/Dow (EO/EG)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BasellLyondell (polyolefins)</td>
</tr>
<tr>
<td>Technology - added value</td>
<td>Restricted (leading)</td>
<td>BP/Celanese (Acetic acid)</td>
</tr>
<tr>
<td>R&amp;D support</td>
<td>Leading licensors</td>
<td></td>
</tr>
<tr>
<td>Corporate commitment</td>
<td>Focused portfolio</td>
<td>Dow, BasellLyondell</td>
</tr>
<tr>
<td>Access to long term feedstock arrangements</td>
<td>General trend to increased 'state' involvement and participation</td>
<td>Venezuela, Iran, Middle East in general</td>
</tr>
</tbody>
</table>
Alberta can meet “brown field” challenge

- Typically Developed Markets: North America, Western Europe
  - Characterised by size and technical requirements
  - Subject to low growth with limited or no investments/closures

- Feedstock or Market Access: Middle East, China, India, SE Asia
  - Characterised by potential growth but risk
  - Significant investments by global leaders
  - Emergence of new players

New Frontiers
- Stranded Feedstock
  - Russia, Central Asia, Alberta, Latin America

Cluster attributes and key performance criteria
Leadership in the GEA will need to address the identified SWOTs to potential petrochemical investors

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abundant (and increasing) <strong>feedstock</strong> (Upgrader bottoms)</td>
<td>Predominately <strong>natural gas</strong> based economics</td>
</tr>
<tr>
<td>Strong and established <strong>petrochemical base</strong></td>
<td>Lack of <strong>critical mass</strong></td>
</tr>
<tr>
<td>Support from <strong>government</strong></td>
<td><strong>Non-integrated</strong> clusters</td>
</tr>
<tr>
<td><strong>Industry friendly</strong> environment</td>
<td><strong>Land locked</strong>, logistics disadvantage</td>
</tr>
<tr>
<td>Quality of <strong>human resources</strong></td>
<td>Generally <strong>high cost</strong> of doing business (capital, housing, wages …)</td>
</tr>
<tr>
<td>Political and economic <strong>stability</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Downstream</strong> development potential</td>
<td><strong>Labour availability</strong> to support growth</td>
</tr>
<tr>
<td><strong>US import substitution</strong> potential</td>
<td>Uncertainty regarding <strong>environmental regulations</strong></td>
</tr>
<tr>
<td>Large scale step-outs in technology to provide <strong>new routes</strong> to petrochemicals</td>
<td><strong>Weak infrastructure</strong> to reach markets</td>
</tr>
<tr>
<td>Developments in <strong>fuels related demand</strong></td>
<td><strong>Electricity and energy costs</strong></td>
</tr>
</tbody>
</table>
Regional and global feedback suggests a number of Key Success Factors to be addressed for the GEA

- **Availability of competitive feedstock and raw materials**
  - To achieve 1st quartile or leading economics
    - Pricing structure and mechanisms re Upgrader bottoms

- **Integration of suppliers and other clusters**
  - To maximize operational efficiency and reduce logistics
    - Need to address common utilities, storage and distribution, etc

- **Appropriate infrastructure to both domestic and export markets**
  - Access to key US markets and ability to supply Asian markets in a timely and cost efficient manner
    - Rail and port facilities

- **Competitiveness of construction costs in relation to other potential locations**

- **Availability of skilled workforce**
  - Recognition of a global issue in both the implementation and maintenance of new operations
Cluster Management Body is accountable for managing cluster operation with contribution from all the stakeholders

Contributions of Stakeholders to the Cluster Management Body:
- Funding
- Expertise
- Manpower
- Appointment of top management
- Policies
- Legislation
- General cluster promotion

Key responsibilities of Cluster management Body:
- Formulate cluster development strategy and vision based on stakeholders’ input
- Implement investor acquisition strategy
- Create/maintain/manage and develop the cluster
- Develop budgets and business plans for capital projects and operational needs
- Manage cluster finances:
  - Service fees for cluster tenants
  - Cluster development fund – CAPEX fund for developing common infrastructure

Cluster attributes and key performance criteria
A number of activities need to be initiated to make the cluster investor ready

Who drives the process

All stakeholders

Local government

Local/federal government/Cluster management

Cluster management

Form Cluster Management Body
Create stakeholders task force
Decide on organizational format
Define tasks and responsibilities
Provide manpower and resources

Initiate land planning process
In-depth analysis of cluster land use
Approve land use/zoning plans

Initiate infrastructure development
In-depth analysis of infrastructure req-ts
Approve development plans
Identify and commit funding
Initiate implementation

