UNIVERSITY OF OXFORD

B2 Engineering, Sustainability and the Environment

Wei Huang, Michaelmas Term 2021

Lecture 3

Sustainable Development
How?

Course outline

1. Why?
   - Global Issues
   - Why Engineering?

2. What?
   Brundtland Report
   Triple Bottom Line
   Stakeholders

3. How?
   - Legislation
   - Tools
   - Metrics

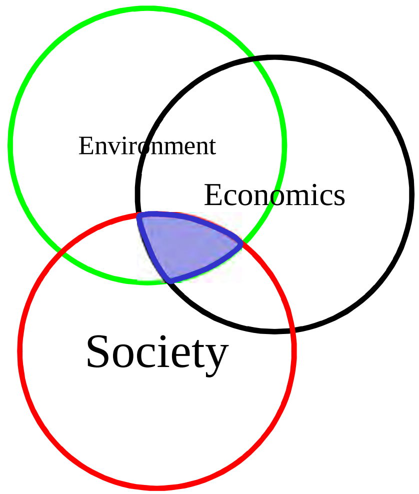
4. When?
   - Scenario Analysis
   - Structural Change?
   - A Sustainable Future

3. Sustainable development – how?

- **- Legislation**
- **- Tools for SD**
- **- Life cycle analysis**
- **- Multi Criteria Analysis**

Revision - the drive to sustainability: How?

The first approach is by means of **legislation**. Understanding this aspect is the minimum that is needed.



- International accords (RIO, Kyoyto)
- National Legislation (Acts of Parliament)
- Regulatory bodies (e.g. Environment Agency)
- Documentation (EIAs)

- But there is also a clear need to consider wider stakeholders (as seen in the Shell example)

- NGOs, Activists, Academics, Greenpeace, FoE

Environment and waste–regulation - the international context

At the international level there are obligations/agreements, such as

- **Rio** – see lecture 2
- **Montreal** protocol on phasing out the use of ozone-layer depleting chemicals
- **Basle** convention on the trans-boundary movement of waste (stops movement of hazardous waste)
- **Kyoto** treaty on greenhouse gasses.

and advice, eg from World Health Organisation (not empowered to legislate) which issues comprehensive guidelines on exposure limits for toxic substances

The Kyoto Protocol

- The Kyoto Protocol committed signatories
  - To reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 by 2008-12
  - This target represented a real 29% cut compared to predictions
  - Covers Carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, HFCs and PFCs
  - Cuts of 8% European Union, 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland."

The main greenhouse gases

Name	Pre-industrial concentration (ppmv *)	Concentration in 1998 (ppmv)	Atmospheric lifetime (years)	Main human activity source	GWP **
Water vapour	1 to 3	1 to 3	a few days	-	-
Carbon dioxide (CO_2)	280	365	variable	fossil fuels, cement production, land use change	1
Methane (CH_4)	0,7	1,75	12	fossil fuels, rice paddies waste dumps, livestock	23
Nitrous oxide (N_2O)	0,27	0,31	114	fertilizers, combustion industrial processes	296
HFC 23 (CHF_3)	0	0,000014	260	electronics, refrigerants	12 000
HFC 134 a (CF_3CH_2F)	0	0,0000075	13,8	refrigerants	1 300
HFC 152 a (CH_3CHF_2)	0	0,0000005	1,4	industrial processes	120
Perfluoromethane (CF_4)	0,00004	0,00008	> 50 000	aluminium production	5 700
Perfluoroethane (C_2F_6)	0	0,000003	10 000	aluminium production	11 900
Sulphur hexafluoride (SF_6)	0	0,0000042	3 200	dielectric fluid	22 200

* ppmv = parts per million by volume, ** GWP = Global warming potential (for 100 year time horizon).

