Introduction to Mitigation Technologies for Industry

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The Climate Technology Centre and Network

- Operational arm of the UNFCCC Technology Mechanism
- Consortium of organizations from all regions
- Mission to stimulate technology cooperation and enhance the development and deployment of technologies in developing countries
- Technologies include any equipment, technique, knowledge and skill needed for reducing greenhouse gas emissions and for adapting to climate change effects
- Core services include:
  - Technical assistance to developing countries
  - Knowledge platform on climate technologies
  - Support to collaboration and partnerships

UNEP

United Nations
Framework Convention on
Climate Change

UNIDO

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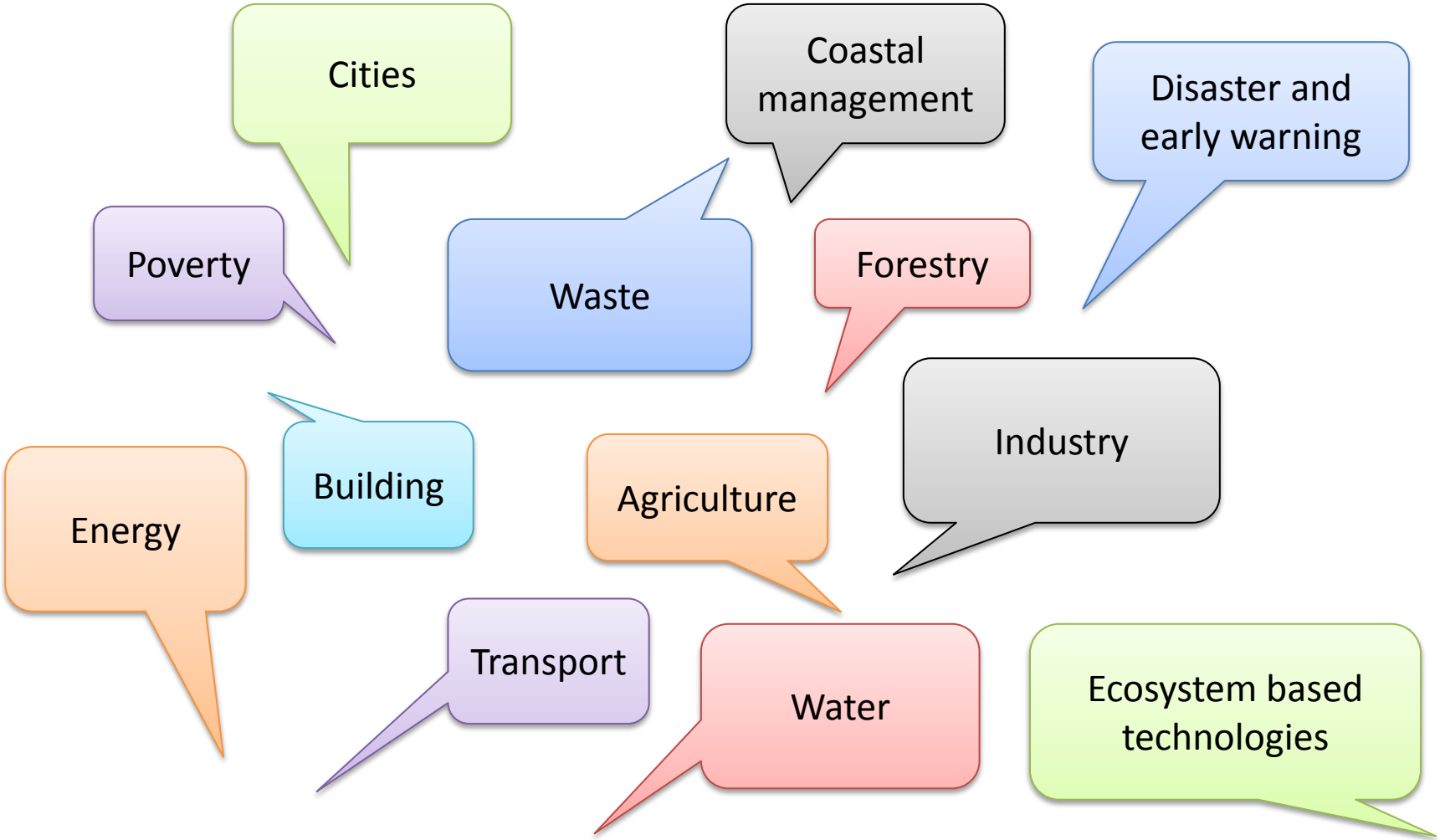
An introduction to climate technologies…



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  - Select the “questions” pane on your screen and type in your questions
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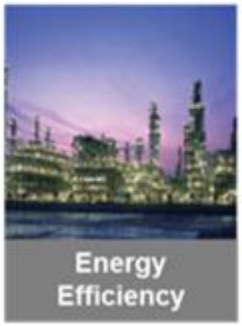
Who we are – ECN

Energy research Centre of the Netherlands

- Knowledge and technology for a sustainable energy system



Experience working in: Argentina, Brazil, Columbia, Ghana, Indonesia, Kenya, Kuwait, Mexico, Mozambique, Pakistan, South Africa, Thailand and others

Global Sustainability Group

- Climate and energy strategies
- Developing country partners

1. Scoping & Prioritizing
2. Policy and Planning
3. Renewable Energy Deployment
4. Increased Policy Effectiveness

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Who we are – Presenters

Arjan Plomp works as a scientist at ECN Policy Studies. He graduated in chemistry and holds a PhD in catalysis. His work involves the energy use and emissions in the industry sector. He is involved in various projects, e.g. design of Dutch energy outlooks and scenarios, technology explorations and other projects with an industrial focus.

Lachlan Cameron is a policy advisor and technical analyst specialising in international climate policy, renewable energy support and themes such as nationally appropriate mitigation actions (NAMAs) and intended nationally determined contributions (INDCs).

Ad Seebregts is a senior researcher at ECN. His key qualifications are power generation energy technologies, cost assessments, energy system modelling and scenario studies, uncertainty analysis, decision analysis, monitoring, risk and reliability analysis. His current projects are related to the power generation sector in the Netherlands and Europe.

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Objective of this webinar

- Show relevance of industrial energy use and emissions
- Introduction to energy efficient technologies in industry by subsector
- Policies available to implement energy efficiency measures in industry
- References for more information

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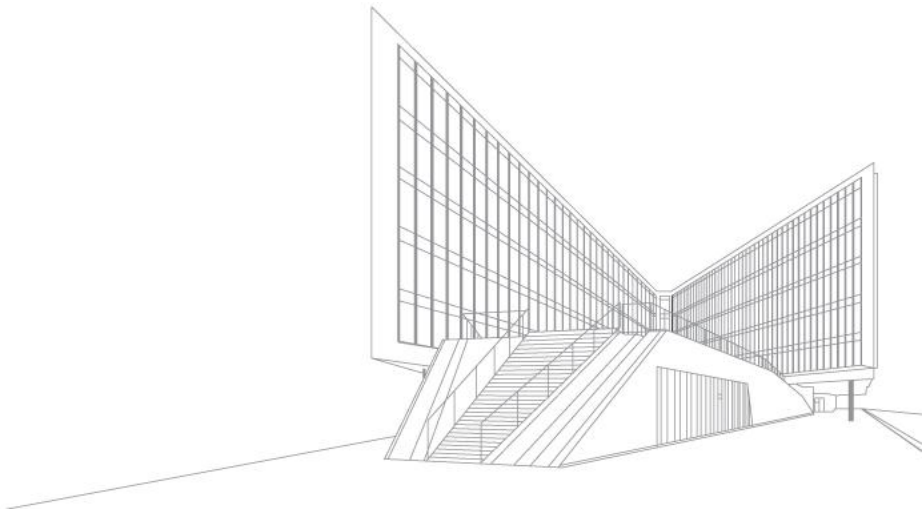

