



CH1203 Industrial Pollution Prevention and Control

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Topics Covered

- 1 Sustainability
- 2 Environmental Regulations
- 3 Pollution
- 4 Air pollution control methods
- 5 Principles of water treatment



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- 2 Environmental Regulations
- 3 Pollution
- 4 Air pollution control methods
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Sustainability

- Industrial Activity and Environment
 - Industrialization and Sustainable development
 - Barriers or Hurdles to Sustainability
 - Achieving Sustainability
 - Sustainable Strategies
 - Indicators of Sustainability
 - Pollution Prevention in achieving sustainability
-

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Sustainability

- Industrial Activity and Environment
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 - Indicators of Sustainability
 - Pollution Prevention in achieving sustainability
-

Sustainability – Industrial Activity and Environment

- Anatomy of Manufacturing Processes
 - Pollution Prevention Practices
 - Pollution Prevention hierarchy
-
- The different layers of atmosphere
 - Air pollutants (Sources, Cause and effects)
 - Various effects of air pollutants (Smog formation, acid rain, global warming, green house effect and ozone depletion)

Industrial activity

Environment

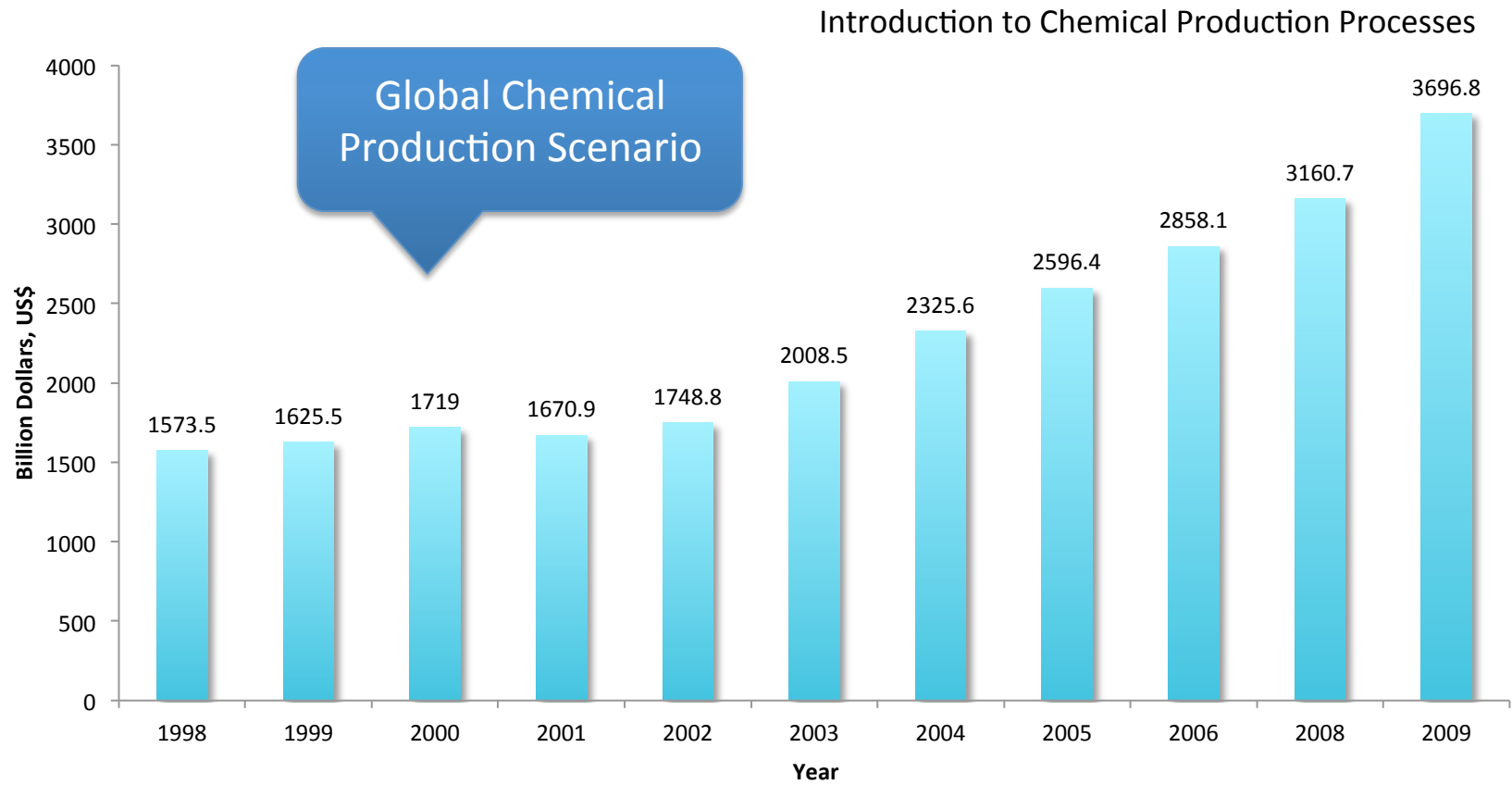
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- Anatomy of Manufacturing Processes
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Sustainability – Industrial Activity and Environment



Source: www.americanchemistry.com/s_acc/sec_directory.asp?CID=292&DID=747

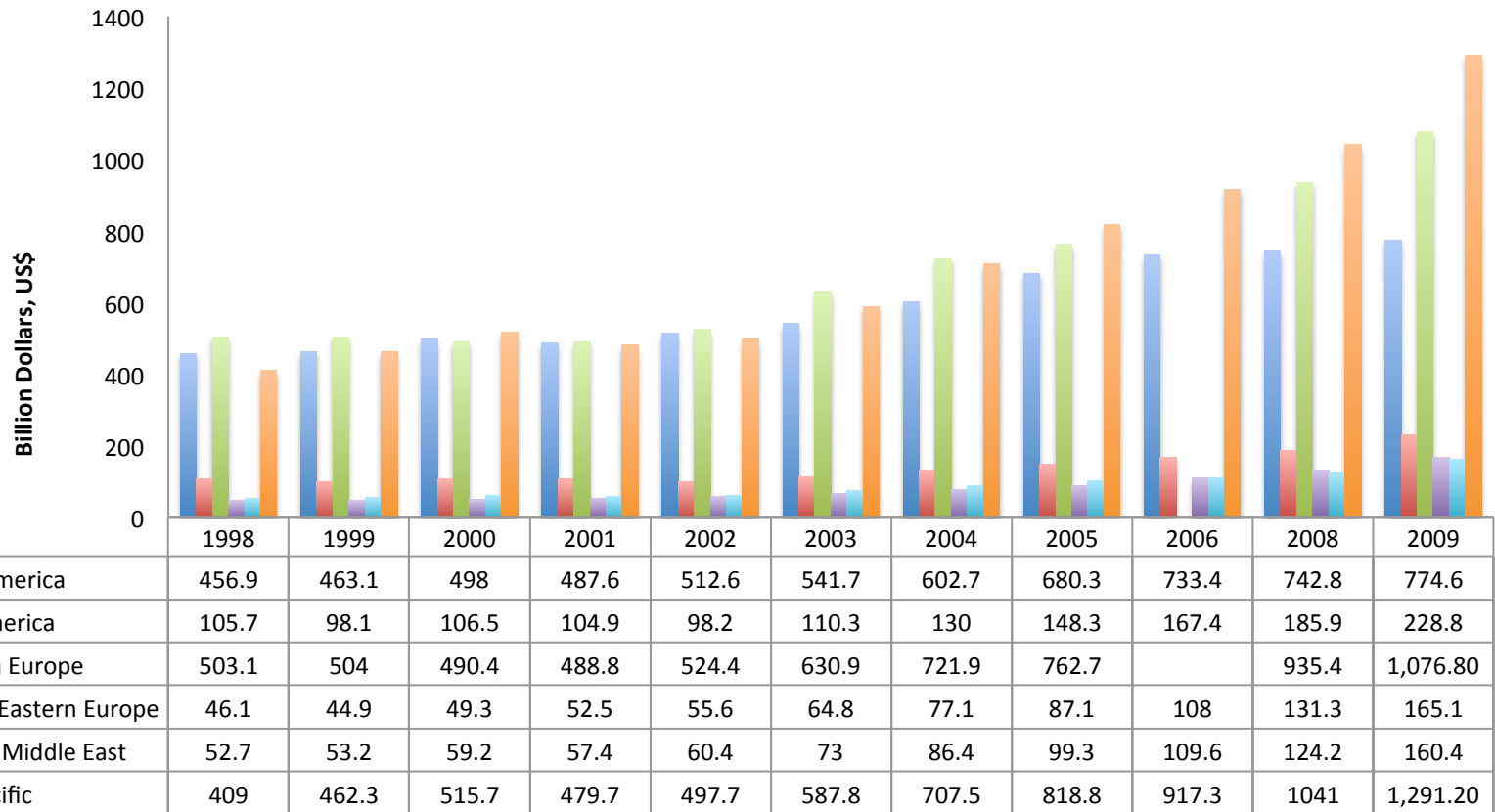
Sustainability – Introduction to Chemical Production Processes

