THE CHEMICAL INDUSTRY IN THE NEXT INDUSTRIAL REVOLUTION, THE “SUSTAINABLE ONE”

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“THE CHEMICAL INDUSTRY BY 2050”
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Q 1 : What was the world population in 1970?
A) 2, 5  B) 3,5  C) 4,5  2010 : 7 billion

Q 2 : What was the world life expectancy in 1970?
A) 35  B) 45  C) 55  2010 : 65 years

Q 3 : What was the World $US GDP in 1970?
A) 15  B) 25  C) 35  2010 : $US73 trillion

Q 4 : What was the world oil demand in 1970?
A) 28  B) 45  C) 65  2010 : 88 million barrel
Q 1 : What was the world population in 1970?

A) 2, 5  
B) 3, 6  **100%**  
C) 4, 5  
2010 : 7 billion

Q 2 : What was the world life expectancy in 1970?

A) 35  
B) 45  **44%**  
C) 55  
2010 : 65 years

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A) 15  **387%**  
B) 25  
C) 35  
2010 : $US73 trillion

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A) 28  
B) 44  **100%**  
C) 65  
2010 : 88 million barrel
GLOBAL MEGATRENDS

SOCIAL

“A WORLD WITH MORE THAN 9 BILLION PEOPLE, HIGHER QUALITY OF LIFE AND LIFE EXPECTANCY, MOVING INTO CITIES”
Social Megatrends – Population

9 to 10 billion people by 2050, with the REST adding 1.8 billion and India 440 million. Japan, Russia, China & EU will face shrinking & older populations.

Life expectancy will increase to 75 years, with people living more than 100 years. Fertility will keep declining and older populations are expected.
GLOBAL MEGATRENDS

ECONOMY

“THE LARGEST MIDDLE CLASS IN HUMAN HISTORY”
Economic Megatrends - GDP

World GDP expected to quadruple to $US281 trillion by 2050; BRIC will double their market share & Advanced Economies their size

Source: IMF and PWC and PriceWaterHouseCoopers for long term economic projections
Economic Megatrends - GDP

China & India might become the largest economies in the world, while China, India & USA alone could host 50% of the world GDP.

Source: IMF and PWC and PriceWaterHouseCoopers for long term economic projections
GLOBAL MEGATRENDS

CLIMATE CHANGE

“A WORLD IN A DIET OF 4,000 GRAMS OF CO2 PER CAPITA AND DAY, REPRESENTS A ENORMOUS TECHNOLOGICAL / POLITICAL CHALLENGE, BUT ALSO AN HUGE BUSINESS OPPORTUNITY

“CLIMATE CHANGE IS THE “WAR” OF THE 21ST CENTURY”
Scientific evidences correlate Greenhouse Emissions with higher temperatures, eventually triggering “climate change”.

Historical CO₂ Emissions

Historical World Temperature Variations

Emissions vs. Temperature Fluctuations

Source: Scripps Institution of Oceanography Annual Mean CO₂ Concentration at the Mauna Loa Observatory in Parts Per Million or PPM (PPM)

Climate Change – Root causes

World CO2 Emissions reached 33 Gigaton in 2010

- 72% CO2 related.
  - 29% Power stations
  - 20% Ind. Processes
  - 19% Transportation
  - 12% residential

- 18% Methane
  - 40% Agricultural

- 9% Nitrous Oxide
  - 60% agricultural
A huge technological challenge but also the single largest business opportunity of this generation.
ISSUE 2 – Economic / Wealth Challenge

Living with 4,000 grams of CO2 per capita & day

Sustainable Scenario 2050 - CO2 Emissions - 4,000 Grams Per Capita & Day

Daily Emissions per Capita in Grams of CO2

- USA, 54,475
- Canada, 48,751
- Brazil, 4,978
- India, 3,995
- Japan, 2,8126
- EU, 22,605
- Russia, 4,235
- China, 4,0111

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GLOBAL LONG TERM MEGATRENDS

“IN A ENVIRONMENT OF MASSIVE ENERGY GROWTH, ENERGY TRANSITIONS OCCUR EVEN WHEN THE INCUMBENT ENERGY IT IS STILL AVAILABLE, AND THE NEW ONE IS MORE EFFICIENT, CHEAPER AND SUSTAINABLE”

“CRUDE OIL PRICES MIGHT HAVE PEAKED FOREVER IN 2011 – PRICE SHOCKS ARE GOOD INDICATORS OF ENERGY TRANSITIONS”
Energy Transitions – **Price “Shocks”**

Price Shocks are tremendous “source” of information.