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Introduction

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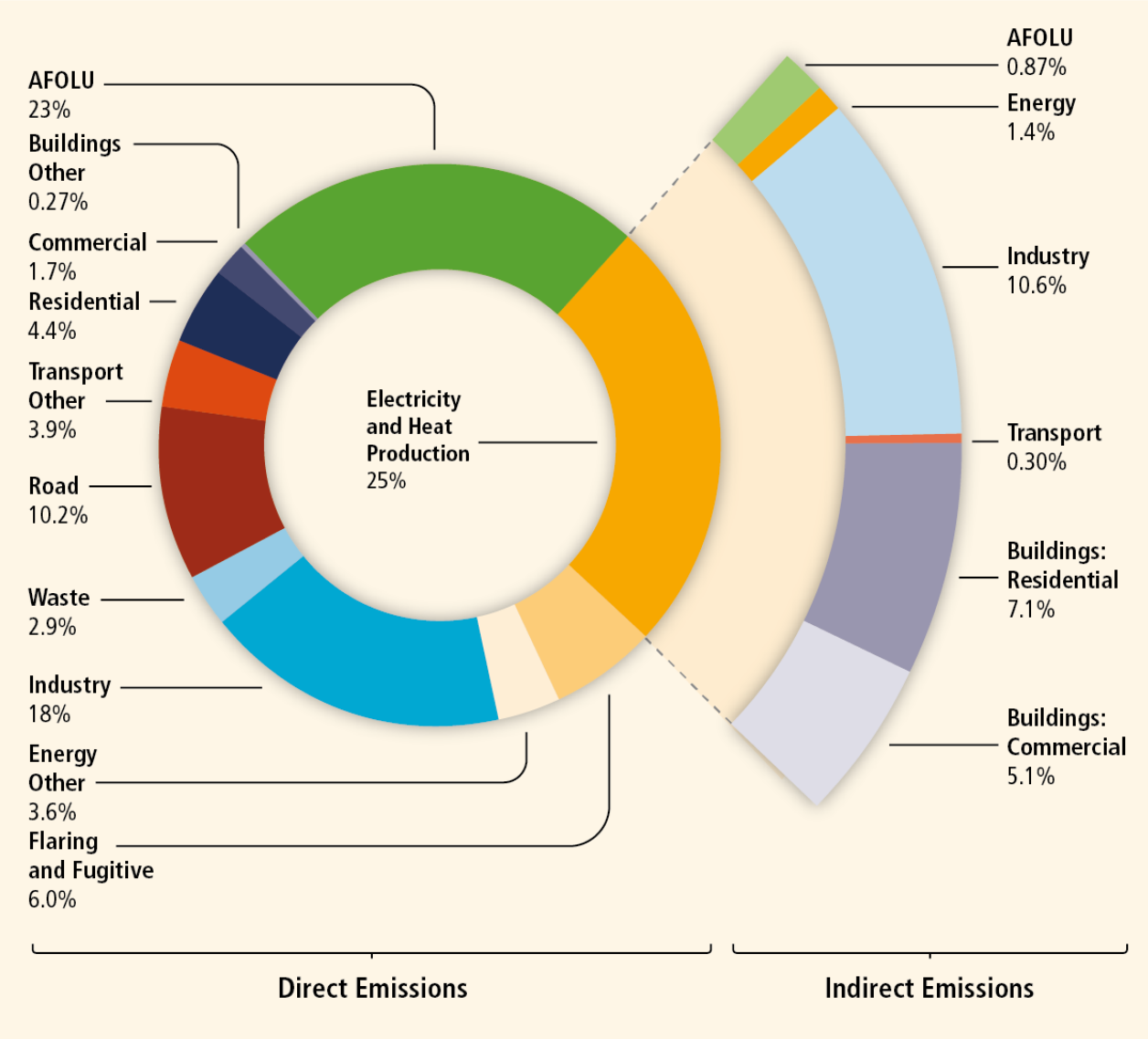
A. Emission trends in industry



Source: IPCC, 2014, AR5

A. Emission trends in industry

- World production trends of mineral extractive industries, manufacturing, and services, have grown steadily in the last 40 years

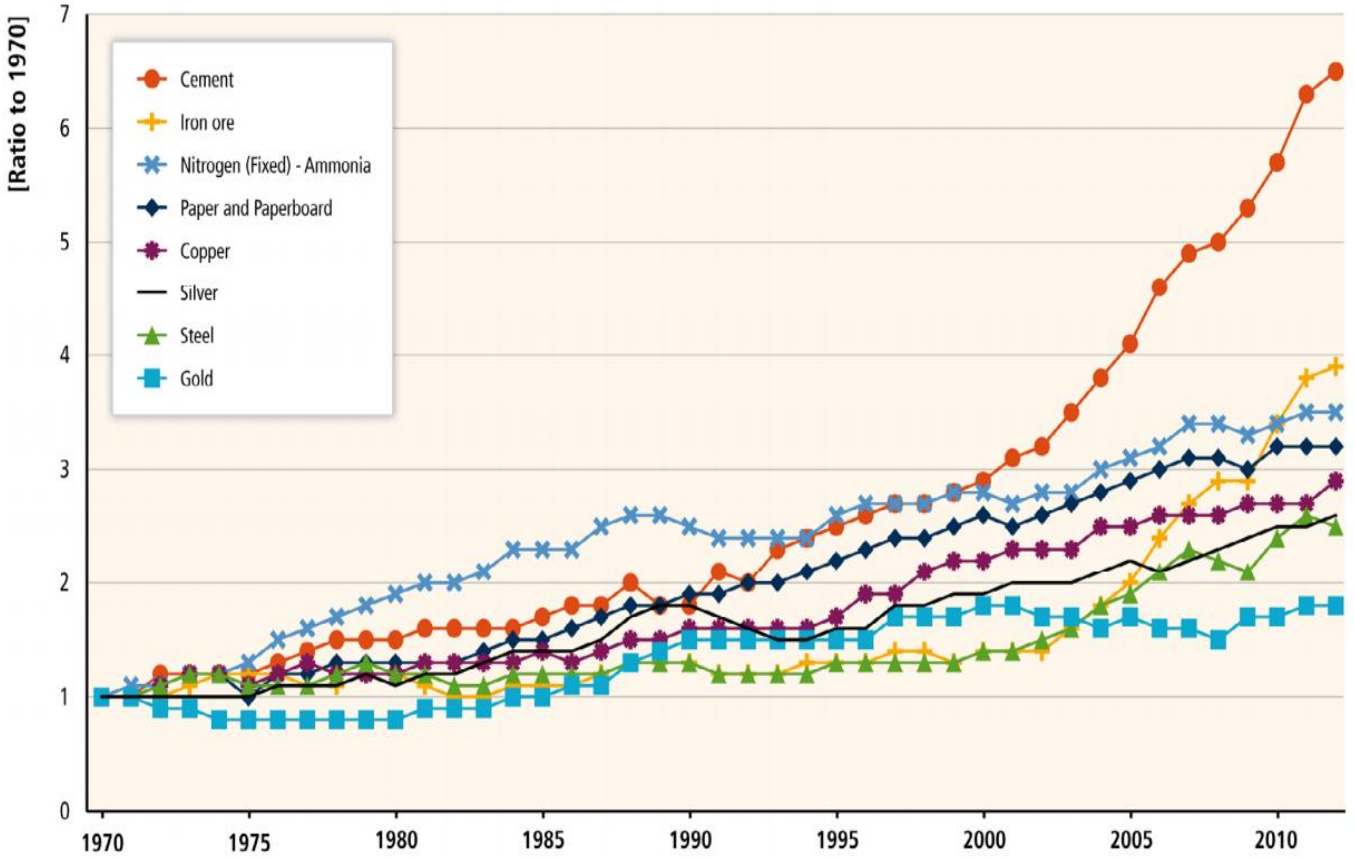


Figure 10.3. World's growth of main minerals and manufacturing products (1970=1). Sources: (WSA, 2012a; FAO, 2013; Kelly and Matos, 2013).

Source: IPCC AR5 WGIII

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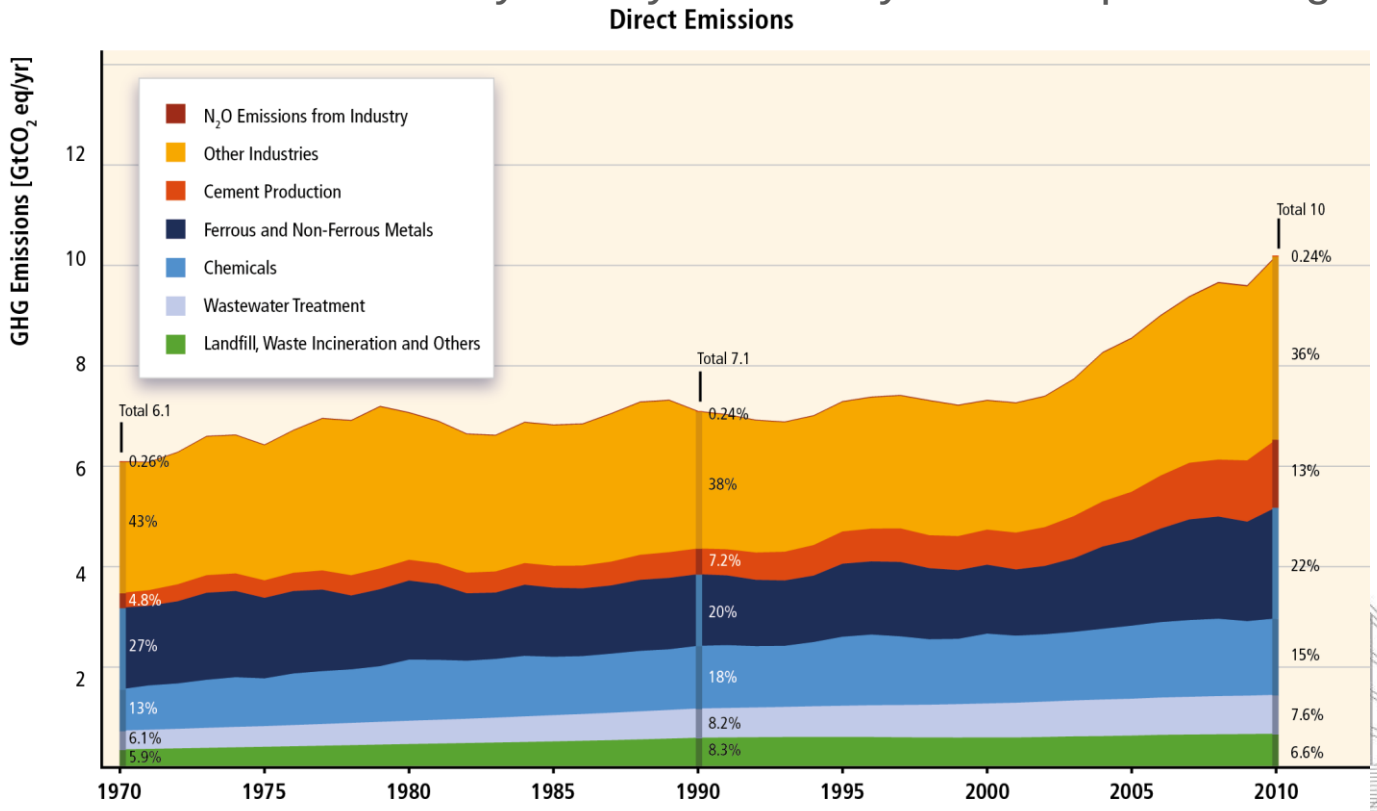
A. Emission trends in industry