Global Chemical Production
Scenario by region

Countries	1998	1999	2000	2001	2002	2003	2004	2005	2006	2008	2009
United States of America	416.7	420.3	449.2	438.4	462.5	487.7	540.9	610.9	657.7	664.1	689.3
Canada	21.1	21.8	25	24.8	25.8	30.5	36.2	40.2	43.7	45.4	47.4
Mexico	19.1	21	23.8	24.4	24.3	23.5	25.6	29.2	32	33.4	37.8
North America	456.9	463.1	498	487.6	512.6	541.7	602.7	680.3	733.4	742.8	774.6
Brazil	46.5	40	45.7	41.5	39.6	47.4	60.2	71.1	82.8	96.4	126.7
Other	59.2	58.1	60.8	63.4	58.6	62.9	69.9	77.2	84.6	89.5	102.1
Latin America	105.7	98.1	106.5	104.9	98.2	110.3	130	148.3	167.4	185.9	228.8
France	79.1	78.5	76.5	76.8	80.5	99.6	111.1	117.5	121.3	138.4	158.9
Germany	124.9	123.2	118.9	116.1	120.1	148.1	168.6	178.6	192.5	229.5	263.2
Italy	63.9	64.6	59.5	58.6	64.5	75.8	86.6	89.8	95.3	105.9	122.9
United Kingdom	70.3	70.1	66.8	66.4	69.9	77.3	91.3	95.2	107.8	118.2	123.4
Belgium	27.1	27	27.5	27.1	28.7	36.1	41.8	43.5	46.9	51.6	62.6
Ireland	16.9	20.1	22.6	22.9	29.1	32.3	33.9	34.9	37.5	46	54.8
Netherlands	29.7	29.4	31.3	30.6	32.2	40.1	49	52.7	59.2	67.9	81.7
Spain	31	30.8	30.8	31.9	33.4	42	48.9	52.7	56.7	63.7	74.8
Sweden	11.1	11.4	11.2	11	12.5	15.9	18.2	19.3	21.2	21.2	22.6
Switzerland	22.1	22.2	19.4	21.1	25.5	30.3	33.8	35.4	37.8	42.7	53.1
Other	27.1	26.8	25.9	26.4	27.9	33.5	38.6	42.9	46.2	50.3	58.9
Western Europe	503.1	504	490.4	488.8	524.4	630.9	721.9	762.7	822.4	935.4	1,076.80
Russia	23.8	24.6	27.4	29.1	30.3	33.4	37.5	40.9	53.1	63	77.6
Other	22.3	20.3	21.9	23.4	25.3	31.4	39.6	46.2	55	68.4	87.5
Central/Eastern Europe	46.1	44.9	49.3	52.5	55.6	64.8	77.1	87.1	108	131.3	165.1
Africa & Middle East	52.7	53.2	59.2	57.4	60.4	73	86.4	99.3	109.6	124.2	160.4
Japan	193.8	220.4	239.7	208.3	197.2	218.8	243.6	251.3	248.5	245.4	298
Asia-Pacific excluding Japan	215.2	241.9	276.1	271.5	300.5	369.1	463.9	567.5	668.8	795.5	993.2
China	80.9	87.8	103.6	111	126.5	159.9	205	269	331.4	406.4	549.4
India	30.7	35.3	35.3	32.5	33.5	40.8	53.3	63.6	72.5	91.1	98.2
Australia	11.3	12.1	11.2	10.8	11.3	14.9	17	18.7	19.1	22.8	27.1
Korea	39.3	45.5	56.3	50.4	54.9	64.4	78.7	91.9	103.4	116.7	133.2
Singapore	6.3	8.5	9.5	9.4	12.5	16.1	20	22	25.8	28.9	31.6
Taiwan	21.9	23.7	29.2	26.8	28.4	34.3	44.5	49.5	53.8	57.4	62.9
Other Asia/Pacific	24.8	29.1	30.9	30.8	33.3	38.8	45.5	52.9	62.9	72.2	90.8
Asia/Pacific	409	462.3	515.7	479.7	497.7	587.8	707.5	818.8	917.3	1041	1291.2
Total world shipments	1573.5	1625.5	1719	1670.9	1748.8	2008.5	2325.6	2596.4	2858.1	3160.7	3696.8

Sustainability – Introduction to Chemical Production Processes

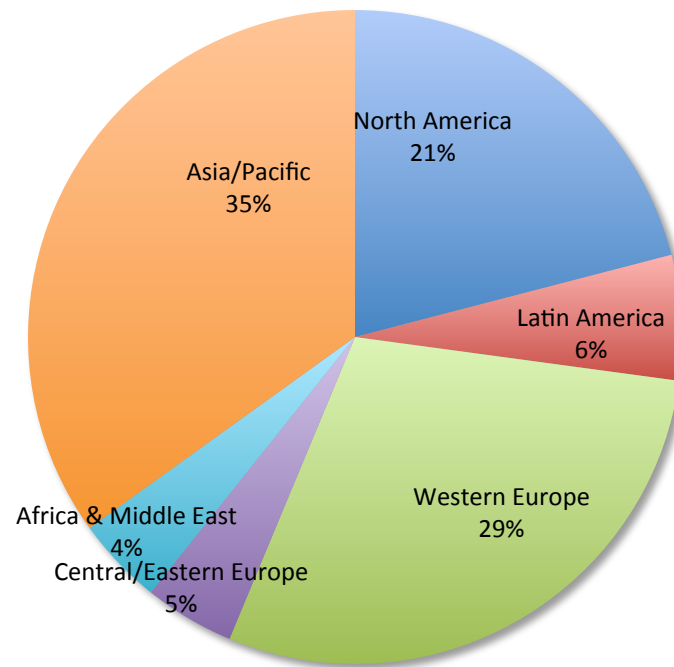
Global Chemical
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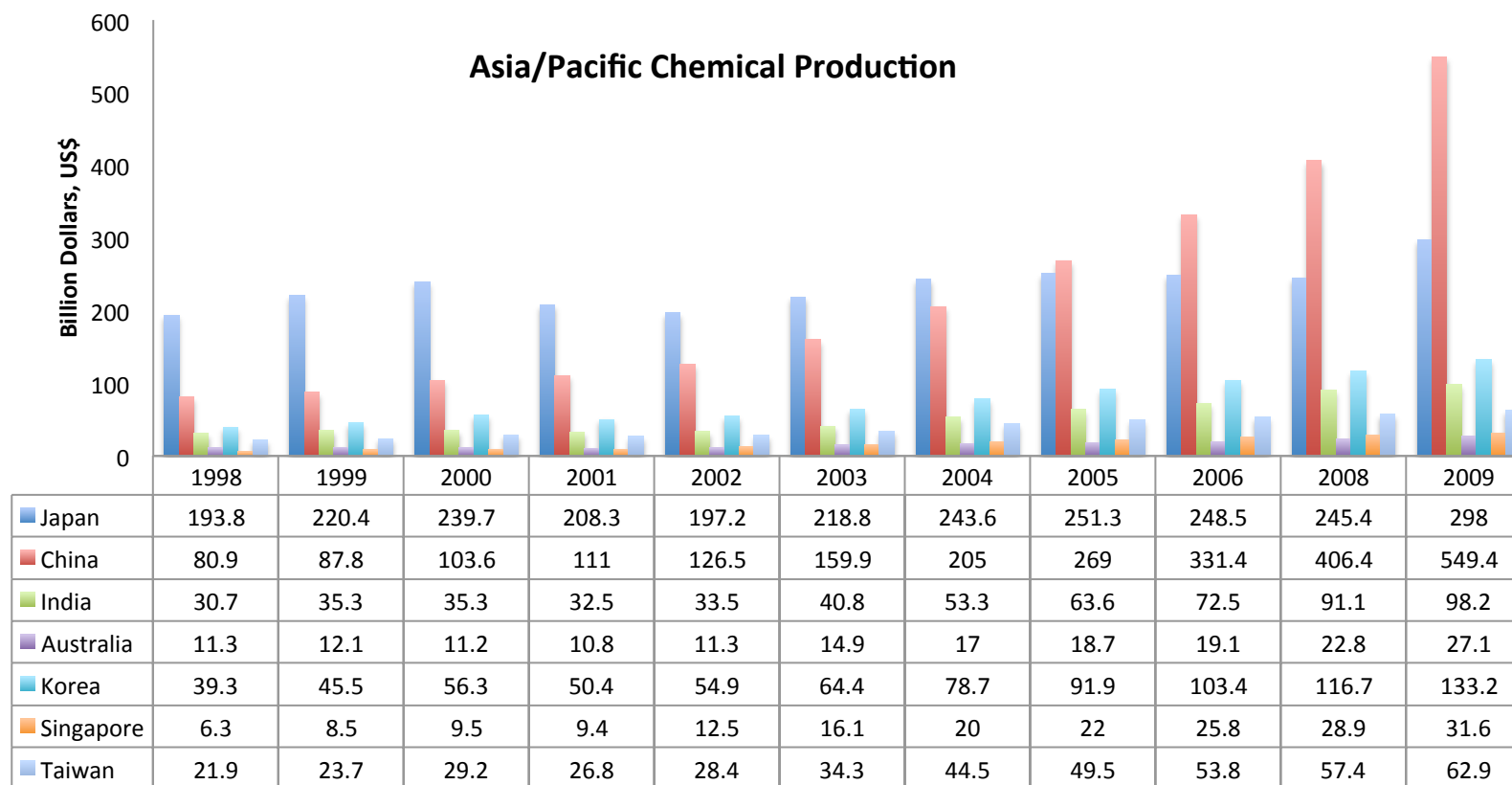
Sustainability – Introduction to Chemical Production Processes