UNEP GRID Arendal

United Nations Environment Programme / GRID-Arendal

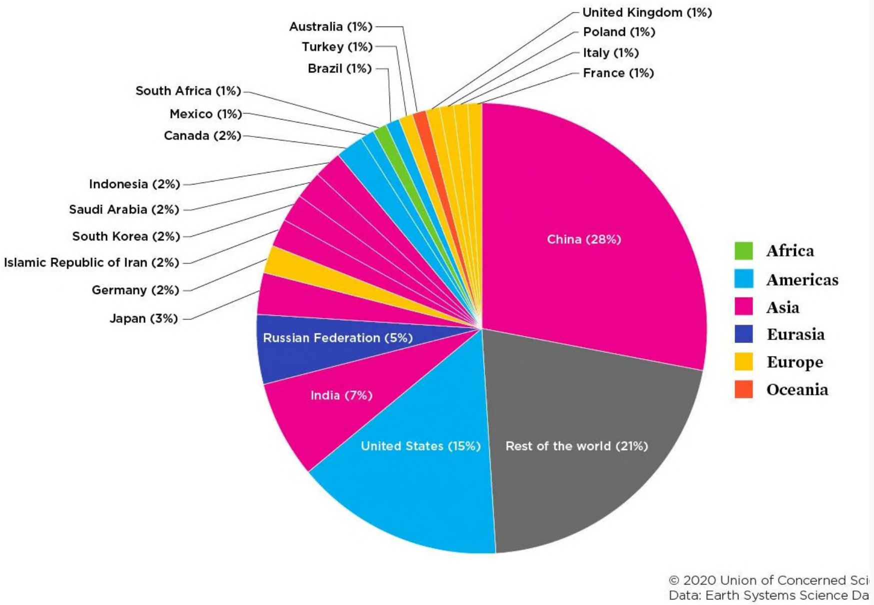
Note that the USA did not ratify the treaty and Canada withdrew in 2012

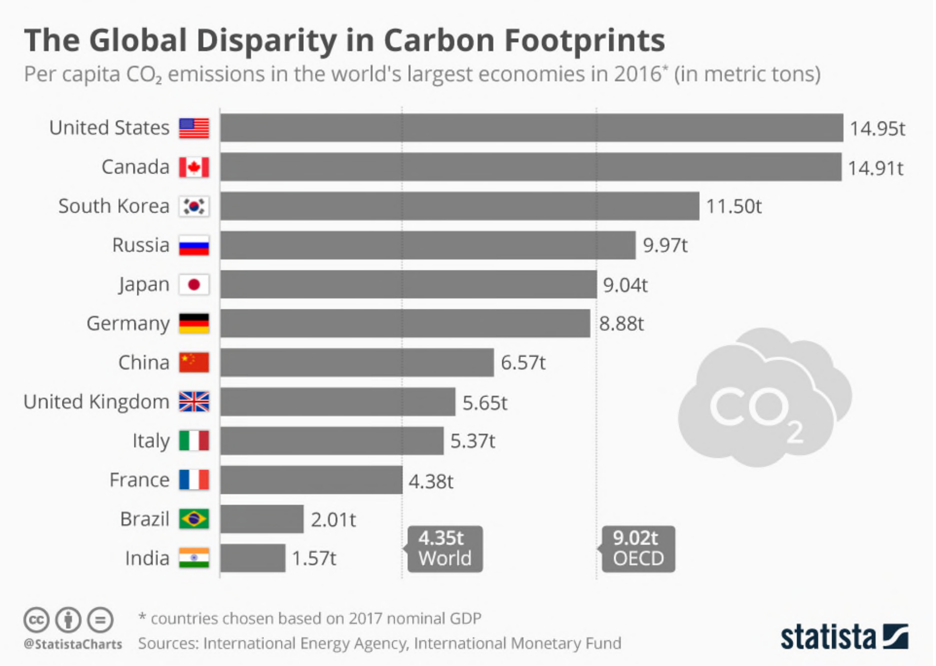
Implementation of Kyoto

Countries were supposed to:

- 1. Each Party included in Annex I, in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall:
- (a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as:
- (i) Enhancement of **energy efficiency** in relevant sectors of the national economy;
- (ii) **Protection** and enhancement of **sinks and reservoirs** of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation;
- (iii) **Promotion** of sustainable forms of agriculture in light of climate change considerations;
- (iv) **Research** on, and promotion, development and increased use of, new and **renewable forms** of **energy**, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies;
- (v) Progressive **reduction or phasing out of market imperfections**, **fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors** that run counter to the objective of the Convention and application of market instruments;
- (vi) Encouragement of appropriate **reforms in relevant sectors** aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol;
- (vii) **Measures** to limit and/or reduce emissions of greenhouse gases not controlled by the Montreal Protocol in the transport sector;
- (viii) Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy;

What happened?