- How much does the industry sector contribute to Green house gas emissions?
  - ~30%, including indirect emissions
- GHG grew from 10.4 GtCO2eq in 1990 to 15.5 GtCO2eq in 2010.
- Emissions from the industry mostly caused by material processing



Source: IPCC AR5 WGIII

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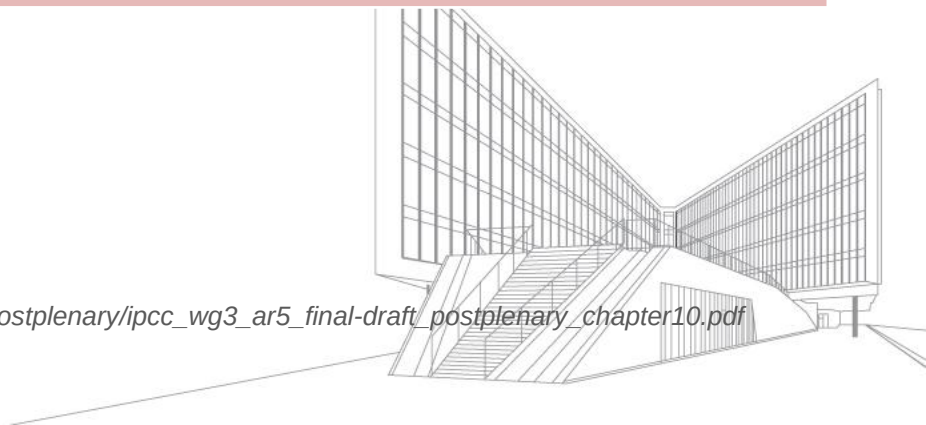
B. Mitigation options across sectors

Mitigation opportunities in the IPCC report are categorized as follows:

Energy efficiency	Emissions efficiency and fuel switching
less energy to achieve the same outputs	lower emissions while achieving the same outputs
Material efficiency	**Reduced product and service demand**
less material demands for the same output	lowering overall demand for outputs



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http://report.mitigation2014.org/drafts/final-draft-postplenary/ipcc_wg3_ar5_final-draft_postplenary_chapter10.pdf page 49, also barriers available

Subsector: Iron and Steel

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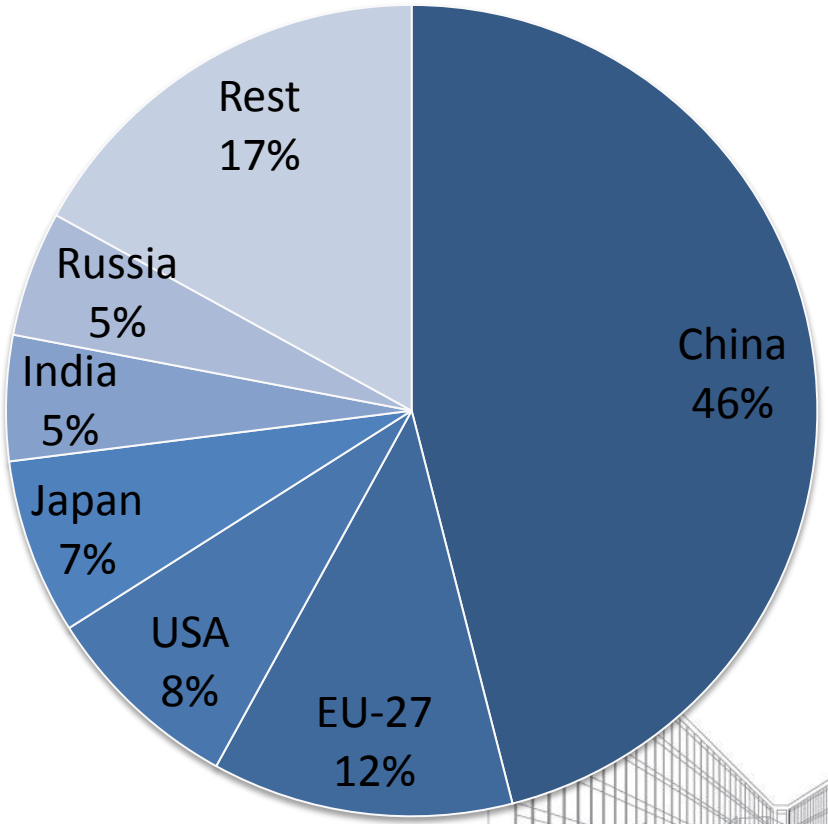
Source picture: http://www.tata.com/images/photo_gallery/blast_furnace/blast_furnace_7.jpg

A. Subsector: Iron and Steel

- 5% of global emissions
- Processes very similar
- 1/3 of steel from scrap

World steel production



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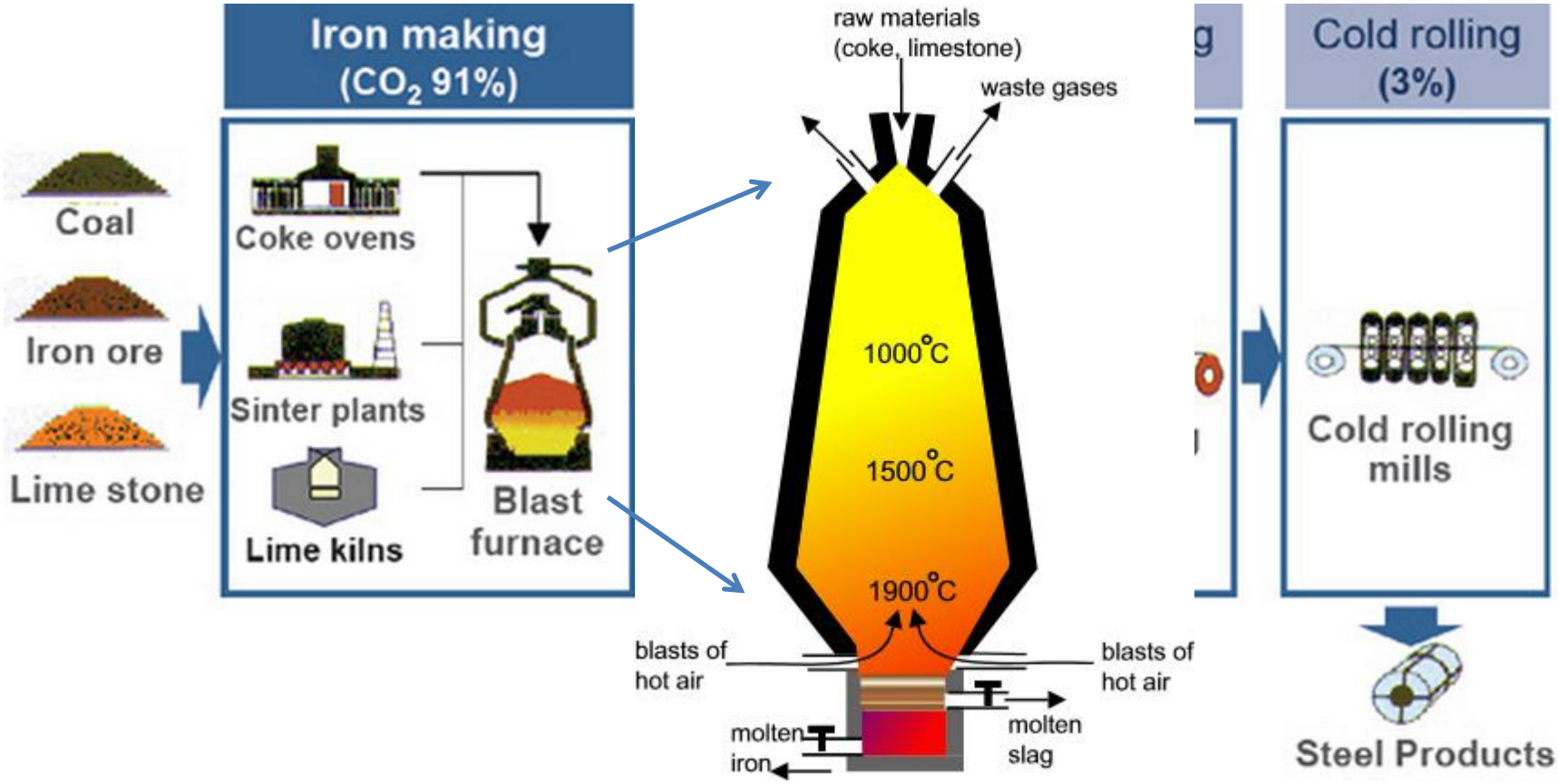
A. Subsector: Iron and Steel