**HISTORICAL CRUDE OIL PRICES 1860 - 2010**

- **Nominal Crude Oil Prices**
- **Real Crude Oil Prices**

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Under “BAU” Scenario, world energy demand could double
Energy—“Sustainable” Scenario

4,000 grams of CO₂ per capita and day

• Natural Gas (+34%),
• Nuclear, Biomass & Renewable (Up)
• Crude Oil (-27%) & Coal (-18%)
• Carbon Capture Storage units (19%).

• 60% to 80% Cars will be electric.

http://my2050.decc.gov.uk/
GLOBAL LONG TERM MEGATRENDS

SINGULARITY

“INFORMATION TECHNOLOGY & COMPUTATIONAL PROGRESS WILL ACCELERATE AND CHANGE ALL ASPECTS OF OUR LIFE, THE WAY WE WORK, LIVE, AND COMMUNICATE”
Computational Progress and Tech. Convergence accelerate Human Progress Exponentially

1. The accelerating pace of change...
   - Agricultural Revolution: 8,000 years
   - Industrial Revolution: 120 years
   - Light-bulb: 90 years
   - Moon landing: 22 years
   - World Wide Web: 9 years
   - Human genome sequenced: 10^16

2. …and exponential growth in computing power...
   - Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

3. …will lead to the Singularity
   - Apple II: At a price of $1,298, the compact machine was one of the first massively popular personal computers
   - Power Mac G4: The first personal computer to deliver more than 1 billion floating-point operations per second
**Exponential Growth – 6 Ds**

- **Digitized** – more information is becoming digitized, opening the door for a layer of analytics (e.g. machine learning) to be placed on top of it

- **Deceptive** – early stages of exponential growth processes may be deceptively linear

- **Disruptive** – once exponential growth reaches the inflection point, or “knee of the curve,” they become truly disruptive

- **Dematerialized** – no longer do you have to buy a flashlight or digital camera, you can simply purchase an app on your phone to accomplish these tasks

- **Demonetized** – as manufacturing techniques improve, technologies are becoming less expensive at an alarming pace

- **Democratized** – 3 billion more people on the Internet by 2020
THE CHEMICAL INDUSTRY
LONG TERM DYNAMICS

BY 2050

"THE CHEMICAL INDUSTRY / SCIENCE / ENGINEERING WOULD BE AT THE CORE OF THE NEXT INDUSTRIAL REVOLUTION – THE SUSTAINABLE & DIGITAL ONE"
China and India will become the largest chemical markets with 50% share.
India will be the fastest growing chemical market in the world.

<table>
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<th>RANK</th>
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<th>INDUSTRY</th>
<th>% GROWTH</th>
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<td>INDIA</td>
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<td>3816%</td>
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<tr>
<td>TOP 2</td>
<td>INDIA</td>
<td>PHARMA</td>
<td>3409%</td>
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<tr>
<td>TOP 3</td>
<td>CHINA</td>
<td>PHARMA</td>
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<td>CHINA</td>
<td>CHEMICAL</td>
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<td>PHARMA</td>
<td>609%</td>
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<td>527%</td>
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</tr>
<tr>
<td>TOP 16</td>
<td>JAPAN</td>
<td>CHEMICAL</td>
<td>38%</td>
</tr>
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</table>
Lighter, renewable and bio but still dependent in Naphtha.
Industry need for cheaper energy, feedstock and lower emissions will accelerate the transition into lighter feedstock.

### Steam Cracker CO₂ Emissions

- **Based on allocation of 100% emissions to ethylene;**
- **No co-products emission benefit; location U.S. Gulf Coast**

#### Source: SRI Consulting

**30% less CO₂ emissions**
The Chemical Industry remains a great contributor to emissions reductions. In 2005, the industry released 3 Gigaton of CO2e while “abating” 6 Gigaton.