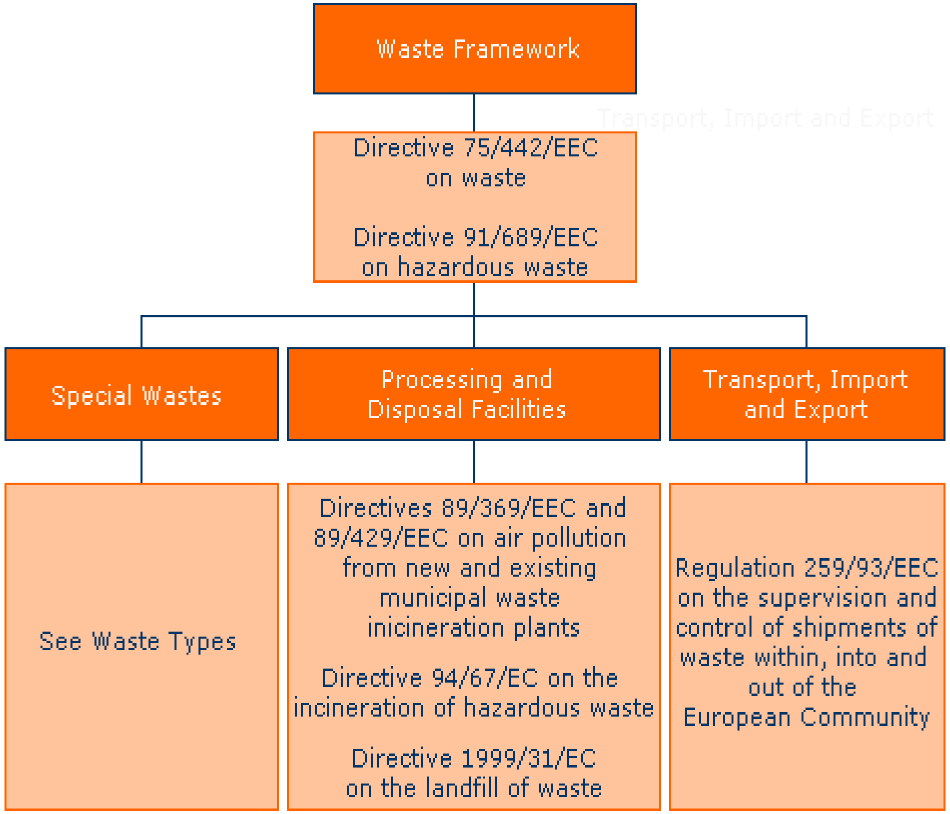


https://www.ucsusa.org/resources/each-countrys-share-co2-emissions
https://www.statista.com/chart/16292/per-capita-co2-emissions-of-the-largest-economies/

Hidden carbon emissions?

- Some may consider that UK has broken the link between greenhouse gas emissions and economic growth
- However, much has been achieved simply by switching to Combined Cycle Gas Turbines for electricity generation
- A recent report by Dieter Helm (Univ of Oxford) suggests carbon emissions may have risen 19% since 1990 when account is taken of
  - Increased import of manufactured goods
  - Emissions from aviation
    - UK per capita aviation emissions are large

Environment and waste – regulation



EU **regulations/directives/agreements** are binding on member states. States are required to incorporate them into national legislation, which is then binding on personnel and companies.

Recommendations – not binding, often promoting ideas and approaches, eg EMAS, BATNEEC (**b**est **a**vailable **t**echnology **n**ot **e**ntailing **e**xcessive **c**ost)

From http://www.wasteonline.org.uk

Example: WEEE and RoHS

- **Waste Electrical and Electronic Equipment Directive** (2005)
  - Minimise the impacts of electrical and electronic equipment on the environment during their life times and when they become waste.
  - Sets criteria for the collection, treatment, recycling and recovery of waste electrical and electronic equipment.
  - It makes producers responsible for financing most of these activities (producer responsibility).
  - Private householders are to be able to return WEEE without charge.
- **Restriction of Hazardous Substances (2006)**
  - Bans the placing on the EU market of new electrical and electronic equipment containing more than agreed levels of
    - lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame
  - Manufacturers will need to ensure that their products - and their components - comply in order to stay on the Single Market.
  - If they do not, they will need to redesign products.