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Source: http://decarboni.se/publications/ideal-portfolio-ccs-projects-and-rationale-supporting-projects-report/332-capture-iron

A. Subsector: Iron and Steel

Energy efficiency	Emissions efficiency and fuel switching
• Heat and energy recovery ①use of top gas turbine ②re-use of blast furnace gas • Improved fuel delivery through pulverized coal injection • Improved furnace design and process controls • Reduced number of temperature cycles	• Electric arc steel making (mainly secondary steel) • Natural-gas based production routes • Top gas recycling
Material efficiency	**Reduced product and service demand**
Significant potential during production of steel products	Amount of steel in buildings and cars

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Subsector: Cement

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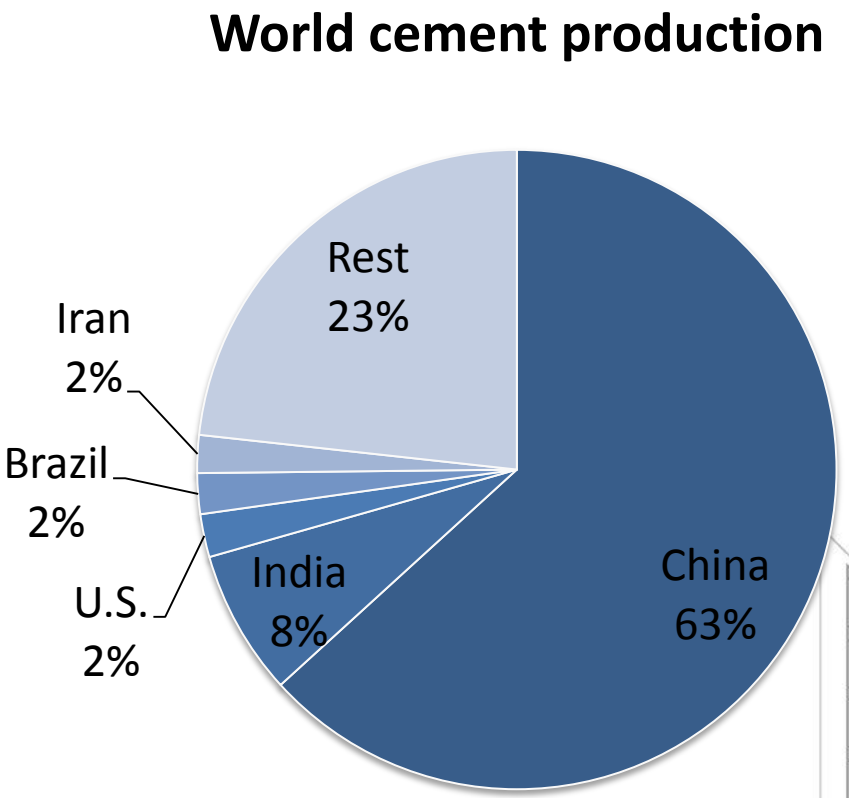
http://www.mining-technology.com/contractors/materials/beumer/beumer5.html

B. Subsector: Cement

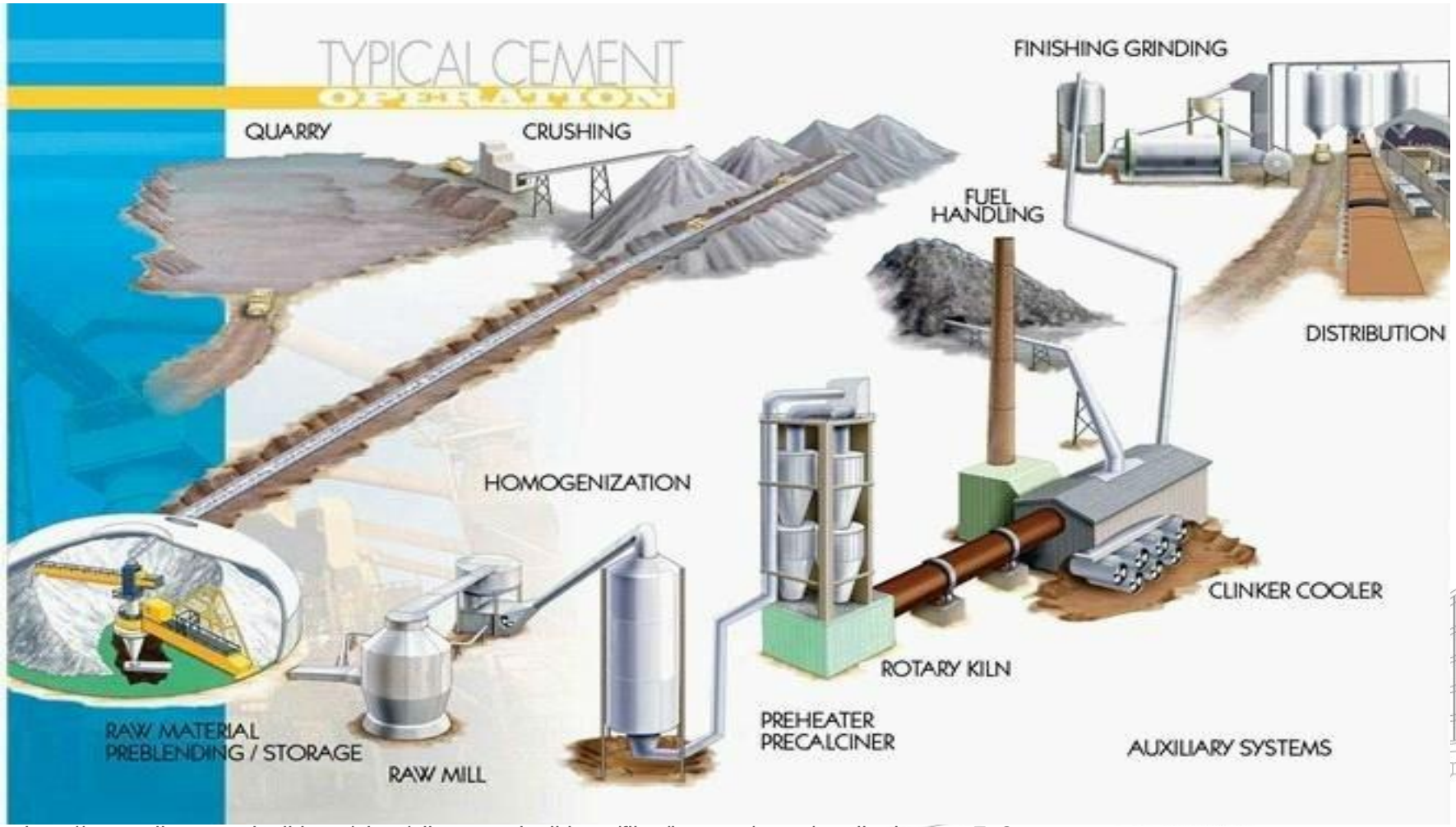
World-wide cement production on the rise



http://www.climatetechwiki.org/sites/climatetechwiki.org/files/images/extra/media_image_7_0.png

B. Subsector: Cement

- Calcination in kiln: major energy-consuming and emitting process.
- Limestone, clay and sand heated to 1450°C via fuel combustion and gives ~40% of emissions



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B. Subsector: Cement

Energy efficiency	Emissions efficiency and fuel switching
• Optimization of the kiln in size and capacity utilization. • Preheaters via 4 to 6-stage cyclones	Coal standard fuel; fuel switch to e.g. biomass wastes or natural gas.
Material efficiency	**Reduced product and service demand**
• Replace cement with concrete • Decrease clinker percentage in cement by using additives such as blast furnace slag or fly ash from power plants	• Extend lifespans of buildings and infrastructure • Reduced demand for building and infrastructure services

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http://www.constructionweekonline.com/ → Jubail ethylene plant

Subsector: Chemicals & Fertilizers

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C. Subsector: Chemicals & Fertilizers

- Main emitters: Ethylene, ammonia, nitric acid, adipic acid, caprolactam
- Ethylene production on the rise outside OECD

REGIONAL CAPACITY BREAKDOWN

Table 2

	Ethylene capacity, tpy		Change	
	Jan. 1, 2013	Jan. 1, 2012	tpy	%
Asia-Pacific	43,101,000	42,631,000	470,000	1.10
Eastern Europe	7,971,000	7,971,000	—	—
Middle East, Africa	26,007,000	24,557,000	1,450,000	5.90
North America	35,035,926	34,508,000	527,926	1.53
South America	6,383,500	6,383,500	—	—
Western Europe	24,904,000	24,904,000	—	—
Total capacity	143,402,426	140,954,500	2,447,926	1.74

Biggest companies (2012) BASF, Bayer, Braskem, Celanese/Ticona, Arkema, Dow, DuPont, Eastman Chemical Company, Evonik Industries, ExxonMobil, Formosa Plastics, Givaudan, INEOS, LANXESS, LG Chem, LyondellBasell, Mitsubishi, Monsanto, PPG Industries, SABIC, Shell, Shin-Etsu, Sinopec, Solvay, Sumitomo Chemical and Wanhua.