Set up regulatory framework
Policy direction
Permits, investor incentives
Environmental regulations
Labour related regulation (incl. visas etc)

Initiate cluster promotion
Develop cluster operation model
Initiate investor acquisition
Carry out general cluster promotion

Key milestones
Cluster management body formed
Land plans approved
Infrastructure development initiated
Key investors committed*

© 2008 Kline & Company  * Timing shown as an illustration only

June 2008
Cluster concept developed

Next steps

2008 2009 2010 2011
## Contents

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background and objectives</td>
<td>Development of the cluster alternatives</td>
</tr>
<tr>
<td>of the study</td>
<td>Benchmarking of the international clusters</td>
</tr>
<tr>
<td></td>
<td>Cluster attributes and key performance</td>
</tr>
<tr>
<td></td>
<td>criteria</td>
</tr>
<tr>
<td></td>
<td>Cluster land use and logistics</td>
</tr>
<tr>
<td></td>
<td>Cluster marketing strategy</td>
</tr>
<tr>
<td></td>
<td>Conclusions and next steps</td>
</tr>
</tbody>
</table>
Land Use and Infrastructure Scenarios

Key Assumptions:

- Development will be phased over 25+ years
- Investments need to be co-ordinated
- Success of initial investments will influence further investment
- Availability of cost competitive feedstock is paramount: volumes, long term pricing agreements
- Appropriate cluster leadership in place to encourage/support inward investment

Location of the investment
- Integration into the current Upgrader area (upstream)
- Integration and development with the current refining and petrochemical area (midstream)
- Development currently not integrated into upgrading/ refining/ petrochemicals (downstream)

Infrastructure requirements
- Logistics: Majority of movements will be rail orientated
  - To US and west coast for export
  - Mainly solids (polymers, fertilizers), some liquids (methanol, ammonia, etc
  - Increasing local demand for intermediates and finished products over time
- Other: Significant demand for utilities and power (oxygen, hydrogen, nitrogen, water)
  - Need to move CO2 for EOR
  - Waste management
Investments are considered with the following timeframe*

- **Current developments as incremental feedstock availability** (heartland off-gases)
- **Investment on existing Brown Field locations** using current infrastructure and logistics

- **Fundamental investment in new ‘building blocks’** and commodities
- **Replacement of existing feedstock** (NG) with more competitive alternative

- **Development of secondary investments:**
  - Allied with related clusters (feedstock)
  - As potential stand-alone facilities (manpower, skills, R&D, etc)

- **Development of ‘mega’ projects and alternative routes** to petrochemicals
- **Green Field developments** but could be linked to established producers (Methanol, fertilizers, polymers)

---

**Cluster land use and logistics**

*Timing reflects plant commissioning post investment decision*
The Heartland Area will be home to the Upstream and Midstream Sub-Clusters

Key Issues to Consider:

- Allocation of a designated industrial park area for chemical plants
- Development of a cluster logistics infrastructure
- Development of the export logistics infrastructure
- Development of a integrated utilities and services infrastructure
- Provision for linkage to the Downstream cluster and other future industry clusters
- Future public infrastructure expansion
- Building the long range community development around the cluster evolution
The Midstream sub-cluster(s) will become the centre for petrochemicals. Upstream will be focus for feed preparation and Downstream added-value.

Upstream
- Upgraders
- Gasifiers
- Syn Gas

Midstream Cluster(s)
- Ethane
- Propane
- Refinery Offgas
- Cracker(s)
- Intermediates
- C1, C2, C3 Value Chains
- C4, C6, C7/8 Value Chains

Downstream
- Truck & Pipe to Downstream Cluster and domestic markets
- Rail to US and West Coast
- Potentially 6-9 million tpa

Phase 2 Derivatives
- Fabrication
- Compounding
- R&D / Tech Centres
- New Technologies

Pipe Track to Midstream Cluster(s)
The Downstream cluster will focus on added-value, intermediates and associated developments including new technology.

Investment timing is a function of availability of intermediates and other feedstocks.