Environmental Management at the company level

ISO 14001 - Environmental Management System

- **an environmental policy**
- **an assessment of environmental aspects/ obligations**
- **a management system**
- **periodic internal audits and reports**
- **a public declaration that ISO 14001 being implemented**

Individual projects are likely to require environmental impact assessments or environmental statements

QMS

ISO 14001

REGISTERED FIRM

Environmental Assessment
or Environmental Impact Assessment

A description of the likely significant effects, direct and indirect, on the environment of the development, explained by reference to its possible impact on -

human beings;
flora; fauna;
soil; water; air;
climate;
the landscape; the cultural heritage;
the interaction between any of the foregoing;
material assets;

Required (EU directive→ UK legislation) for projects from steelworks to roads to hotels to pig farms.

Environmental Statement

To include

- a non-technical summary
- description of main alternatives and reason for choice taking into account environmental effects
- baseline data for identification and assessment of main effects
- description of development
- description of likely significant effects, direct and indirect, on the environment
- mitigating measures proposed

- Lower level than an EIA

Organisations over a certain size should have a sustainability policy

An interesting exercise is to write one for yourself as an individual. How might it change your lifestyle?

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Environmental Sustainability Policy

The University of Oxford has over 22,000 students. The University's functional estate covers 600,000 m^2 and includes 220 departments distributed across more than 230 buildings. The Sustainability Steering Group is responsible for the development of sustainability strategy and monitoring its delivery, while day-day implementation of sustainability initiatives is managed by the Environmental Sustainability team.

Through its activities and actions the University recognises it impacts on the environment, locally, nationally and globally. The University will work to enhance its positive impact and reduce its negative impacts. The University of Oxford has made a commitment within the Oxford University Strategic Plan 2013 – 2018 to continue to deliver its sustainable targets. These targets will be met through continual improvement. The University will also meet legislation and other requirements to which the University subscribes, and where practicable strive for best practice.

The University has identified ten key areas through which environmental sustainability shall be approached. These are:

- **Energy and carbon management -** by encouraging energy efficient practices and investing in its estate to reduce carbon emissions;
- **Emissions and discharge -** by putting in place appropriate controls to prevent pollution and work to reduce where practicable emissions and discharges to air, land and water;
- **Waste and material resources -** by encouraging preventing and reducing waste and reuse of resources prior to recycling or disposal;
- **Water -** by reducing water consumption through water efficient practices and technologies;
- **Education, research and knowledge transfer -** by increasing awareness and understanding of environmental sustainability by staff and students and serving society by contributing and promoting the University's research and knowledge transfer on sustainability;
- **Sustainable travel -** by reducing emissions from work-related travel and University-owned vehicles;
- **Sustainable buildings -** by making full use of available space and designing and refurbishing buildings in line with the University's Sustainable Building Philosophy;
- **Biodiversity** - by enhancing wherever possible wildlife habitat on University-owned land and supporting wider initiatives as appropriate;
- **Sustainable purchasing -** by encouraging and embedding sustainable and life-cycle considerations into purchasing decisions.
- **Community -** by working with local schools and businesses and supporting an extensive volunteering programme.

The University will set clear environmental objectives and targets reviewed annually by the Sustainability Steering Group and supported by long-term strategies and plans. Performance will be monitored, measured, and communicated to stakeholders as appropriate. To assist in delivering the University's strategy an environmental management system is being established and rolled out over the functional estate.

This policy, approved by Council on 10 February 2014, covers the University of Oxford's functional estate. The policy has been endorsed by the Oxford University Student Union.

The policy is available to all students, staff working for or on behalf of the University, and to the general public. The policy will be reviewed annually by the Sustainability Steering Group which shall report to Council, making such recommendations as it considers appropriate, at least once every five years.

Ewan C McKendrick

Professor Ewan McKendrick
Registrar

Endorsed by the Council on 10 February 2014 [minute 16 e]
Endorsed by Oxford University Students Union on December 2013
Reviewed by the Sustainable Steering Group on 30 October 2015 [minute 6]
Managed by the Head of Environmental Sustainability sustainability@admin.ox.ac.uk
Publicly available from www.admin.ox.ac.uk
(EMS_P_0001 Version 3/March 2016)

Sustainable Development – some criticism

"In the absence of any precise meaning, the concept of sustainability is pointless.

It could mean virtually anything, and therefore means absolutely nothing. It has become merely a marketing slogan.

If you buy a 'sustainable' hardwood floor does it mean that the factory could theoretically carry on sawing up trees *ad infinitum*, or that the floor will sustain your weight?