Global chemical production in year 2009



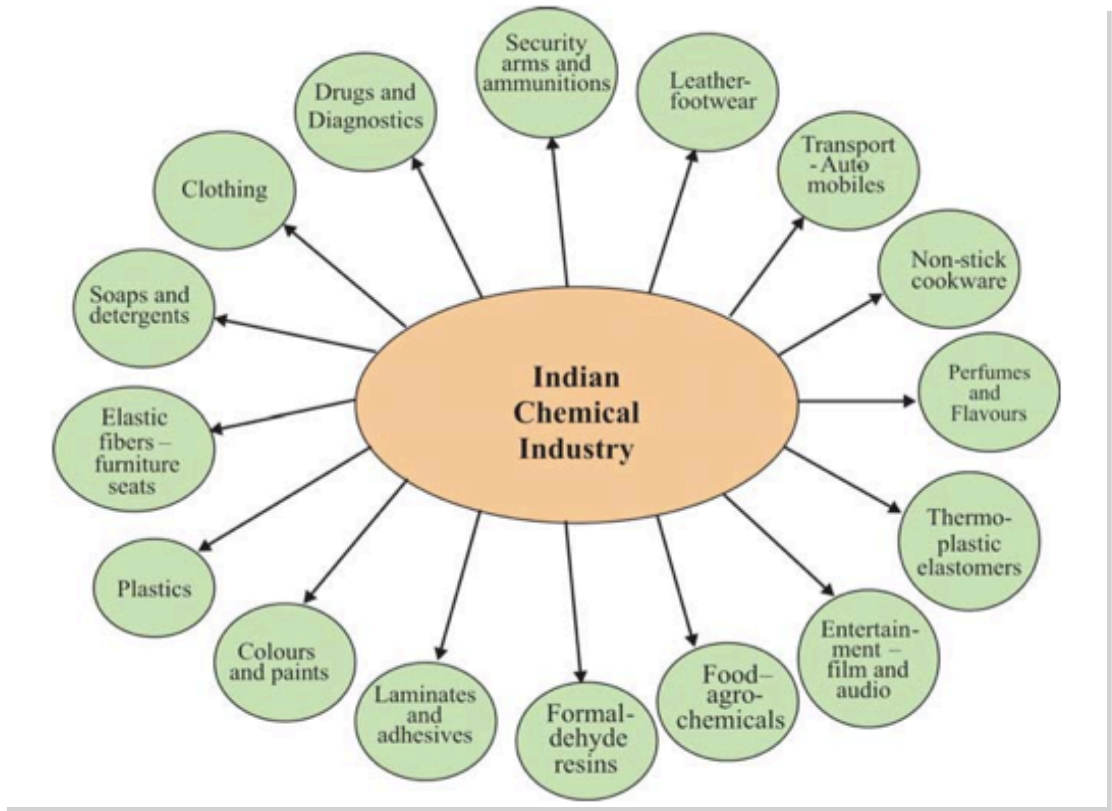
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Sustainability – Introduction to Chemical Production Processes



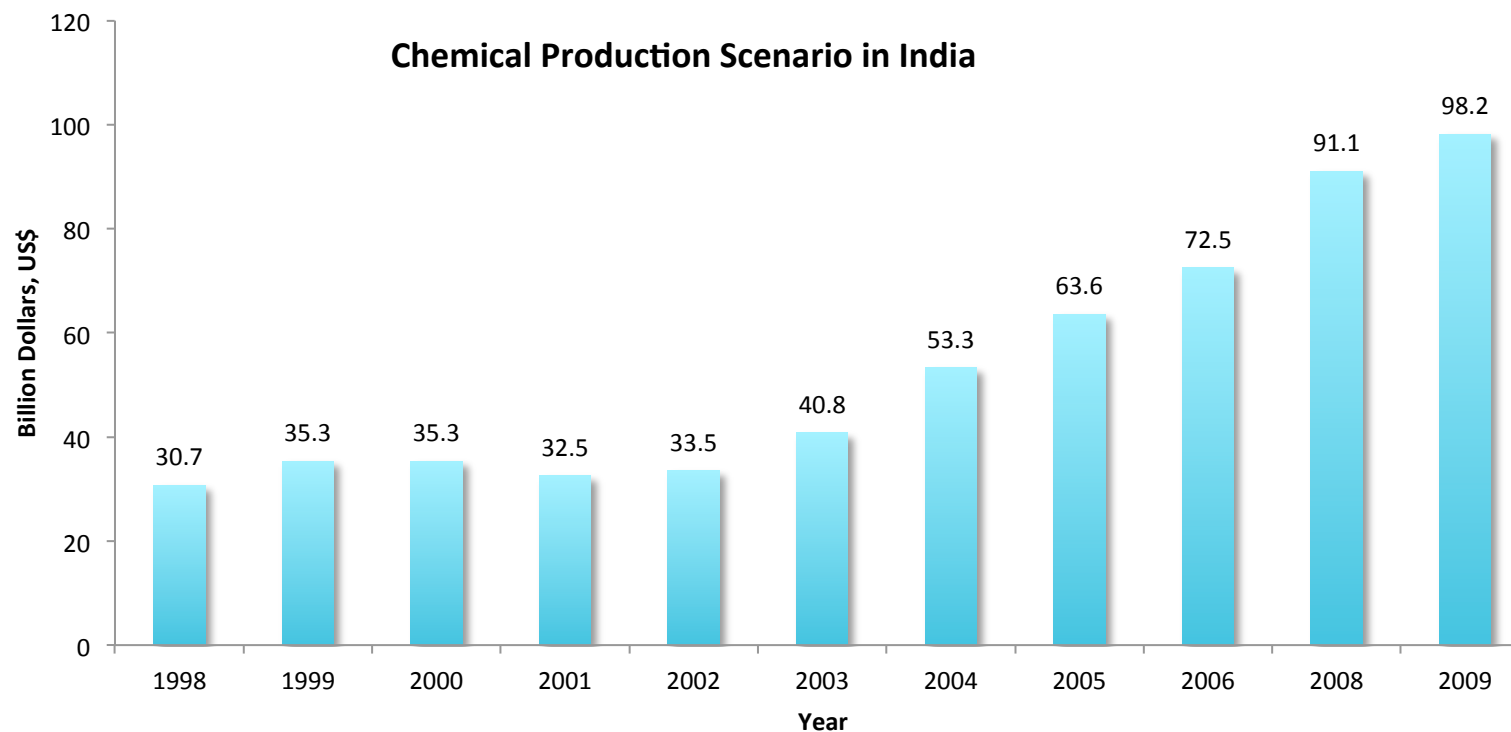
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Sustainability – Introduction to Chemical Production Processes