EMISSIONS vs. ABATEMENT = 1 to 2

X 2 times Abatement
More global and stringent regulation, with higher CO2 prices.

EMISSION TRADING SCHEMES

- **2005**
  - Europe: Mandatory
  - Japan: Voluntary

- **2008**
  - Canada: Voluntary
  - N. Zealand: Voluntary

- **2010**
  - UK: Mandatory
  - US States*: Mandatory

- **2012**
  - Australia*: Mandatory

- **2015**
  - China: Mandatory
  - Korea: Mandatory

*Note*: WCI Western Climate Initiative
Regulation – **Global, Stringer, Unbearable**

4,000 grams of CO2 per capita & day

“Under the new perspective many companies and industries will peril”

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**Exxon Mobile uses $60 tonne as internal carbon price for CO2**

Expected EBITDA annual lost of $US 8 Billion!!

Sustainable?
INNOVATION – Technology
THE 3rd INDUSTRIAL REVOLUTION

NEXT INDUSTRIAL REVOLUTION
“The Sustainable / Digital One”
4,000 grams per capita & day

2nd INDUSTRIAL REVOLUTION
Enormous Growth - Fossil Fuel

INNOVATION Level 2

INNOVATION Level 3

INNOVATION

Globalization
BRIC
China
World Peace

Technological CONVERGENCE

Business COLLABORATION

Bioeconomy, bio-refineries, bio-feedstock/plastics, Nanotechnology, Circular Economy, Singularity

R&D in Chemical Industry in 2010
- 25% new chemistry
- 75% in incremental innovation
- Source: McKinsey

OPERATIONAL EFFICIENCY

1850
1900
1950
2000
2050
2100

1,2
1,7
2,5
6,0
9,0
12 Billion people

4,000 Grams

2nd IND REV - Textile
3rd IND REV - India & China
4th IND REV - Singularity

Moorhen Oil Shocks, Berlin Wall, Internet, China, BRIC, Convergence Networks, Shale Gas

Convergence Collaboration Singularity INDIA & N11

Humans 150 years Singularity
Circular Economy, Technological Convergence and Collaboration will be at the core of the next industrial revolution.

This require new biz models, new skills (employees/leaders), regulatory systems (IP protection, patents, antitrust) and technological frameworks.

Companies will be valued by the innovation pipeline of its value chain; not only by their own innovation, financials or R&D pipeline.

Innovation will become disruptive and exponential rather than incremental (Singularity)
CONCLUSION
Conclusions
UNDER THE 3rd INDUSTRIAL REVOLUTION

• We are leaving historical and strategic times. During this transition the world is poised to witness another period of massive transformation. A world with 9 billion people and $US 280 trillion GDP; the world will have the potential to host “the largest, wealthiest and healthiest societies in human history”.

• China, USA & India will become the largest world economies but also the largest chemical and pharmaceutical markets. World avg. life expectancy will to 75 by 2050, with millions of people living more than 100 and up to 130 years.

• During this transition world GDP per capita will triple to US$ 30,675; creating a massive middle class and pulling millions of people our of poverty.

• Singularity and the Digital Revolution will accelerate and change most of the aspects of our life, the way we work, live, and communicate.

• However our world will not be sustainable. A world poised to live with just 4,000 grams of CO2 per capita an day it is not only a moral obligation and technological and political challenge, but also a large business opportunity.
Conclusions
UNDER THE 3rd INDUSTRIAL REVOLUTION

- Emissions reductions, resource scarcity and digitalization will trigger the Next Industrial Revolution – “Sustainable & Digital one” – moving the industry from operational efficiencies into innovation and fostering “technical convergence, business collaboration and the “circular economy”.

- The industry will be “called into action”. New companies and industries will blossom, others will disappear. Massive growth and disrupting changes (markets, feedstock, products & technologies); combined with stringent emissions reductions, will stretch the industries to levels never seen before.

- Addressing emissions and energy reductions is not only a huge technological challenge and a moral obligation; but also it is a enormous business opportunity, at least $100 trillion dollars.

- This is an historical opportunity for the chemical industry to shine on what it does best: technology and innovation!

- The Chemical Industry will be at the core of the 3rd Industrial Revolution, I hope this time we will not forget it very soon.
“Welcome to a much larger and sustainable world thanks to chemistry”