I couldn't argue with a consumer who was more interested in the latter assurance: at least it can be proven." (Ross Clark, The Times, 29 0ctober 2005)

Quantifying sustainability

- “How can something so vague be so popular?” (Bell & Morse, 1999)

- Challenges associated with quantifying sustainability:
  – Sustainability is relative
  – Definitions are needed: what is to be sustained, at what scale, and in what form?
  – Scales depend on understanding ***how*** a system operates as well as the ***purpose*** of evaluating the system (i.e. stakeholders and their needs)
  – Inherent value judgments and uncertainty

Engineers are tasked with determining how to measure the sustainability of complex and dynamic systems in the most objective way possible.

What we need are some tools to do the job

Tools used to quantify SD

- Who: Stakeholder Analysis
- What: Metrics and indicators
- Combine: Sustainable Footprints, Life cycle Analysis
- Decisions: Multi-criteria analysis

Who decides what is important:? Stakeholder analysis

- **Who are key stakeholders?**

  project owner,
  customers or users,
  community, suppliers,
  share holders,
  Government,
  NGOs etc.

- **Is consultation required with stakeholders? If so:**

  Consultation process developed?
  What are the key issues?
  When should the process start?

Establishing stakeholder viewpoints

www.weblyer.com

Ask them! Public meetings, surveys, interviews, focus groups….

Not always practical for University projects. Consider:

- **Role play**. ***Members represent stakeholders and debate***
- **Literature**. ***Published case studies of similar projects***
- **Consultants**

DO NOT TRY TO GUESS!!

The choice of metrics - local and global

Safe and efficient control of a complex process needs hundreds of measurements (T, P, F etc.). Each one is an indicator of local performance.

Catalytic cracker, Shell Stanlow refinery
Photo: Shell UK

Overall performance can be presented in terms of a few key indicators like yield of gasoline per tonne of feedstock, or the profit ($/day).

The choice of metrics - requirements

1. Relevance to the defined purpose
2. Available data – quantifiable empirical data, not qualitative judgements
3. Coverage – key aspects must be included
4. Normalized – allow for comparison independent of size, (e.g. kg CO_2 **per kWhr** or tonne fertilizer **per** sq km).
5. Avoid duplication and needless complexity
6. Composites if appropriate (recognise weighting problem)

A set of metrics which is not planned for some defined purpose is merely a collection of statistics.

Example: How can we use metrics to measure sustainability in Oxford colleges?

Defining the metrics

1. Overview of the business
2. System boundary
3. Definition of sustainability
4. The sustainability domain
5. Capitals
6. Impact Generators (and impact receivers)
7. Issues
8. Indicators
9. Metrics
10. Verification

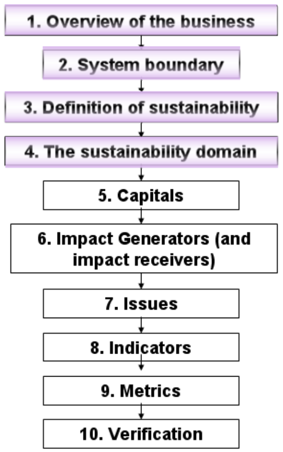
Steps 1 - 4 : Setting the scene

1. **Overview of the business** – what does a college do?

2. **System boundary** – include anything that happens on a college site

3. **Definition of sustainability** – "development, which meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987)

4. **The sustainability domain** – three areas of sustainability:
   - Environment
   - Economy
   - Society



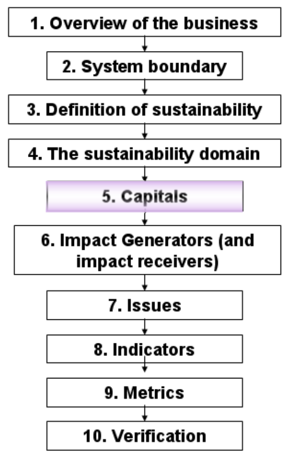
Step 5 : Capitals

Capitals – stores of value

- ***Natural and built capitals*** – the value of the natural and built environment contained in the sustainability domain

- ***Financial capitals*** – the value of money in the sustainability domain

- ***Human and social capitals*** – the value of people as individuals and as a group and the skills they possess in the sustainability domain.