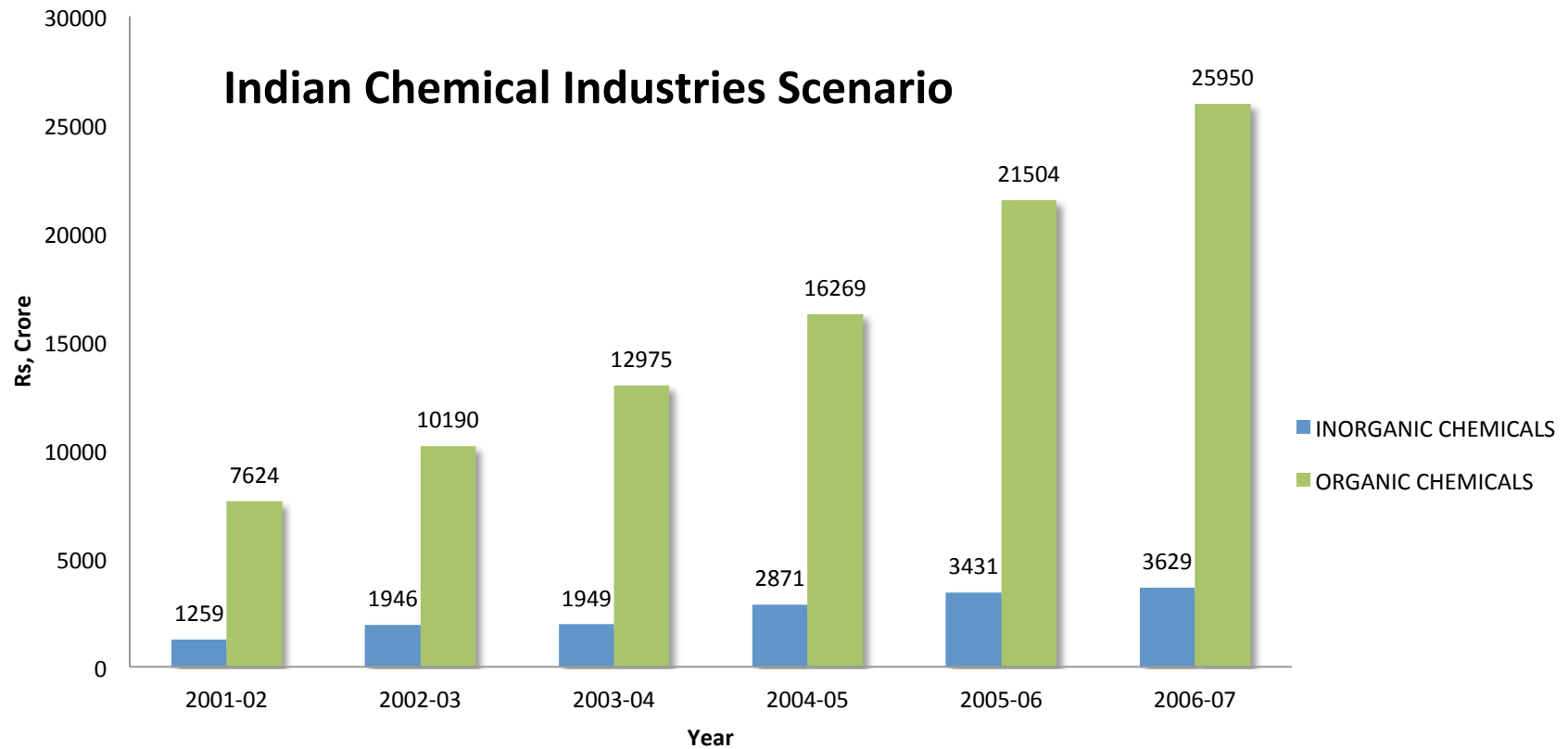
SOURCE: Indian Chemical Industry: A Sector Study, Export-Import bank of India, Quest Publications, March 2007

Sustainability – Introduction to Chemical Production Processes



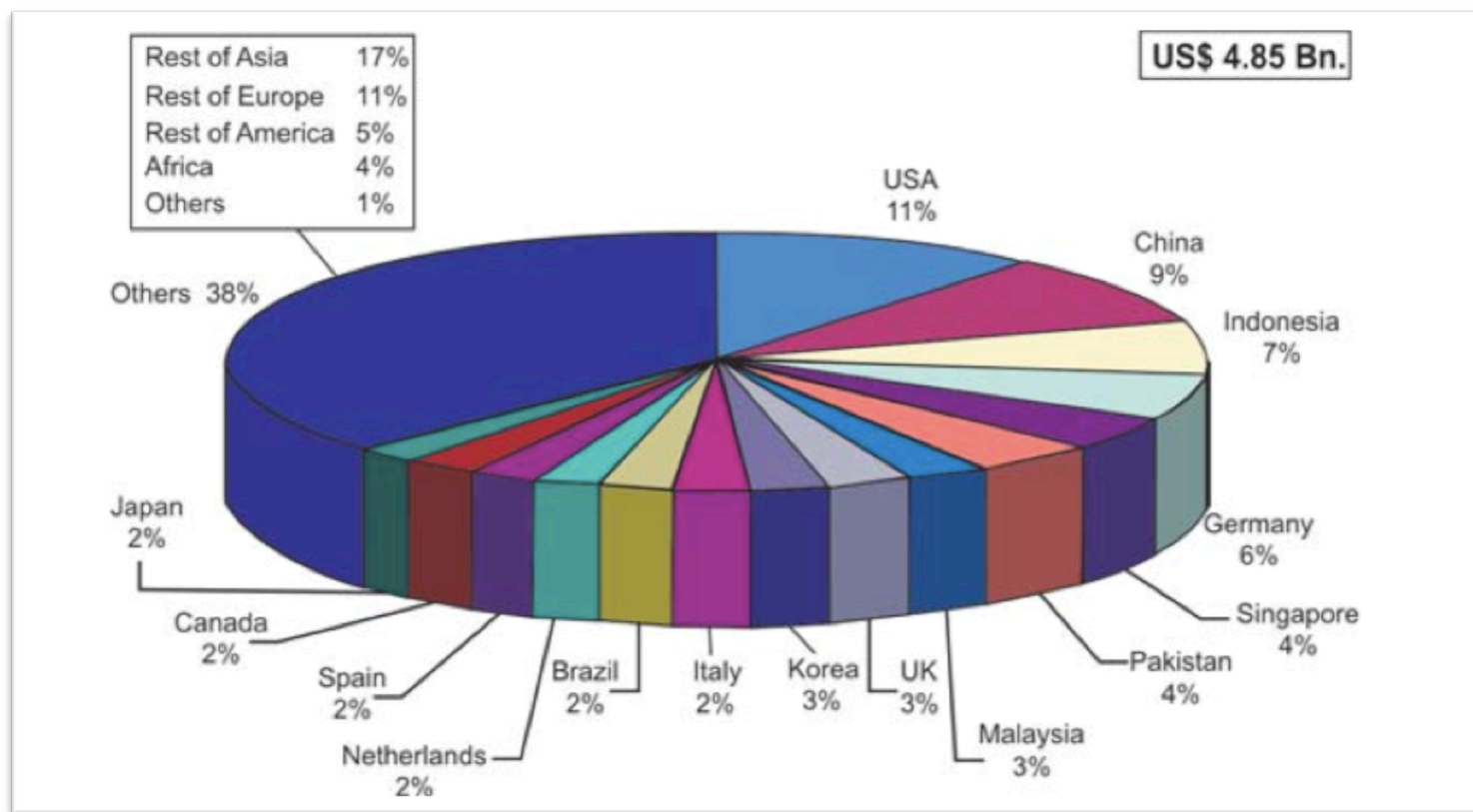
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Sustainability – Introduction to Chemical Production Processes

The screenshot shows the top navigation bar of The Hindu BusinessLine website with links for Today's Paper, Topics, ePaper, WealthCheck, and Subscription. Below this is a banner for Uti Mutual Fund with the text 'SYSTEMATIC INVESTMENT PLAN' and 'SOMEDAY NAHI TRAVEL THE WORLD TODAY.' The main header features the BusinessLine logo and a search bar. A secondary navigation bar includes Home, News, Markets, Companies, Economy, Info-tech, Opinion, Specials, Portfolio, Catalyst, BLink, Multimedia, and Blogs. The article title 'India's chemical industry to touch \$214b by 2019: report' is circled in blue. Below the title are social media sharing buttons for Facebook, Twitter, Google+, LinkedIn, and YouTube. A sub-headline reads 'OUR BUREAU' and 'COMMENT PRINT T+'. The article text includes a sub-headline 'Ecofriendly wetting agent - Free APEO, green wetting agents Special wetting agent, Toynol agent' with the website 'www.surfychem.net'. Another sub-headline states 'Tata Strategic Management Group estimates industry to grow at 9% a year'. The main text begins with 'GANDHINAGAR, OCTOBER 29: India's chemical industry is likely to touch \$214 billion (approx ₹13,91,000 crore) in the next four years from \$139 (approx ₹9,03,500 crore) in fiscal 2014 with estimated growth of around 9 per cent a year amid growing demand scenario.'