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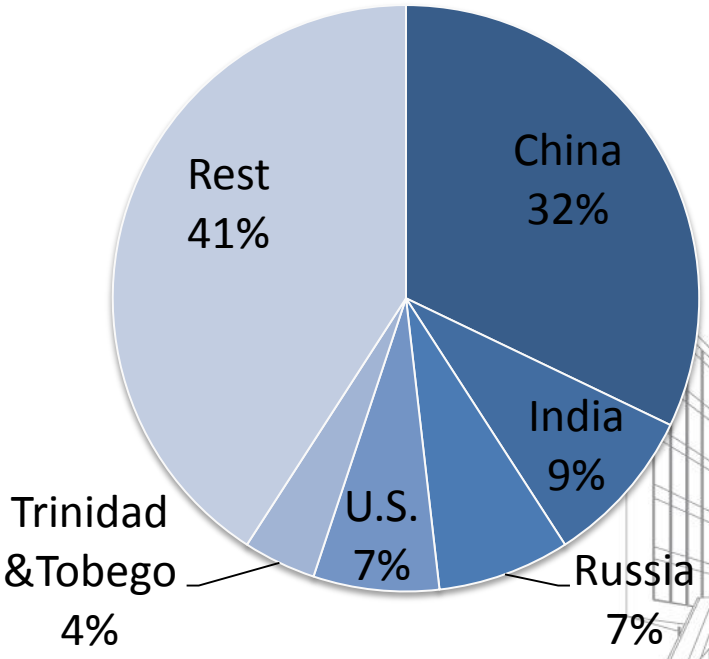
C. Subsector: Chemicals & Fertilizers

- **Fertilizer types**: **Nitrogen fertilizers**, Phosphates, Potassium, Compound fertilizers, Organic fertilizer, Other elements: calcium, magnesium, and sulfur.
- Ammonia (NH_3) most common fertilizer: $N_2 + 3H_2 \rightarrow 2NH_3$
- Energy intensive process

Ammonia production



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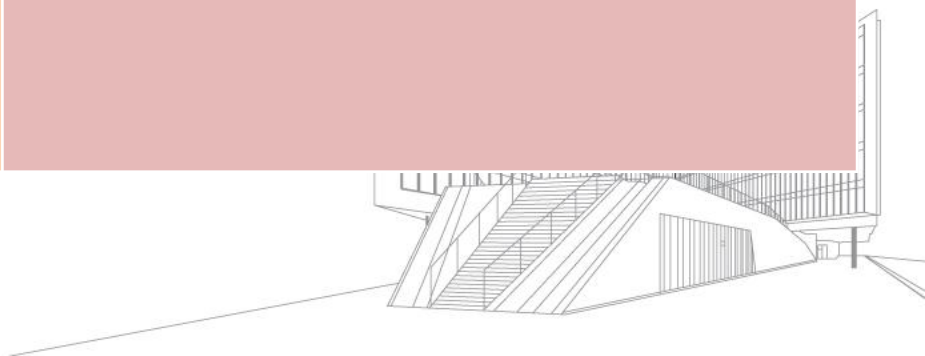
Further reading: http://en.wikipedia.org/wiki/Haber_process

C. Subsector: Chemicals

Energy efficiency	Emissions efficiency and fuel switching
• Upgrade steam cracking plants to BAT • More selective coils giving higher ethylene yield • Optimize Transfer Line Exchangers (TLE's) → heat exchanger • Increase overall fuel efficiency (typically 92 - 94 %)	• Fuel switching: from liquid fuel to gas
Material efficiency	**Reduced product and service demand**
• Material efficiency has little attention • Plastics: pure waste streams for recycling	Reduction of plastics use (e.g. less packaging)



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C. Subsector: Fertilizers

Energy efficiency	Emissions efficiency and fuel switching
• Advanced conventional processes • Reduced primary reforming ➢ CO_2 removal with improved solvents ➢ Indirect cooling of the ammonia reactor ➢ Use of gas turbine to drive process air compressor	• Common ammonia production: Haber-Bosch process from natural gas • Alternative: ammonia production using hydrogen from water electrolysis (using renewable electricity)
Material efficiency	**Reduced product and service demand**
• Efficient application of fertilizer on agricultural land: test need of crops for nitrogen or apply N-sensor for variable fertilizer application	• Use organic fertilizers instead of industrially produced fertilizer

Subsector:
Pulp and Paper

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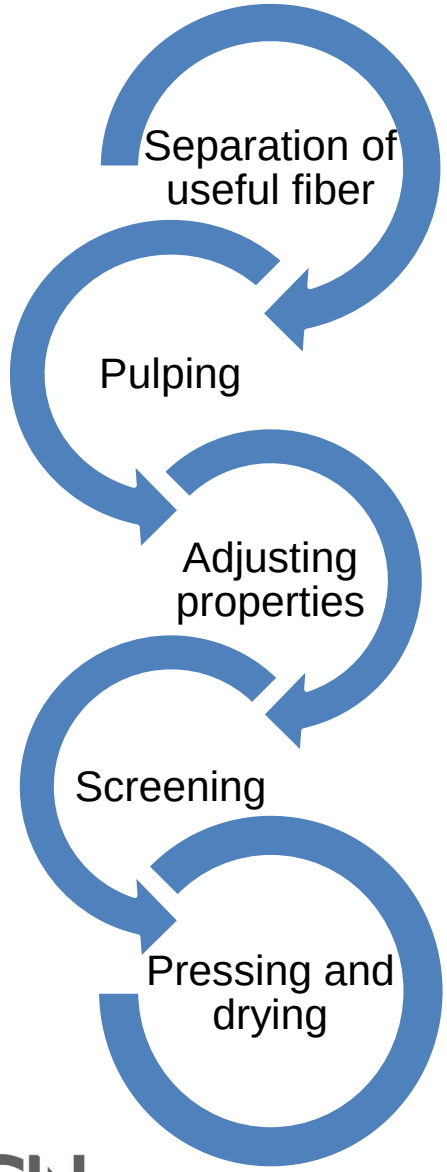
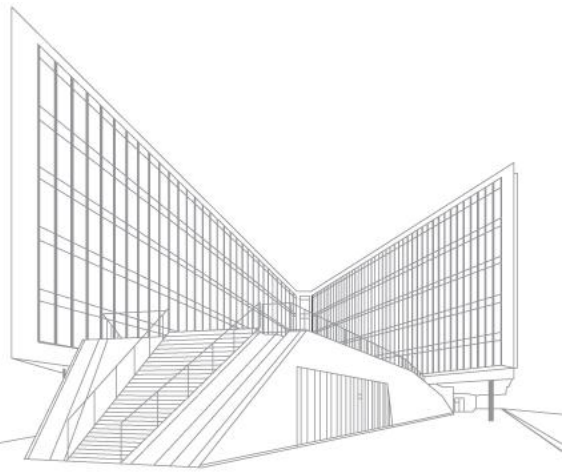
http://www.iscwater.com/filebin/images/wastewater-treatment-paper-pulp-industry-isc.jpg

D. Subsector: Pulp and Paper



- Over half the energy used for drying
- The use of additives, an increased dew point, and improved heat recovery
  → 32% reduction



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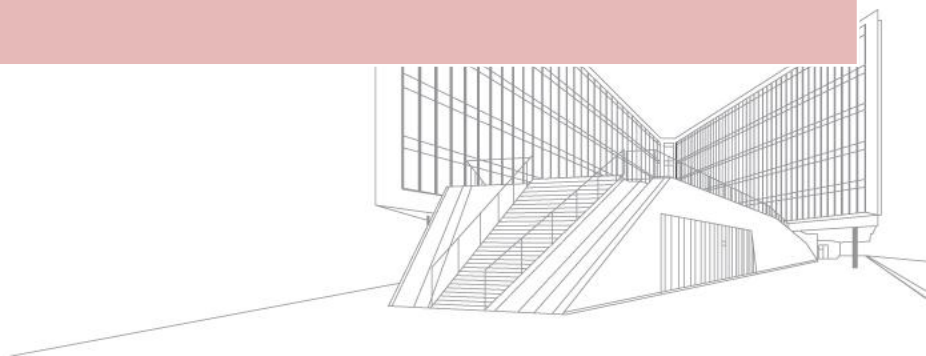
Source: http://en.wikipedia.org/wiki/Papermaking

D. Subsector: Pulp and Paper

Energy efficiency	Emissions efficiency and fuel switching
• Heat recovery from radial blowers used in vacuum systems • Use of thermo-compressors • Use excess heat	• Use biomass as a fuel instead of fossil fuels • Emerging technology: black liquor gasification (waste-to-energy)
Material efficiency	**Reduced product and service demand**
• Paper recycling has positive output on total lifecycle of paper • Efficient printing (e.g. duplex) • Lighter paper	• Substitute paper



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Source: http://www.fataepc.com/