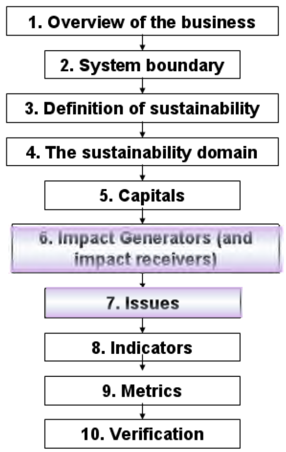
Steps 6 – 7: Impact generators and Issues

6. Impact generators – things that have an impact on our capitals
e.g. energy management (affects all three capitals)

Impact Receivers – who is affected by these impacts?

- *Students*
- *Staff*
- *Electricity/gas supplier*

7. Issues – what issues are related to each impact generator?
e.g. conserving energy use, increasing the amount of renewable energy used

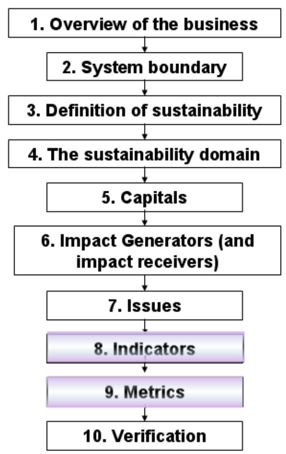


Steps 8 – 9: Indicators and Metrics

8. Indicators – describe each issue
e.g. energy use, renewable energy use

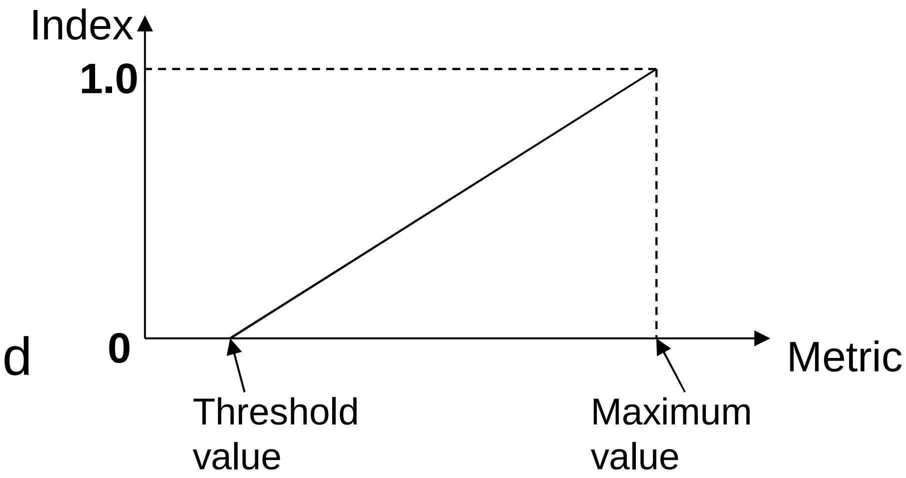
9. Metrics – measure the magnitude of these issues *e.g. total electricity consumption per year…*

…but how do we use these metrics in a way which can allow comparisons between colleges?



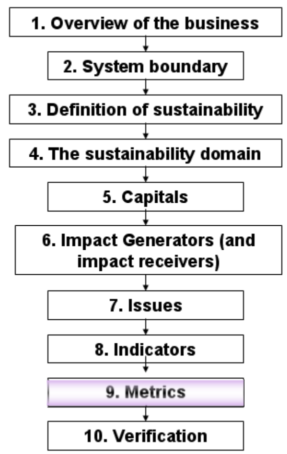
Normalising, indexing and weighting

• **Normalising** – so we can compare between colleges of different sizes
e.g. electricity consumption per student per year



• **Indexing** – assign each value an index between 0 and 1 using maximum expected values, required or desirable threshold values and interpolating between the two

• **Weighting** – involving stakeholder opinions (remember the definition of sustainability) to judge how each metric contributes to the overall sustainability of the college
i.e. questionnaires, interviews



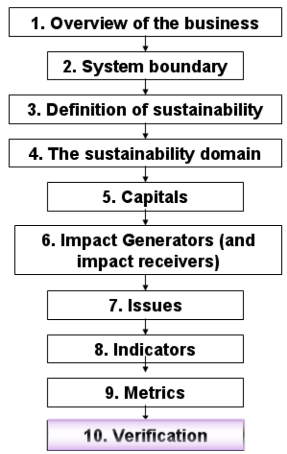
Step 10 : Verification

Verification - use data collected from various colleges to verify that the information required for the metrics is available and make any adjustments

And finally...