SOURCE: <http://www.thehindubusinessline.com/economy/macro-economy/indias-chemical-industry-to-touch-214b-by-2019-report/article7818782.ece>

Sustainability – Classification of Industries in India

BROAD STRUCTURE

Sections, Divisions and Groups

Section A : Agriculture, forestry and fishing

Section B : Mining and Quarrying industries

Section C : Manufacturing

Section D : Electricity, gas, steam and air conditioning supply

Section E : Water supply; sewerage, waste management and remediation activities

Section F: ConstructionSection P

Central Statistical Organization
Ministry of Statistics and
Programme Implementation
Government of India
New Delhi India

Sustainability – Classification of Industries in India

BROAD STRUCTURE

Sections, Divisions and Groups

Section F

Divisions 41

Group 410

Divisions 42

Group 421

Construction

Construction of Building

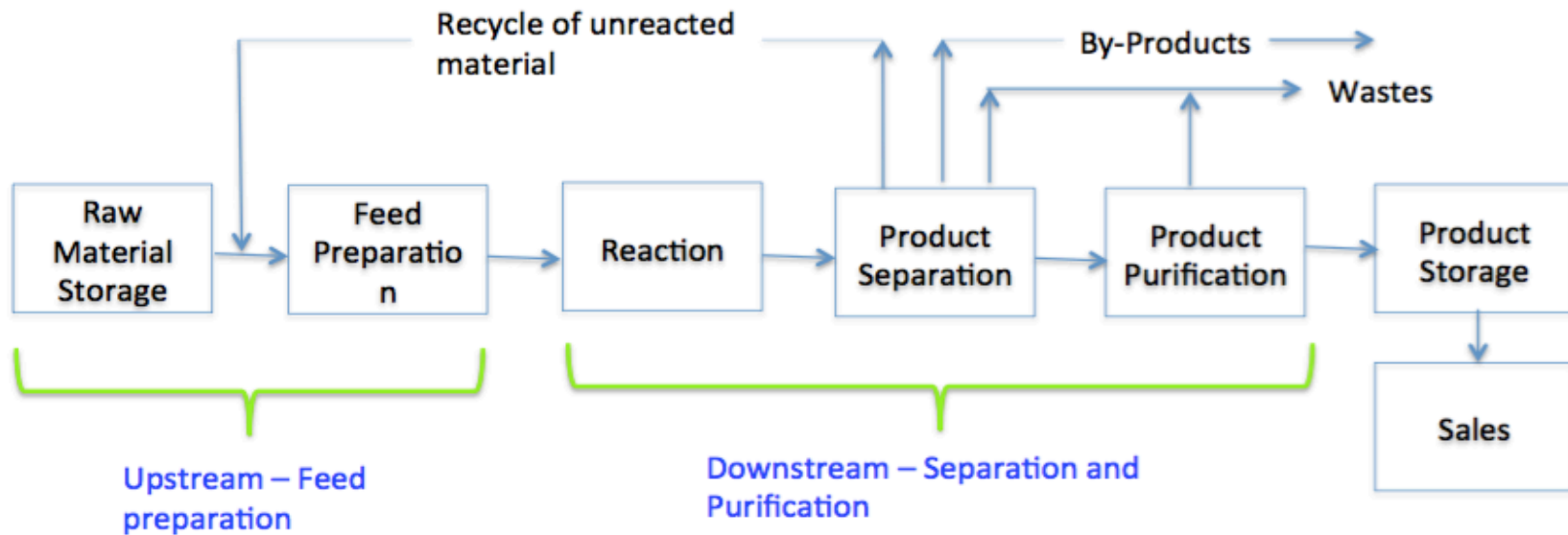
Construction of Buildings

Civil Engineering

Construction of Roads and Railways

Central Statistical Organisation Ministry
of Statistics and Programme
Implementation Government of India
New Delhi India

Sustainability – Anatomy of Manufacturing/Production Process



Sustainability – Anatomy of Manufacturing/Production Process

Upstream Process

The process that are employed in petrochemical, chemical and biochemical industries where the raw materials are processed.

The various process that are covered till the separation and purification of raw materials are called upstream process or **feed preparation** process in the above mention process industries.

Downstream Process

The process by which **separation and purification** of products from raw materials takes place.

Sustainability – Anatomy of Manufacturing/Production Process

Continuous Process

Continuous process are designed to operate **24 hours a day, 7 days a week, throughout the year**. Some **downtime** (Shut down and Start up) will be allowed for maintenance and for some processes, catalyst regeneration.

The plant attainment, that is, the percentage of available hours in a year that the plant operates, will be usually 90 to 95%.

$$\text{Attainment, \%} = (\text{hours operated}) / (8760 \text{ days}) \times 100$$

Continuous processes will be more economical for **large scale production**.

Sustainability – Anatomy of Manufacturing/Production Process

Batch Process

Batch processes are designed to operate **intermittently (or periodically)**.

Some or all, the process units being frequently **shut down and start up**.

Batch processes are used where **some flexibility** is wanted in production rate or product specification.

- Anatomy of Manufacturing Processes
- Pollution Prevention Practices
- Pollution Prevention hierarchy



- Anatomy of Manufacturing Processes
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Sustainability – Pollution Prevention Practices

- Solve its own environmental pollution and conservation problems
- Prevent pollution at source wherever and when ever possible
- Develop products that will have a minimum effect on the environment
- Conserve natural resources through the use of reclamation and other appropriate methods
- Assure that its facilities and products meet and sustain the regulations of al federal, state and local governments.
- Assist whenever possible, governmental agencies and other official organizations engaged in environmental activities

Sustainability – Pollution Prevention Practices

Waste

Materials that are coming from a manufacturing process in solid, liquid and gaseous form that are

- ① released into the environment
- ② that are not marketed for disposal
- ③ not directly used within the industry

The materials (solid, liquid and gas) may be waste to a particular process may still have value to some one else.

Sustainability – Pollution Prevention Practices

Waste

For instance, the spent liquor from the steel mill is considered as a significant waste problem by the steel industry, but it has great potential as a neutralizing agents and coagulation in other applications. The problem is that cost of marketing and transporting it to the potential user often makes it as a waste.

Thus some industrial process by-product could be categorized as a waste or a usable commodity depending on its quality and ready accessibility of a market for it.

Sustainability – Pollution Prevention Practices

Waste

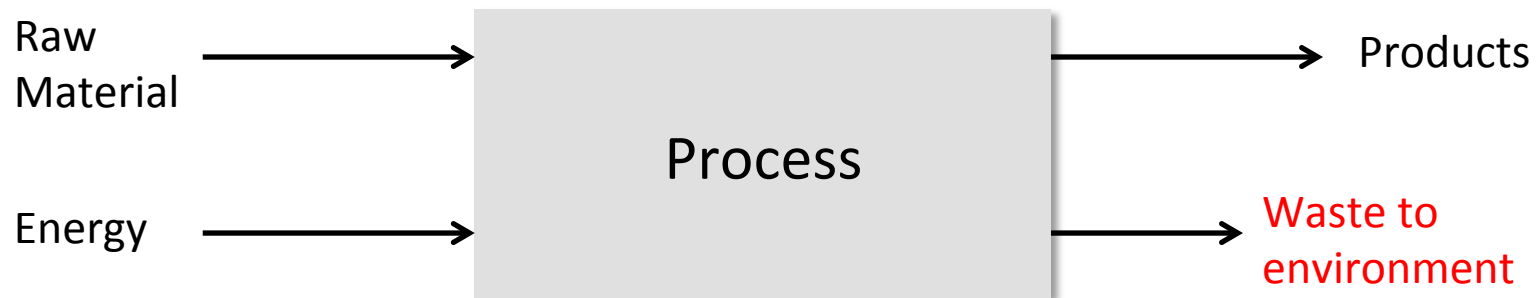
Therefore a better definition of waste:

“Waste is resource out of place”

It is the responsibility of pollution prevention personal to find the right place to turn the “waste into resource”

