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The University of Manchester





Centenary of chemical engineering and environmental protection at lasi





Manchester: The birthplace of chemical engineering





Global challenges

Population growth
Rapid urbanisation
Food supply
Water access
Energy demand
Climate change
Resource scarcity







Food demand to treble by 2050



FAO, 2011



Water demand to increase by 50% by 2050



Source: OECD, 2012



3 bn people to be affected by water scarcity





Energy demand to grow by 1/3rd by 2035



IEA, 2012. World Energy Outlook



GHG emissions doubled since 1970









Sustainable engineering: Shaping our future



Systems approach and life cycle thinking





Providing sustainable engineering solutions





Systems approach: Energy





Key sustainability issues for energy

OFossil fuels

OClimate change

OSecurity of supply

OFuel poverty





Opportunities in energy

Sustainable solutions
Low-carbon
Flexible
Diverse
Locally relevant
Affordable

OExamples

OEnergy efficiency

ONuclear

- ORenewables
- Carbon capture and utilisation
- OEnergy storage
- Ounconventional gas and oil



Systems approach: Food





Key sustainability issues for food

OGHG emissions

OWaste

OLand competition

○Food security







Opportunities in food

- Improved agricultural practices and yields
- OImproved process efficiencies
- Waste reduction and utilisation
- ONew technologies and foods





Systems approach: Water





Key sustainability issues for water

○ Water scarcity

O Up to 3 bn people will be living in water-scarce areas by 2025

Access to clean water
 1 bn people lack access

Access to sanitation
 2.5 bn people lack adequate sanitation

Inefficient water use

• Agriculture uses 70% of all water withdrawals globally

O Tap water used for sanitation

• Water pollution



Opportunities in water

- Improved water efficiency
 Reduction and reuse
- Better irrigation and water management systems
- New water sources
 Desalination
 Waste water
- Water treatment technologies
 Personal care products
 Nutrients



Reduction of water footprint



The systems approach: resources





Key sustainability issues for resources

Profligate and inequitable use

 Developed countries consume much more than developing countries

Lack of/low reuse and recycling
 90% of products become waste within 6 months





Some opportunities in resources

O Catalysis

- Many of the critical elements used as catalysts: e.g. platinumgroup metals, Co, Ce, Ge, Sb, In
- Our Use of non-critical metals
- O Use of non-metallic catalysts, e.g. enzymes

○ Urban mining

- O Electronic and electrical waste (50 million t/yr)
- O Municipal solid waste (1.6 bn t/yr)
- Road dust (platinum-group metals)
- Landfills

Delivering service rather than product



Sustainable engineering: Shaping our future

- We face unprecedented challenges
- Addressing these requires systems approach and life cycle thinking
- Understanding economic, environmental and social trade offs is essential
- And so is providing robust evidence for and engaging with policy makers
- Above all, next generation of engineers must be educated with sustainability in mind to ensure that challenges are addressed more sustainably than so far