Subsector: Non-ferrous Metals

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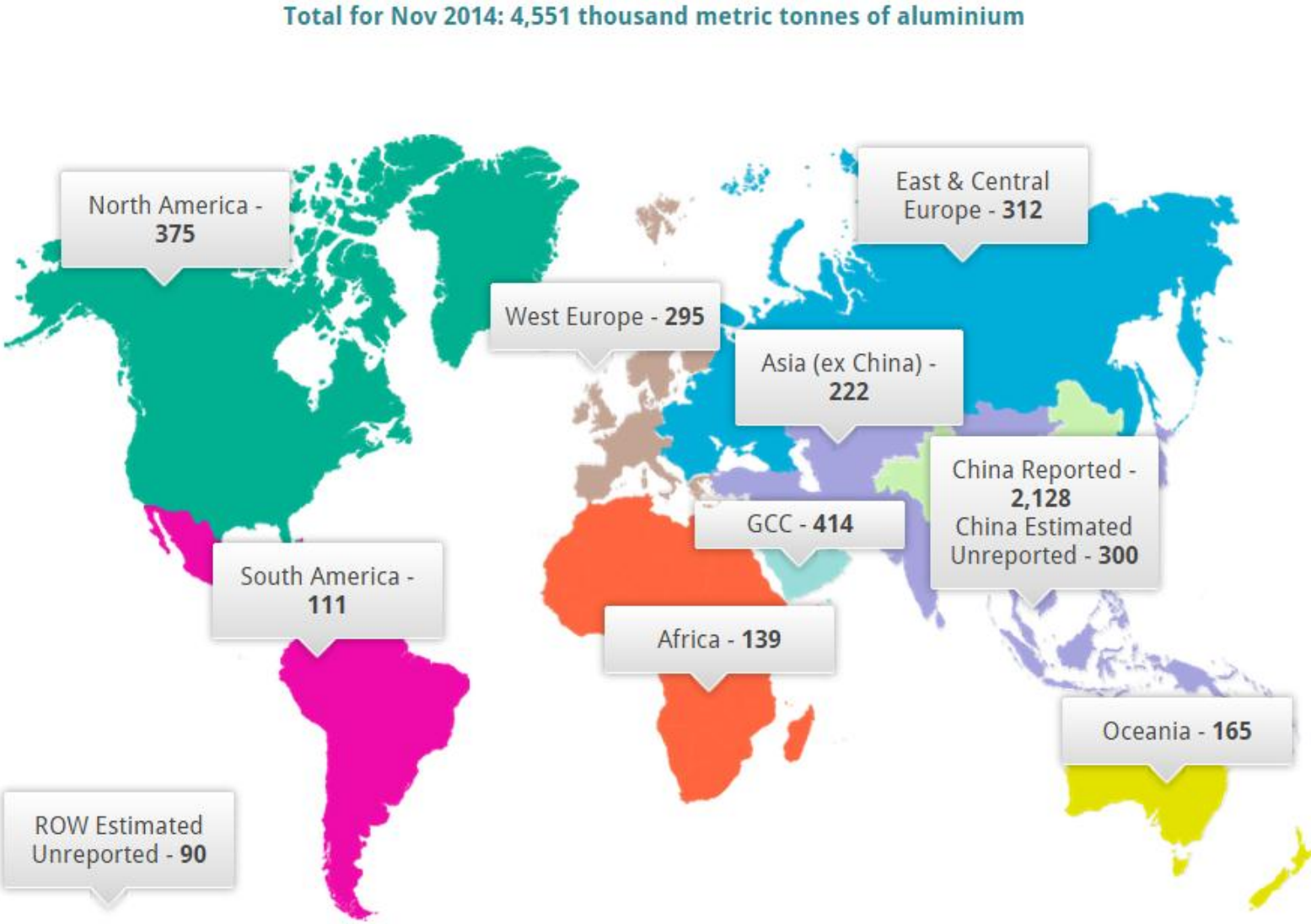
E. Subsector: Non-ferrous Metals



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Source: http://www.world-aluminium.org/statistics/primary-aluminium-production/

E. Subsector: Non-ferrous Metals

Energy efficiency	Emissions efficiency and fuel switching

• Copper: optimise heat consumption
  • Regenerative burners
  • Heat exchangers
  • Etc
• Aluminum:
  • Automatic alumina point feeding and control of electrolysis;
  • Improved burner for incineration of PAHs and other hydrocarbons in pot exhaust gas;
	• Emerging technique: inert anodes for aluminum production
	• PFCs (such as CF4; having high GWP) in aluminium or SF6 in magnesium

Material efficiency	**Reduced product and service demand**
• Yield in forming and fabrication can be improved by innovation • Recycle	• Reuse • Material substitution

Source : http://www.foodprocessing-technology.com/

Subsector:
Food Processing

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F. Subsector: Food Processing

Some of the major sectors:

- Oil and fat industry
- Sugar industry
- Dairy industry
- Beer and beverages industry
- Preservation, e.g. vegetables
- Fodder/animal-feedstock production

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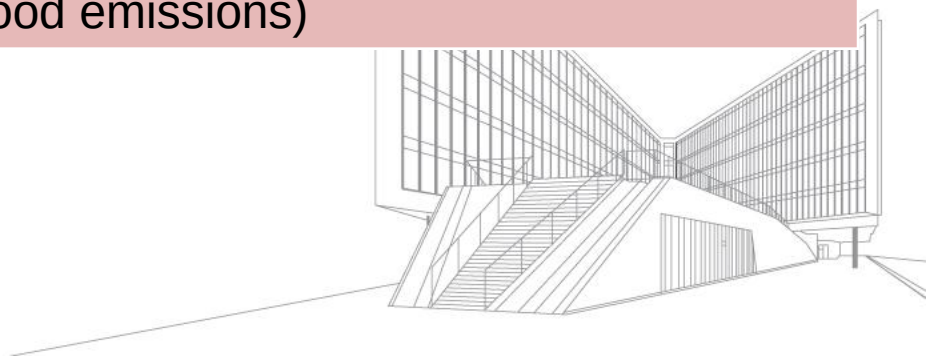
Image sources: http://www.foodprocessing-technology.com/
http://www.wageningenur.nl/upload_mm/5/9/8/4ddff50c-c162-4782-af35-a06763146fcc_shutterstock_99203219_melkpakken_zuivel_industrie_verpakken_levensmiddelen_fabriek_LR_640x430.jpg

F. Subsector: Food Processing

Energy efficiency	Emissions efficiency and fuel switching
• CHP, optimize drying and evaporation methods, reversed osmosis • Better insulation and reduced ventilation in fridges and freezers • Cooling before freezing • Re-use heat of e.g. fat hardening • Two-stage drying for milk powder	• Switch from heavy fuel oil to natural gas and/or renewable energy sources • Lower-emission modes of transport • Food waste and/or by-products may be source of biogas via anaerobic digestion

Reduced product and service demand
• Reduce spill of food (e.g. optimize logistics) • Transport distances, processed food, cooling demand • Replace meat and dairy products by low-emission products (Meat and dairy products are source of over 1/2 of total food emissions)



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Subsector: Textiles

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http://www.thehindubusinessline.com/multimedia/dynamic/00870/BL22_TEXTILE_MILL_7_870586g.jpg

