Petcoke Monetization

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- Almost 15,000 people
- Almost 60,000 people
- Over 50 countries
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Advisian is a global consulting firm that provides strategic advice, integrated with deep technical expertise to clients in the energy, resources and infrastructure sectors.

Major Projects
Specialists in full project project delivery of large, complex, strategically important projects wherever they are in the world.

Integrated Solutions
Delivers maintenance, modification, operations, engineering, fabrication, construction, hook-up and commissioning in support of greenfield and brownfield assets.

Services
The Services business line effectively combines local service, knowledge, relationships and capability to deliver projects of all sizes across the asset lifecycle. It is the local partner for companies and communities to deliver sustained economic and social progress.

Hydrocarbons
Power
Infrastructure

Chemicals
Low Carbon

Hydrocarbons
Power
Infrastructure
## Advisian Service Lines and Practices

### Global Service Lines

<table>
<thead>
<tr>
<th>Service Line</th>
<th>Focus Areas &amp; Practices</th>
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<tbody>
<tr>
<td>Upstream &amp; Midstream</td>
<td>Upstream (offshore and onshore)</td>
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<td>Midstream (gas processing, pipelines, LNG)</td>
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<td>Downstream &amp; Market Services</td>
<td>Refining, Chemicals &amp; Petrochemicals</td>
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<td>Market Services</td>
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<td>Low Carbon</td>
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<td>Downstream Risk &amp; Compliance</td>
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<td>Sulphur &amp; Process Technology</td>
<td>Downstream Asset Management</td>
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<td>Downstream Energy &amp; Utilities</td>
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<td>Advisory</td>
<td>Consulting</td>
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<td>Licensing</td>
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<td>Process Solutions</td>
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<td>R&amp;D</td>
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<td>Proprietary Solutions (Catalyst)</td>
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<td>Advisory</td>
<td>Capital Project Advisory</td>
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<td>Strategy &amp; Transaction Services</td>
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<td>Operational Readiness</td>
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<td>Operations Excellence</td>
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<td>Business Case</td>
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<td>Asset Solutions</td>
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<td>Advanced Analysis</td>
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<td>Environment</td>
<td>Decommission &amp; Restoration</td>
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<td>Environment &amp; Society</td>
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<td>Geosciences</td>
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<td>Safety &amp; Risk</td>
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<td>Environmental Data Services</td>
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<td>Power &amp; Transport</td>
<td>Water</td>
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<td>Industrial Water</td>
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<td>INTECSEA</td>
<td>Power Generation</td>
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<td>Power Networks</td>
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<td>Power Advisory &amp; Energy Transition</td>
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<td>Ports &amp; Marines</td>
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<td>Transport Planning</td>
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<td>Rolling Stock &amp; Train Operations</td>
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<td>Rail &amp; Road Infrastructure</td>
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<td>Full field developments</td>
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<td>Floating systems, subsea, pipelines</td>
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What is Petcoke?

- Petroleum coke (petcoke) is a solid carbon material that resembles coal
- **It is a by-product of refining crude oil, not intentionally made**
- The quality of the petcoke is dependent upon the crude oil processed
- It has various industrial applications
- The term "**green petroleum coke**" refers to all petcoke that is not calcined (both fuel and calcinable grade)
- **It is not** a waste product
Petcoke Properties

• Similar properties to coal, but:
  • High carbon content – 85 to 90%
  • Low volatile component - 6 to 12%
  • Typically high sulphur – 6 to 8% is common
  • Low ash - <0.5% is normal
  • High heating value - >35 GJ/MT (HHV)
Monetizing Petcoke - Options

• Refinery Consumption
  – Power (Boiler / IGCC)
  – Steam (Boiler / IGCC)
  – Hydrogen (Gasification)
  – Fuel Gas (Gasification)

• Export
  – Power (Boiler / IGCC)
  – Steam (Boiler / IGCC)
  – SNG (Gasification)
  – Liquid Fuels (Gasification)
  – Commodity Chemicals (Gasification)
Gasification Products (1)