Sustainability – Pollution Prevention Practices

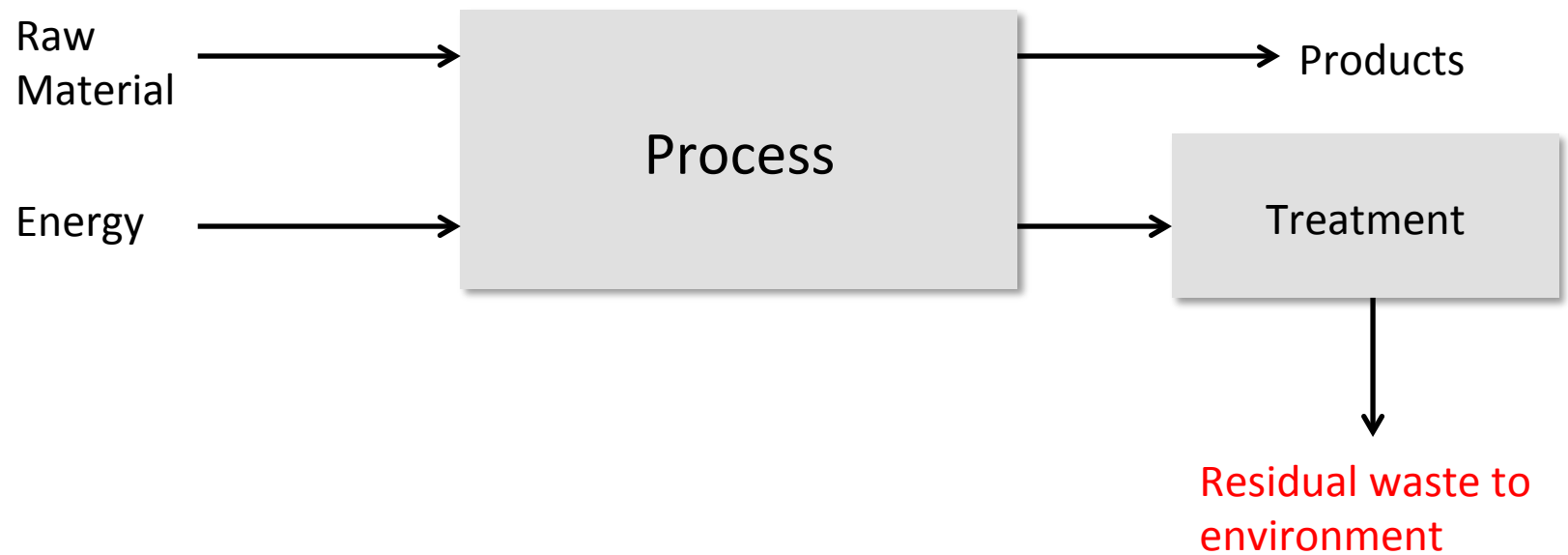
Pollution Prevention



Past industrial practices

Sustainability – Pollution Prevention Practices

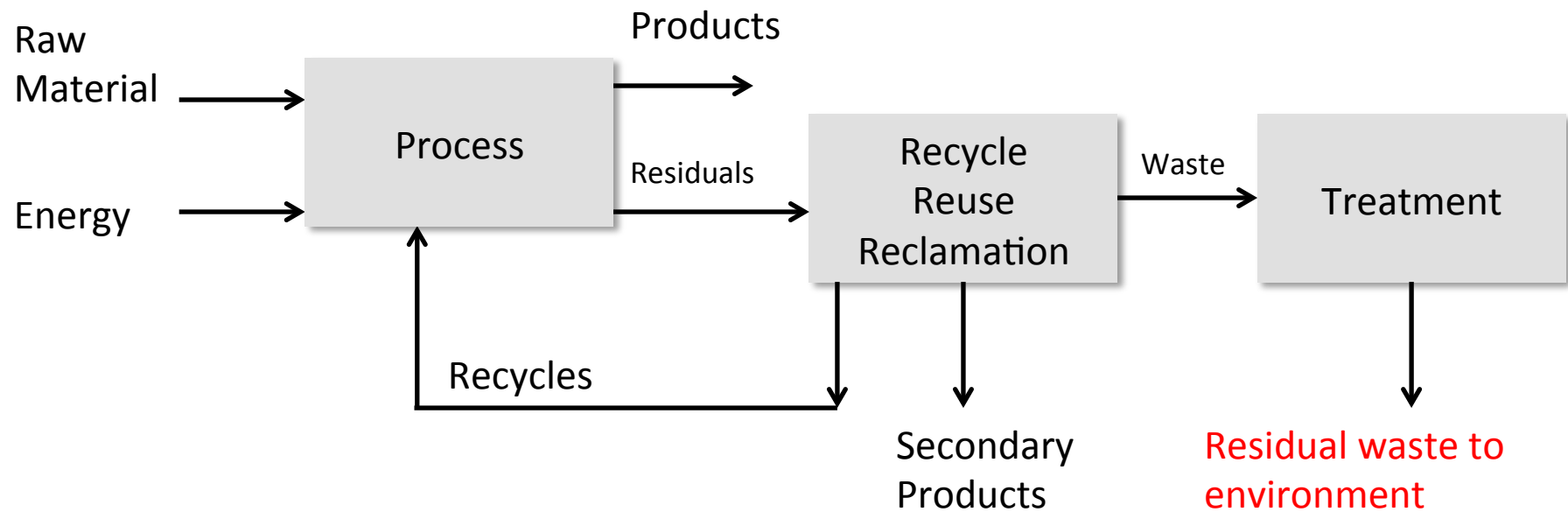
Pollution Prevention



Recent industrial practices

Sustainability – Pollution Prevention Practices

Pollution Prevention



Current Pollution Prevention Practices

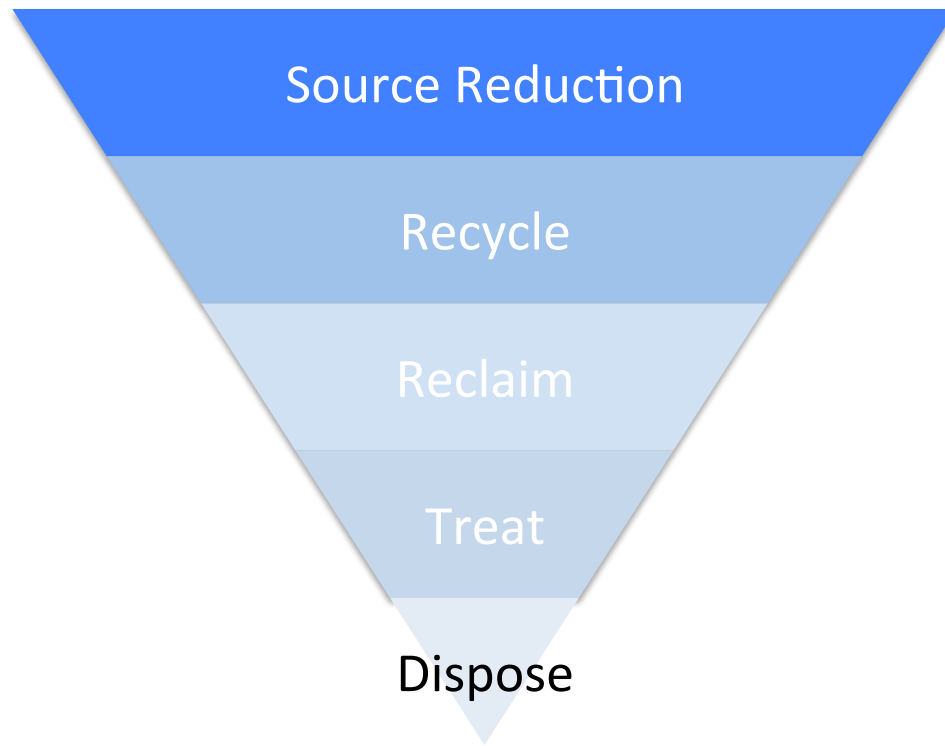
- Anatomy of Manufacturing Processes
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- Anatomy of Manufacturing Processes
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Sustainability – Pollution Prevention Hierarchy



Source Reduction

An activity that reduces or eliminates waste at the step where the pollution is created.

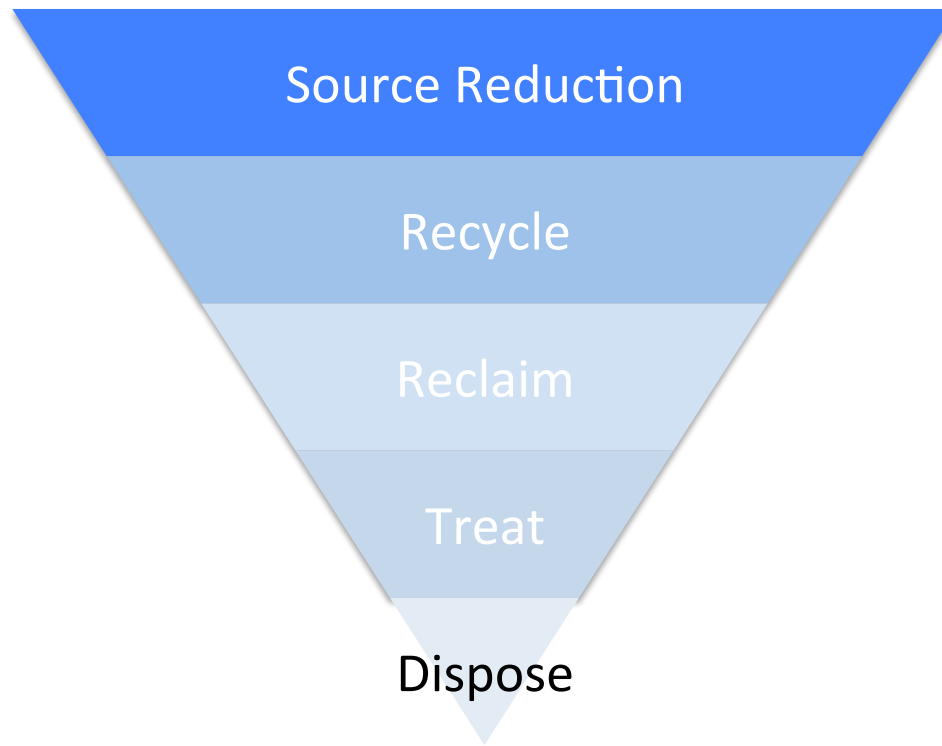
Recycle

Refers to recovery and direct reuse of a material from a waste stream

Reclaim

Generally indicates that the recovered chemical is used in some other applications