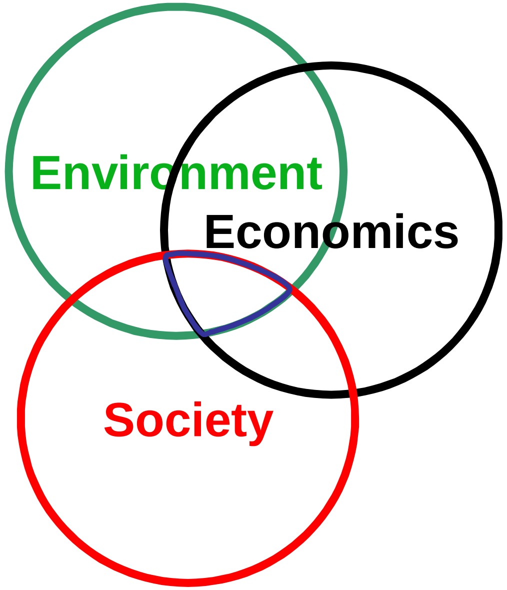
Bring together the scores for each weighted metric to get an overall index for each college which can then be used to:

- Compare the sustainability of different colleges
- Look at the scores in each area of sustainability and suggest where improvements could be made to improve the overall score.



Sustainability Indicators for Industry

Institution of Chemical Engineers, www.icheme.org/sustainability/



Environmental indicators

- Resource usage
- Emissions, effluents and waste

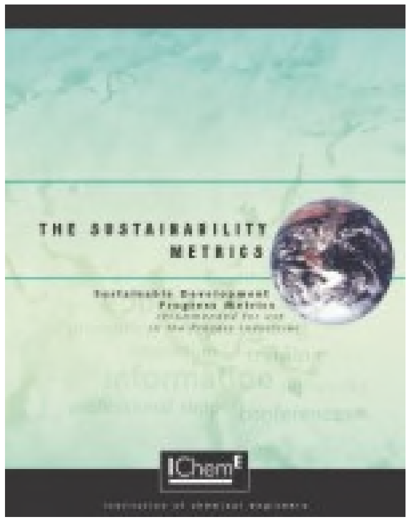
Economic indicators

- Profit, value and tax
- Investments

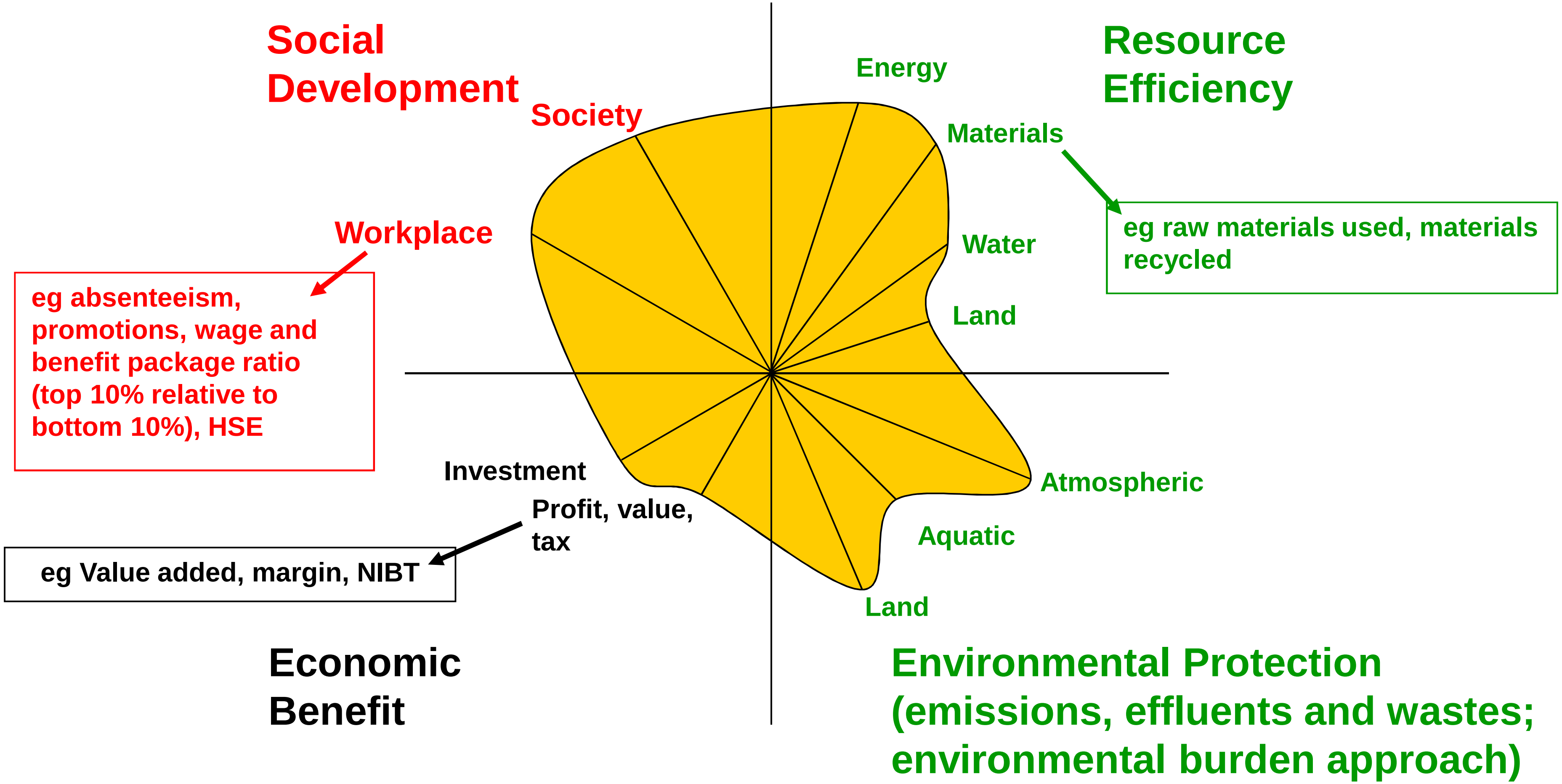
Social indicators

- Workplace
- Society

50 indicators in total, but under each heading there is scope for additional items. Example: R&D expenditure as % sales - an economic indicator for investment.



IChemE Metrics



The sustainability footprint of a process plant measured by the set of IChemE metrics
www.icheme.org/sustainability/

Goodhart's Law

When a measure becomes a target, it ceases to be a good measure.

Charles Goodhart
Norman Sosnow Professor of Banking and Finance at the London School of Economics

Meeting the target for one sustainability indicator, should not mean that some other aspects becomes significantly worse. This implies the need for composite targets, as well as composite indicators.

References and Suggested Reading

Websites:

http://unfccc.int/resource/docs/convkp/kpeng.html (Kyoto Protocol)
http://www.netregs.gov.uk

http://www.environment-agency.gov.uk/