- Argon, Nitrogen, & Oxygen
- Carbon Dioxide
- Sulphur / Sulphuric Acid
- Fuel Gas
- Steam
- Hot Water
- Electricity
- Hydrogen
- Carbon Monoxide
- Ammonia - Nitrogen Fertilizer
- Substitute Natural Gas
- Industrial Chemicals
- Methanol & Derivatives
- Fischer Tropsch Synthesis
- Naphtha
- High Cetane Diesel
- Jet Fuel
- Wax
- Slag / Ash for Construction Materials
- Combined Cycle
- Syngas
Gasification Products (2)

- Syngas
  - Methanol Synthesis
    - Methanol
    - Acetic Acid
    - MTO
    - Gasoline
    - Transport Fuel
  - Ammonia Synthesis
    - Anhydrous Ammonia
    - Urea
    - Nitric Acid
    - UAN
    - Ammonium Sulphate
Product Drivers External (1)

• **Industrial Gases**
  – Local market served by pipeline or tanker truck, limited to <300 km. Usually an opportunity by-product

• **Sulphur / Sulphuric Acid**
  – Dependent on local market for sulphuric acid.

• **Hydrogen**
  – External to refinery, local market served by pipeline or tanker truck, limited to <300 km. Usually an opportunity by-product.
Product drivers (2)

• **Ammonia**
  - World scale plant up to 3000 MTPD (pet coke). Often converted to:
    - Urea (with CO2),
    - Nitric acid then to Ammonium Nitrate
    - UAN
    - Ammonium Sulphate (with Sulphuric Acid)
    - Other Ammonium Salts

• **SNG**
  - Dependent on price of NG.
  - Useful swing product.
Product drivers (3)

• Methanol
  • Can be sold on spot or contract market. Can be converted to:
    • Acetic Acid (with CO) and then to formaldehyde for resin and particle board,
    • Olefins
    • Gasoline

• Fischer Tropsch synthesis
  • Specialist waxes and lubricants.
Technology Line-up

Plant expected to comprise:

- ASU
- Petcoke prep
- Gasifier
- Water Gas Shift
- Acid Gas Removal
- Sulphur Recovery
- Product synthesis / purification
- Offsites and Utilities
Hydrogen Production

- Gasification
- Sour Shift & Gas Cooling
- Oxygen
- ASU
- Pure H2
- Offgas
- CO2
- Sulphur
- AGR
- PSA
- Coke
- Raw Syngas
- Shifted Syngas
MeOH, FT, SNG Production

- **Gasification**
  - Coke
  - Raw Syngas
- **Sour Shift**
  - Shifted Syngas
  - Un-Shifted Syngas
  - Oxygen
- **Gas Cooling**
- **ASU**
- **AGR**
  - CO2
  - Sulphur
- **Methanol Synthesis**
  - Methanol
- **Methanation**
  - SNG
  - Diesel
  - Jet A
  - Wax
- **FT Synthesis**
## Value Added Ratio

<table>
<thead>
<tr>
<th>Product</th>
<th>$ Product / $ Petcoke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>4.5</td>
</tr>
<tr>
<td>Olefins (MTO)</td>
<td>4.2</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>4.0</td>
</tr>
<tr>
<td>Ammonia (anhydrous)</td>
<td>3.2</td>
</tr>
<tr>
<td>Urea</td>
<td>5.5</td>
</tr>
<tr>
<td>Ammonium Nitrate</td>
<td>10.2</td>
</tr>
</tbody>
</table>
## Projected Rates of Return

<table>
<thead>
<tr>
<th>Petcoke Feed Rate (MTPD)</th>
<th>Product 1</th>
<th>Capacity</th>
<th>Product 2</th>
<th>Capacity</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,500</td>
<td>Hydrogen</td>
<td>160 (MMscfd)</td>
<td></td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td>2,500</td>
<td>Ammonia</td>
<td>1,602 (MTPD)</td>
<td>Ammonium Nitrate</td>
<td>2,894 (MTPD)</td>
<td>14%</td>
</tr>
<tr>
<td>5,000</td>
<td>Methanol</td>
<td>4,819 (MTPD)</td>
<td></td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td>10,000</td>
<td>Olefins</td>
<td>3,508 (MTPD)</td>
<td></td>
<td></td>
<td>13%</td>
</tr>
</tbody>
</table>
Summary

• Limited risk – all technologies offered by multiple well established vendors and licensors
• Is the basis for a variety of downstream pathways
• Should be evaluated in the context of broader Petcoke production and utilization options