Sustainability – Pollution Prevention Hierarchy



Treat

An activity to reduce the release of hazardous waste from the industrial production process

Dispose

Final form of pollutant that are non-hazardous residues released into the atmosphere

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 - Pollution Prevention in achieving sustainability
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Sustainability – Definitions

The word sustainable was derived from Latin “**Subtenir**” meaning “**to hold up**” or “**to support from below**”.

Sustainable also means “**an action**” or “**process**” can **continue indefinitely**.

Sustainability refers to the ability of the society, ecosystem or any such ongoing system to continue function into the definite future without being forced into decline through exhaustion of key resources.

Definition for Sustainability

Sustainability – Definitions

A sustainable development meets the needs of the present without compromising the ability of the future generations.

Definition for Sustainability

Sustainability – Industrialization and Sustainable development

Safe

Universally Stable

Technology that benefits all

Antipollution

Improvement in quality of life

Non toxic

Awareness

Beautiful

Indigenous knowledge

Least-cost production

Income

Total Quality

Youth

Definition for Sustainability

Sustainability – Industrialization and Sustainable development

What is a sustainable Development?

Sustainability is essentially made of the following percepts that are closely interconnected

1. The **environment** is an **integral part** of the economy; it is **not free of cost**
 2. **Equity** between the **developing and developed** countries are essential.
 3. **Every entity** (country to individuals) **should have long term futuristic goals** in mind and **should not operate** on the basis of **short term benefit**.
 4. **Holistic approach** and **policies** need to be **proactive rather than reactive**.
-

Sustainability – Industrialization and Sustainable development

What is a sustainable Development?

Therefore based on Brundtland Commission Definition Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainability – Industrialization and Sustainable development

What is a sustainable Development?

Sustain : Maintain; supply with necessities or nourishment; support

Develop : Expand or realize the potentials of growth; bring gradually to a higher scale

Sustainability – Comparison of What is? and What is not Sustainability

What is?	What is not?
Integrated decision making process	Justification of business as usual
Research and information	Growth at all costs
Democratic values	Heavier command and control systems
Community participation	All things to all people
Collaboration	Static or declining economy
Equity, justice and shared progress	Quick fixes and ad hoc solutions

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Sustainability – Barriers or hurdles in Sustainable development

- Level of Consumption
 - Apathy
 - Developing Nations
 - Lack of public awareness
 - Lack of knowledge
 - Magnitude and Number of Uncertainties
-

Sustainability – Barriers or hurdles in Sustainable development

- Level of Consumption

Mass consumption is not possible indefinitely and if we continue to consume the resources indiscriminately, there will be nothing left to the future generation.

For example. The way people live in developed countries like America is extremely expensive in terms of per capita resource and energy consumption.

Every year on an average each American consumes 20 metric ton of new materials including the energy which is equal to 12 tons of coal.

Sustainability – Barriers or hurdles in Sustainable development

- Level of Consumption (Continued...)

If all the people living in the earth are likely to in the latter part of the 21st century consumes the resources (Materials and Energy) in such a rate as Americans, the worlds energy production would be 14 times greater than the present level.

So the recoverable energy resources would be exhausted in about 14 years.

Sustainability – Barriers or hurdles in Sustainable development

- Apathy (Lack of interest or enthusiasm)

Wealthy people are often apathetic towards the need of conserving the resources and affluent (great deal of money) living styles commonly leads to mass consumption.

- Developing Nations

Peoples in the developing countries aspire towards higher standards of living and often disregard the importance of conserving the environment. Much of the time, the production capacity is being used for the benefit of rich or developed countries and as a result the environmental status of developing countries keeps on deteriorating because they have more urgent needs than environmental improvement.

Sustainability – Barriers or hurdles in Sustainable development

- Lack of public awareness

The public needs to be provided with sustainable information and needs to be made aware of importance of achieving a sustainable world.

- Lack of knowledge

Developed countries do not fully ware of achieving sustainability and even less is known in developing countries.

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Sustainability – Achieving Sustainability

- To achieve a sustainable development we must consider all its dimensions



Ecological



Social



Economic



Economic

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Sustainability – Sustainable strategies

- A strategy or framework is required to guide the path of sustainability

 - 7 Principles towards the preparation of sustainable development
 1. Integrative approach
 2. Focus on issues
 3. Global orientation
 4. Compatibility with policy processes
 5. Consensus building
 6. Action Orientation
 7. Capacity enhancement
-

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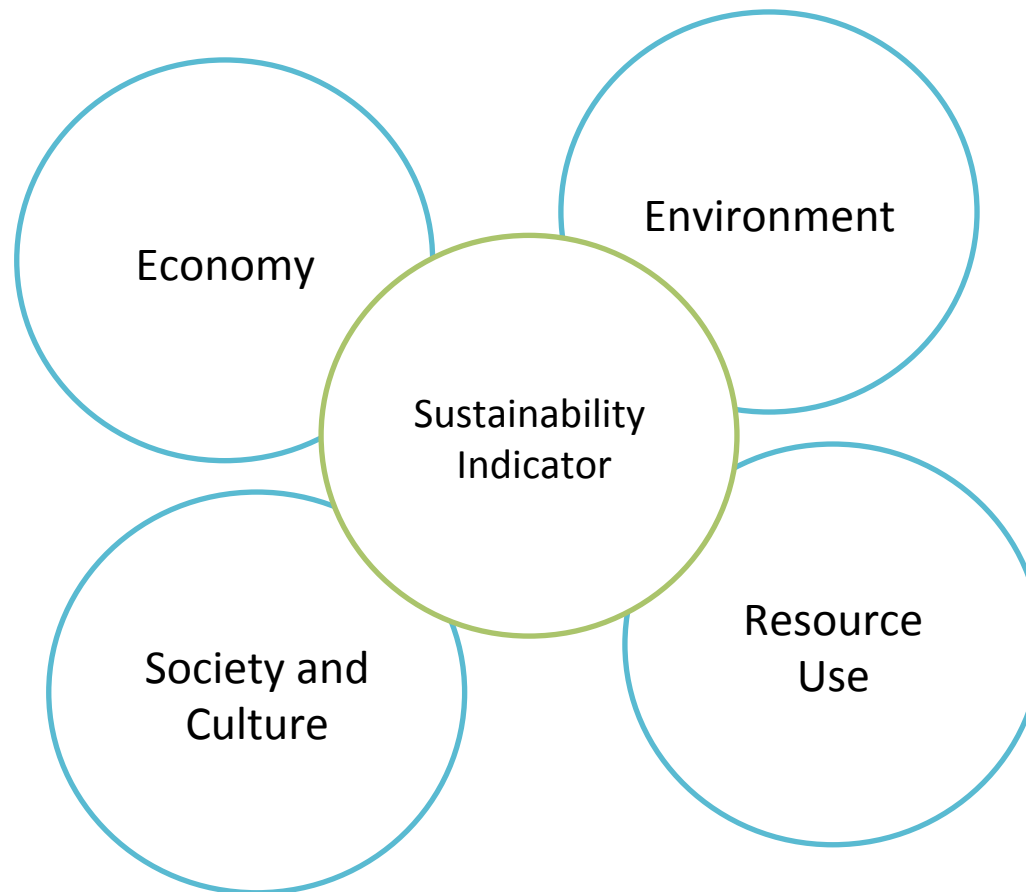
Sustainability – Indicators of sustainability

- Once we take steps to achieve sustainability, we need some indicators to tell us if we are on the right track.
- Indicators are required to make any necessary mid course actions.