G. Subsector: Textiles

Cotton production

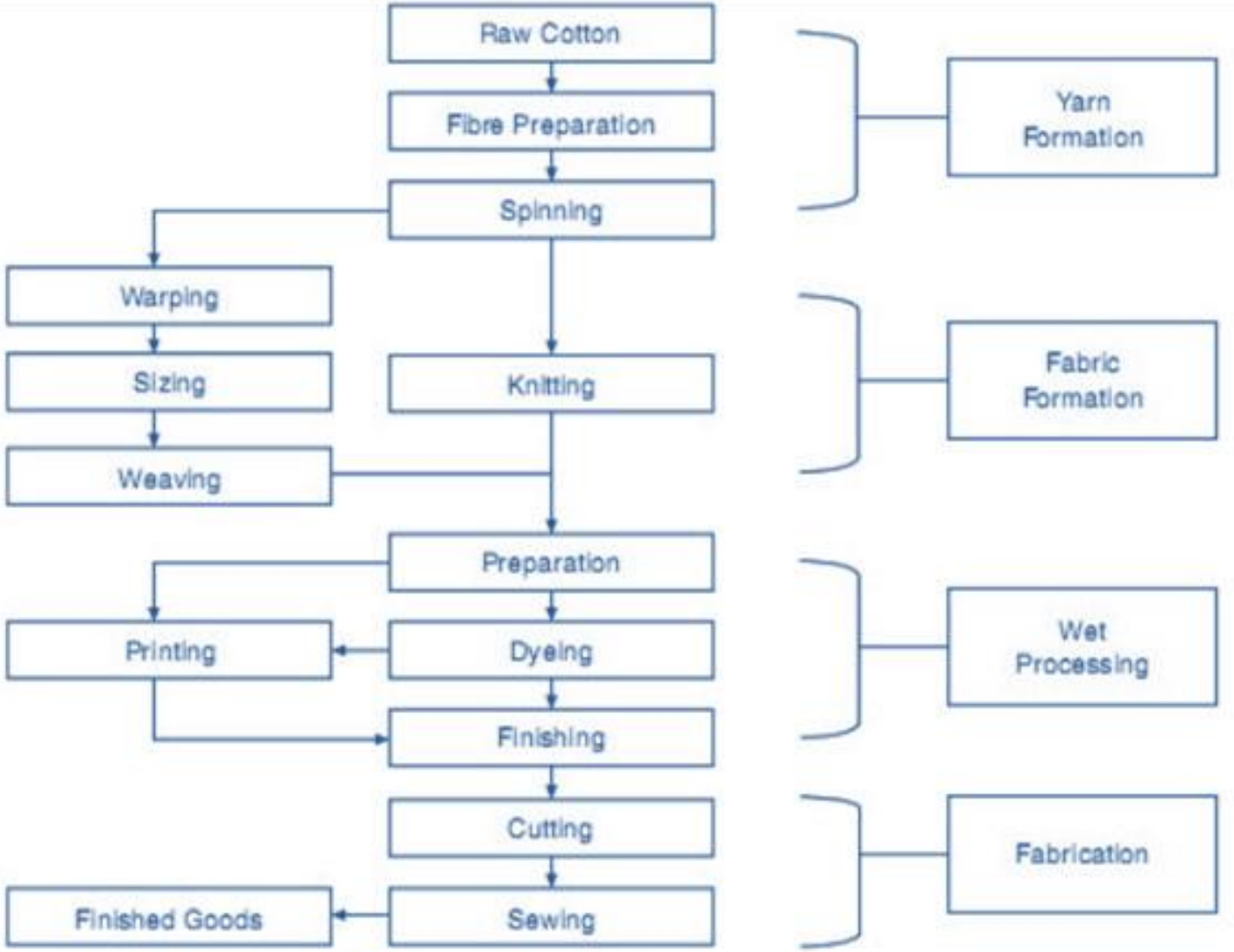
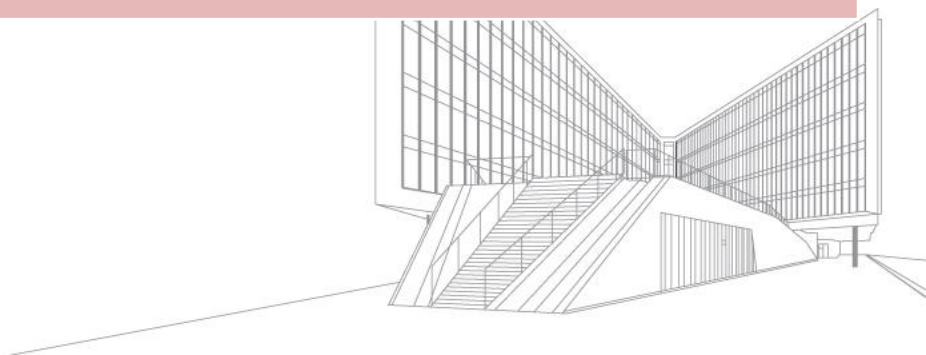


Image source: http://2.bp.blogspot.com/_kD1QvlOtMj4/SwQk0TRC42I/AAAAAAAAAEw/xT_ZrHJJRbI/s1600/cotton-process-flow-chart.jpg

G. Subsector: Textiles

Energy efficiency	Emissions efficiency and fuel switching
• Insulation of High Temperature (HT) machines, e.g. dyeing • Airflow jet dyeing machines • Optimize washing and rinsing (e.g. counterflow washing and heat recovery)	• Switch from heavy fuel oil to natural gas and/or renewable energy sources
Material efficiency	**Reduced product and service demand**
Water consumption and energy consumption seem to be related. Efficiency helps on both compartments at the same time	It is difficult to limit textile demand. Re-use or recycling of textiles is a good option.



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Policy recommendations

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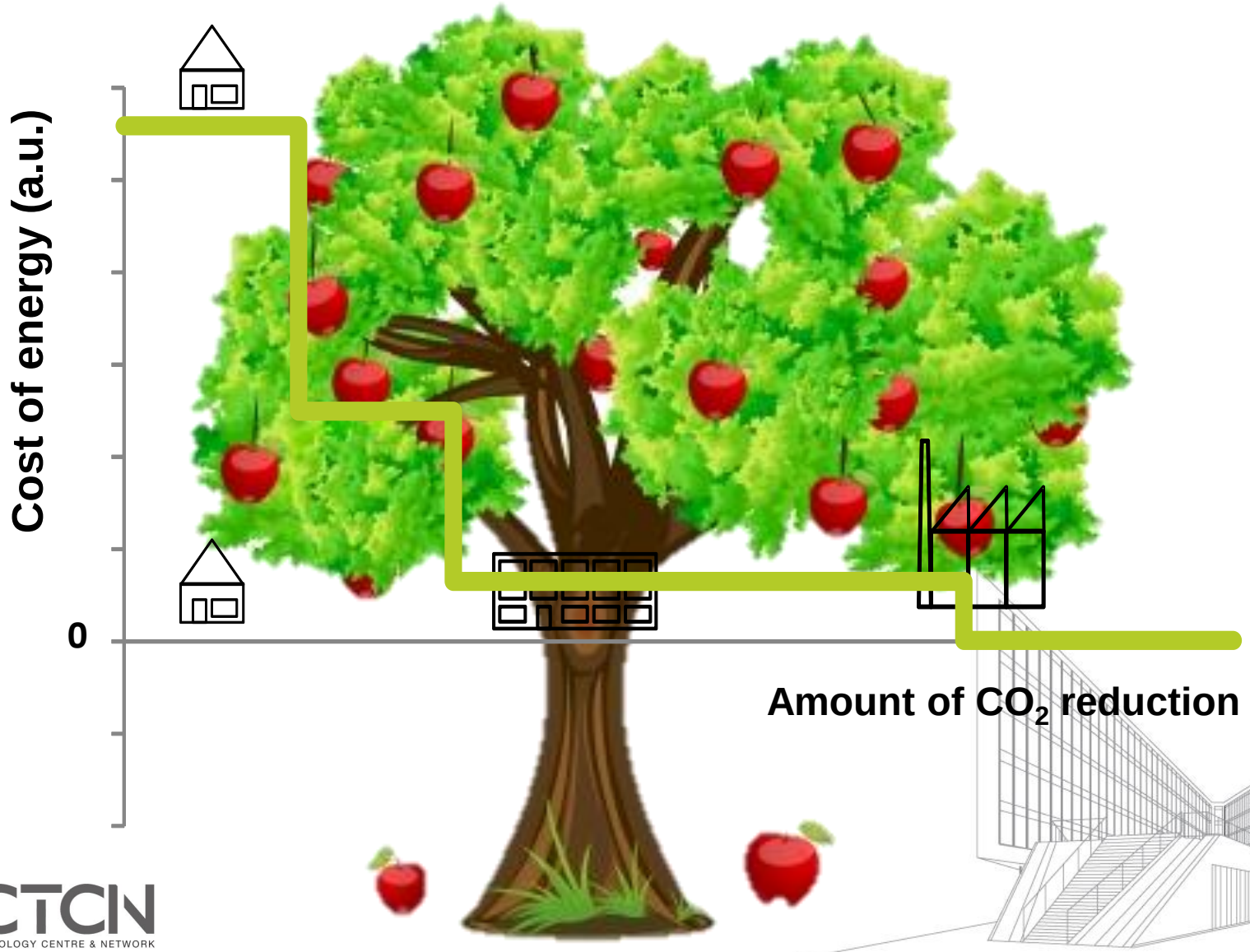
3. Policy recommendations



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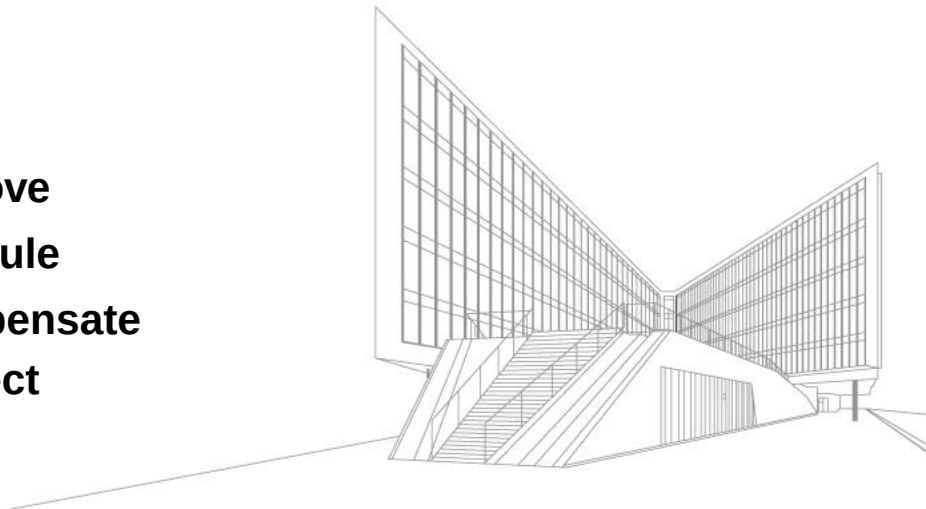
3. Policy recommendations