- **Phase 2 Derivatives**
  - Fabrication
  - Compounding
  - R&D / Tech Centres

- **Phase 3**
  - New Technologies

- **Further expansion and investments**
  - Rail to US and West Coast

### Derivatives
- Acetyl derivatives
- EVOH polymers
- EO/PO Glycols
- EVA polymers
- Acrylates
- Compounding
- Amines
- Polyolefin films
- Ethanolamines
- PPG
- Ethoxylates
- SAP
- Surfactants
- PET Resins
- PBT
- EVA polymers
- UPR
- Compunding
- Urea
- Polyethylene glycol
- MMA
- THF
## Contents

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Background and objectives of the study</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
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<td>Benchmarking of the international clusters</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Strategically imperative products</td>
</tr>
<tr>
<td></td>
<td>Cluster attributes and key performance criteria</td>
</tr>
<tr>
<td></td>
<td>Cluster land use and logistics</td>
</tr>
</tbody>
</table>

**Cluster marketing strategy**

Conclusions and next steps
### Some target investors operate across several value chains

<table>
<thead>
<tr>
<th>Investor group</th>
<th>Strategic drivers</th>
<th>Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgraders</td>
<td>Downstream integration</td>
<td>Various</td>
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<tr>
<td>Refiners</td>
<td>Maximizing refinery / petrochemical interface / synergies</td>
<td>Shell, Imperial Oil, PetroCanada</td>
</tr>
<tr>
<td></td>
<td>Enhancing chemical portfolio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regional growth</td>
<td></td>
</tr>
<tr>
<td>Gas Separation</td>
<td>Downstream integration</td>
<td>Williams, Aux Sable</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Competitive feedstock access and market access</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Global positioning / regional portfolio extension / technology capability</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C6</th>
<th>C7/8</th>
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<tbody>
<tr>
<td>BP</td>
<td>Nova</td>
<td>BASF</td>
<td>BASF</td>
<td>BASF</td>
<td>BP</td>
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<tr>
<td>Agrium</td>
<td>Shell</td>
<td>Dow</td>
<td>Hexion</td>
<td>Shell</td>
<td>Shell</td>
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<tr>
<td>Yara, Terra Mosaic</td>
<td>Dow</td>
<td>LyondellBasell</td>
<td>ISP</td>
<td>Dow</td>
<td>Invista</td>
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<td>Methanex</td>
<td>LyondellBasell</td>
<td>BASF</td>
<td>Lanxess</td>
<td>LyondellBasell</td>
<td>C7/8</td>
</tr>
<tr>
<td>Celanese</td>
<td>CPChem</td>
<td>BASF</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Eastman</td>
<td>MEGlobal</td>
<td>BASF</td>
<td></td>
<td></td>
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<tr>
<td>DuPont</td>
<td>Ineos</td>
<td>BASF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global plays</td>
<td>A new regional entry</td>
<td>Reliance, Sasol, Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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# Contents

<table>
<thead>
<tr>
<th>Summary Stage 1</th>
<th>Development of the cluster alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benchmarking of the international clusters</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Strategically imperative products</td>
</tr>
<tr>
<td></td>
<td>Cluster attributes and key performance criteria</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
</tbody>
</table>

**Conclusions and next steps**
What are the specific critical issues that need to be considered to develop a World-Class Cluster?

- Secure **Competitive Feedstock** supply
- **Designated/Zoned Land** for cluster development
- **Regional infrastructure** connecting to local, regional and international markets
- Competitive **regional utilities** and **services**
- **Targeted Investment Acquisition** for strategically imperative products and downstream products
- **Cluster site development** and chemical **industry specific infrastructure**
- Efficient **Permitting** Procedures
- **Cluster coordination/leadership** for development and investment attraction
- **Trigger** mechanism to **kick-start** the cluster development
Putting it all together: charting the way forward

Conclusions and next steps

June 2008 Cluster concept developed

- June 2008
- Cluster concept developed
- Next steps

2008 Concept
- 2009-2011 Becoming investor ready
- 2011+ Investment phase – Cluster operational

Who drives the process?
- Form Cluster Management Body
- Create stakeholders task force
- Develop an organizational chart
- Define roles and responsibilities
- Provide leadership and resources

Next steps
- Initiate land planning process
- In-depth analysis of cluster land use
- Approve land use/building plans

Next steps
- Cluster operations
- Develop cluster operation model
- Initiate investor promotion
- Continue general cluster promotion

Local government
- Set up regulatory framework
- Policy direction
- Provide investment incentives
- Environmental regulations
- Labour related regulations (e.g., visas, etc.)

Local and federal government/Cluster management
- Initiate infrastructure development
- In-depth analysis of infrastructure needs
- Approve development plans
- Identify and commit funding
- Initiate implementation

Conclusions and next steps

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If you require additional information about the contents of this document or the services that Kline provides, please contact:

Name: Fred du Plessis
Title: Senior Vice President
Phone: +44 1865 781 320
E-mail: Fred_duPlessis@KlineGroup.com

Kline Global Headquarters

Kline & Company, Inc.
Overlook at Great Notch
150 Clove Road
Little Falls, NJ 07424-0410
Phone: +1-973-435-6262
Fax: +1-973-435-6291

www.KlineGroup.com