Minimum requirements for good sustainable indicators

1. Should represent a critical ecosystem
 2. Should measure accurately and provide information repeatedly
 3. Understand the health of the eco system
 4. Should be accepted by the community
 5. Should have the potential to link with other sustainability indicators
 6. represent and relate community values
-

Sustainability – Examples of sustainability indicators



Sustainability – Examples of sustainability indicators

Indicator	Description
Economy	
Income	Distribution of jobs and income, GDP, GNP and stock market average
Industrial Business outcomes	Percentage of wages or salaries earned within a community and spent within the community
Training	Employer dedication towards continuous training and education
Human Development	Education, health care, cost of living, and cultural diversity

Sustainability – Examples of sustainability indicators

Indicator	Description
Environment	
Air	CO ₂ emissions from transportation and rapid industrialization.
Drinking Water	Percentage reduction in drinking water supply
Land use	Percentage of development occurring annually within an urban area

Sustainability – Examples of sustainability indicators

Indicator	Description
Resource Use	
Energy	% of energy used that is derived from renewable sources
Drinking Water	Consumption of hazardous materials
Land use	Water conservation

Sustainability – Examples of sustainability indicators

Indicator	Description
Society and Culture	
Abuse	Child abuse/neglect/abandonment
Diversity	Racism perception
Volunteerism	Volunteer rate for sustainability activities

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Sustainability

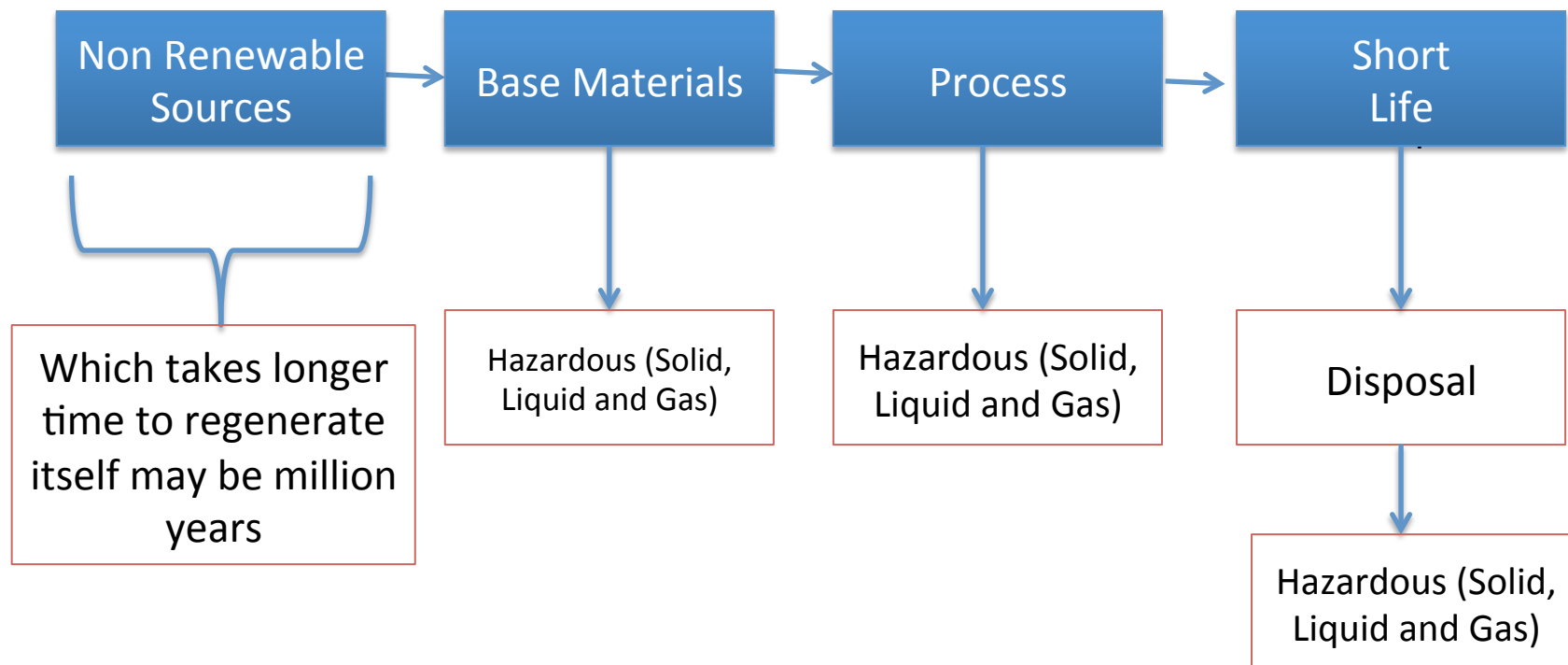
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Sustainability – Pollution Prevention in Achieving Sustainability

- Cleaner Production
 - Four approaches in cleaner production
 1. Precautionary approach
 2. Preventive approach
 3. Democratic control
 4. Integrated and holistic
-

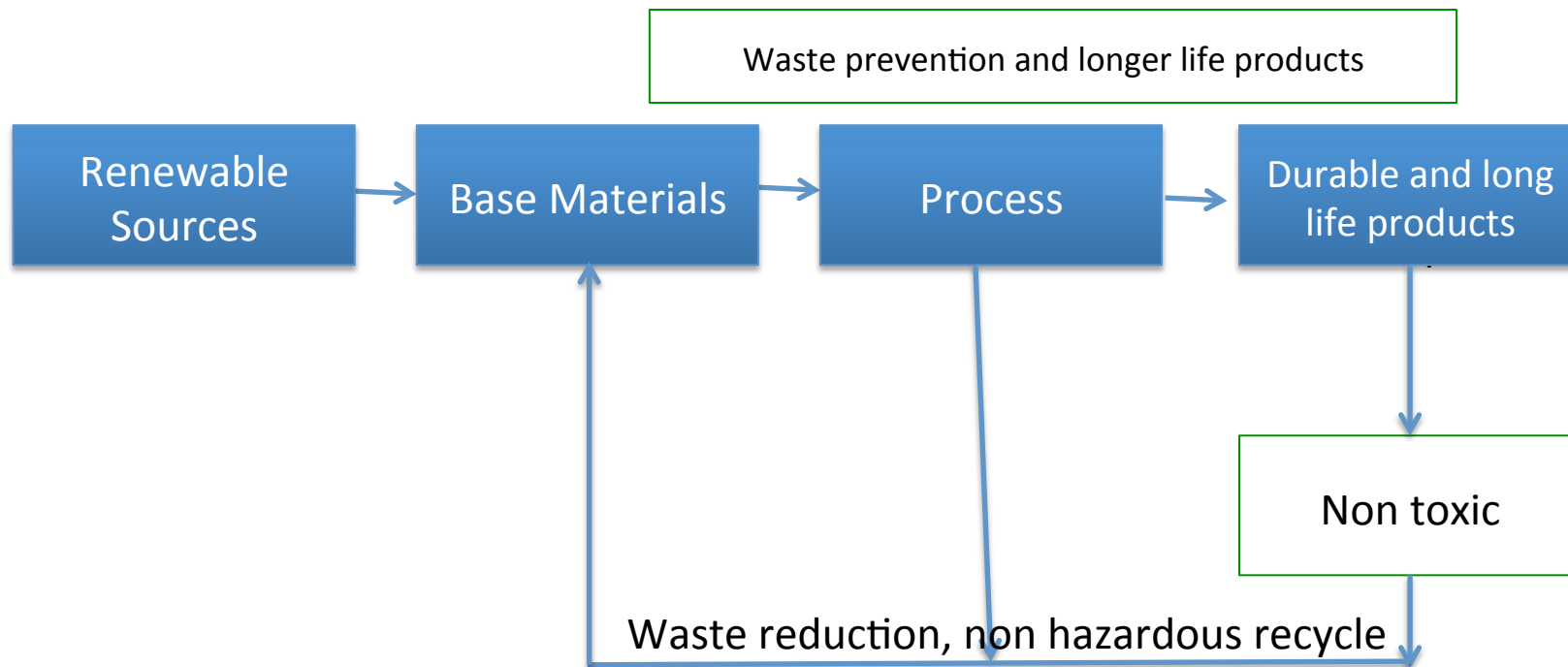
Sustainability – Pollution Prevention in Achieving Sustainability

- The past production system (linear approach)



Sustainability – Pollution Prevention in Achieving Sustainability

- The present cleaner production (circular approach)



Sustainability – Pollution Prevention in Achieving Sustainability

- Cleaner Production
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 4. Integrated and holistic
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Sustainability – Topics Covered

- Industrial Activity and Environment
 - Industrialization and Sustainable development
 - Indicators of Sustainability
 - Sustainable Strategies
 - Barriers to Sustainability
 - Pollution Prevention in achieving sustainability
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