Concepts for instruments

Barriers	Motivation			Possibility	
Motivation	Price	Subsidize	Regulate	Facilitate	Inform
Not cost-effective					
Not important					
Other disadvantages					
Possibility					
No funds					
No knowledge					

Remove
Overrule
Compensate
Indirect



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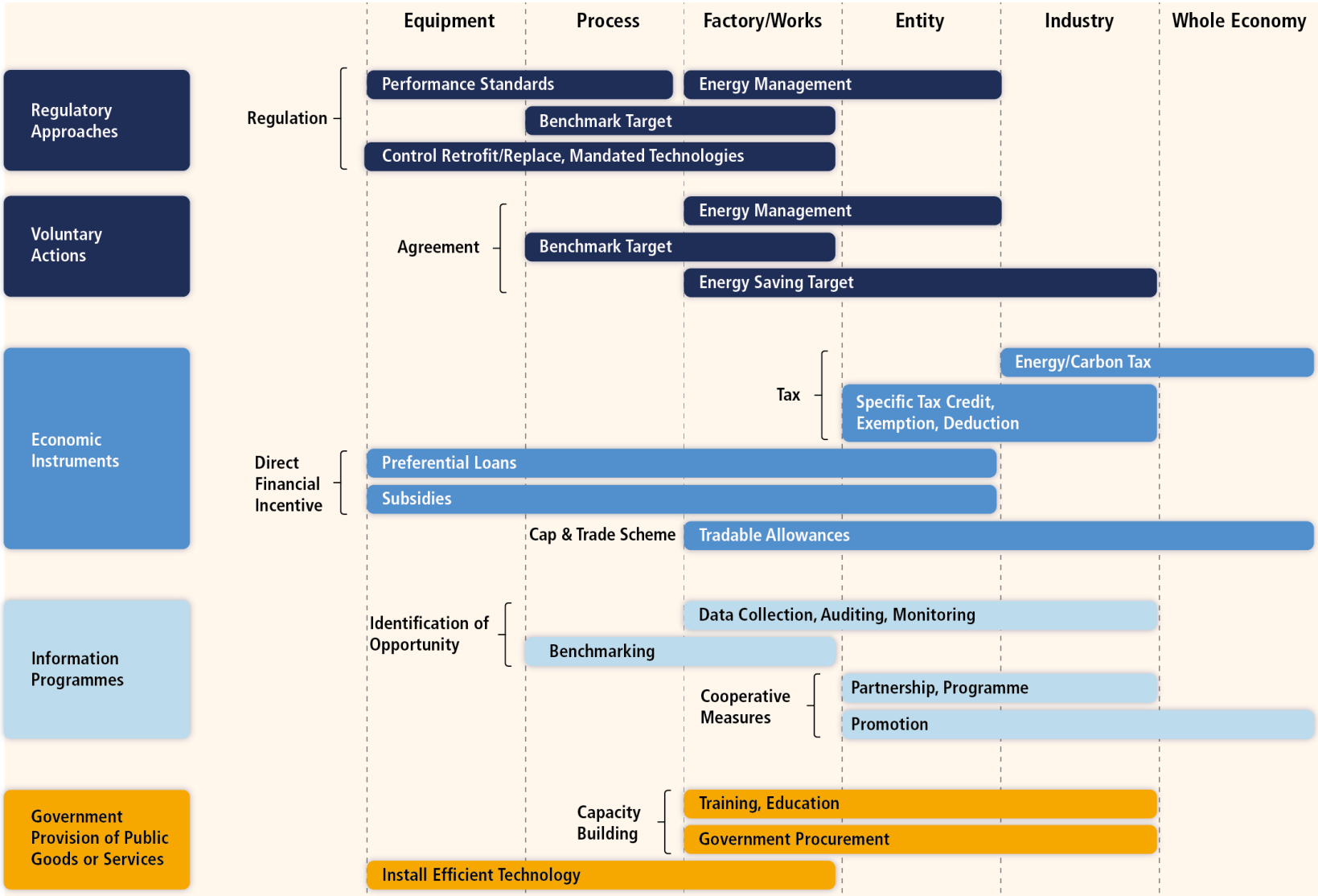
3. Policy recommendations



Source: IPCC, 2014, AR5

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4. Case studies

FaL-G Brick technology in Bangladesh: ground blend of fly ash, lime and gypsum yielding a matrix as strong as ordinary cement

+ Climate-friendly technology
+ Eliminates carbon emissions
+ Reduce air pollution from fly ash (coal power plants)

(Source: IIP http://www.iipnetwork.org/Bangladeshi_Brick_Rtable#sthash.7Ia6LQzH.dpuf)

ArcelorMittal Saldanha Works in South Africa (IEE): by implementing an Energy Management System, this steel plant saved roughly R90 million within the 2011 period, against a minimal capital investment of R500,000

+ Reduce CO2 emissions
+ Low investment costs
+ High energy and electricity cost savings

(Source: NCPC/UNIDO http://ncpc.co.za/media-room-ncpc/case-studies-and-success-stories/27-case-studies/arcelormittal-saldanha-works-2013)

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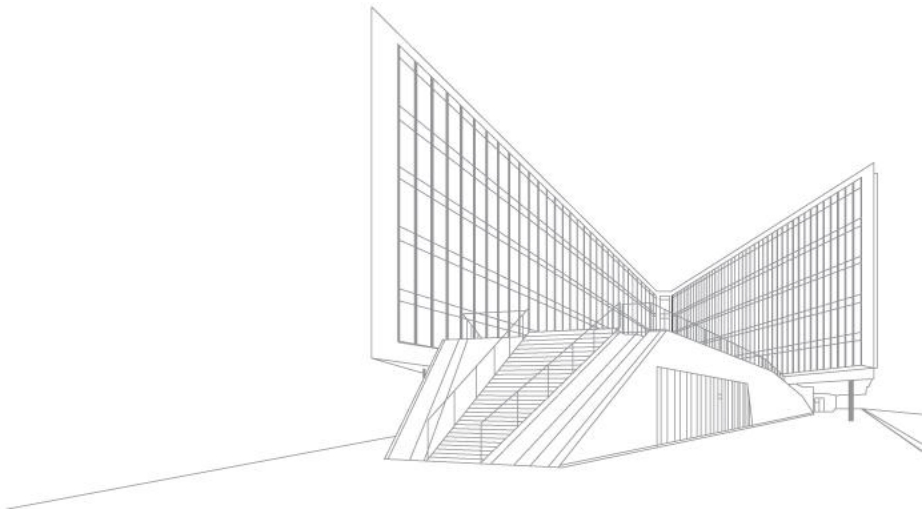
5. Conclusions

Several emission-reducing options are cost-effective and profitable

- Varies regionally and per site-specific situation

Mitigation measures are often associated with co-benefits

- Competitiveness, business opportunities, environmental compliance, health benefits and waste reduction



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For more information

- IPCC Workgroup III “Climate Change 2014: Mitigation of Climate Change” Chapter 10: Industry

- MURE ODYSSEE database, overview of general energy efficiency parameters and policies in the EU: http://www.odyssee-mure.eu/

- Best Available Techniques Reference Documents (BREF): http://eippcb.jrc.ec.europa.eu/reference/

- Industrial Efficiency Technology Database (IETD): http://ietd.iipnetwork.org/

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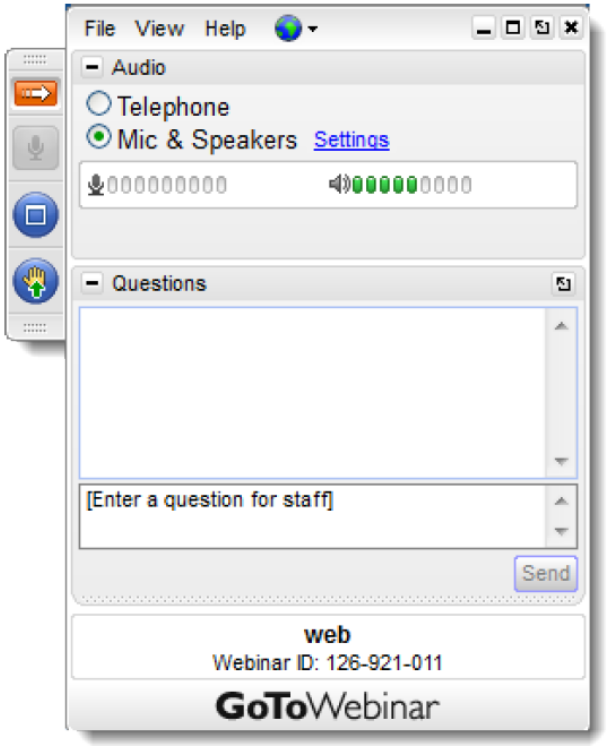
Thank you for participating in this webinar

Contact:
Arjan Plomp: plomp@ecn.nl
Ad Seebregts: seebregts@ecn.nl
Lachlan Cameron: cameron@ecn.nl
Agathe Laure: Agathe.Laure.affiliate@unep.org

Questions and Answers

- Please type your question into the “Questions” pane and click “Send”
- Kindly limit yourself to one specific short question
- Kindly refrain from giving broad statements
- Send us an email



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