http://www.dti.gov.uk/sustainability/weee
http://www.defra.gov.uk/
http://www.gre.ac.uk/~bj61/talessi/tlr3.html

Books:

Environmental assessment a guide to the procedures, HMSO 1989 ISBN 0-11-752244-9

Integrated pollution management, F Feates and R Barratt McGraw Hill 1995 ISBN 0-07-707867-5

Management of Process Industry Waste, R Bahu, B Crittenden and J O'Hara IChemE 1997 ISBN 0-85295-324-0

Introduction to Environmental Engineering 3rd ed, ML Davies and DA Cornwell McGraw Hill 1998 ISBN 0-07-015915-1

Life Cycle Analysis is a process to:

Evaluate:	**the environmental burdens of a product, process or activity**
Identify & quantify:	**energy & materials use and releases to the environment**
Assess:	**the impact of energy & material use and wastes**
Identify & evaluate:	**opportunities for improvement**

Life Cycle Analysis – "Cradle-to-grave"

Analysis considers entire life cycle including:

- **Extracting & processing raw materials**
- **Manufacturing**
- **Transportation and distribution**
- **Use**
- **Maintenance**
- **Re-use**
- **Recycling and final disposal**

Simplified analysis of part of the total system is often adequate to compare options

For example:
In the transport sector use predominates

Life-Cycle Analysis Questions

- **How can the system be improved?**
- **What are the most significant environmental impacts of the system?**
- **What are the 'hot spots' in a system?**
- **What are the options for maximum improvements?**
- **Which products, processes and activities are more sustainable?**

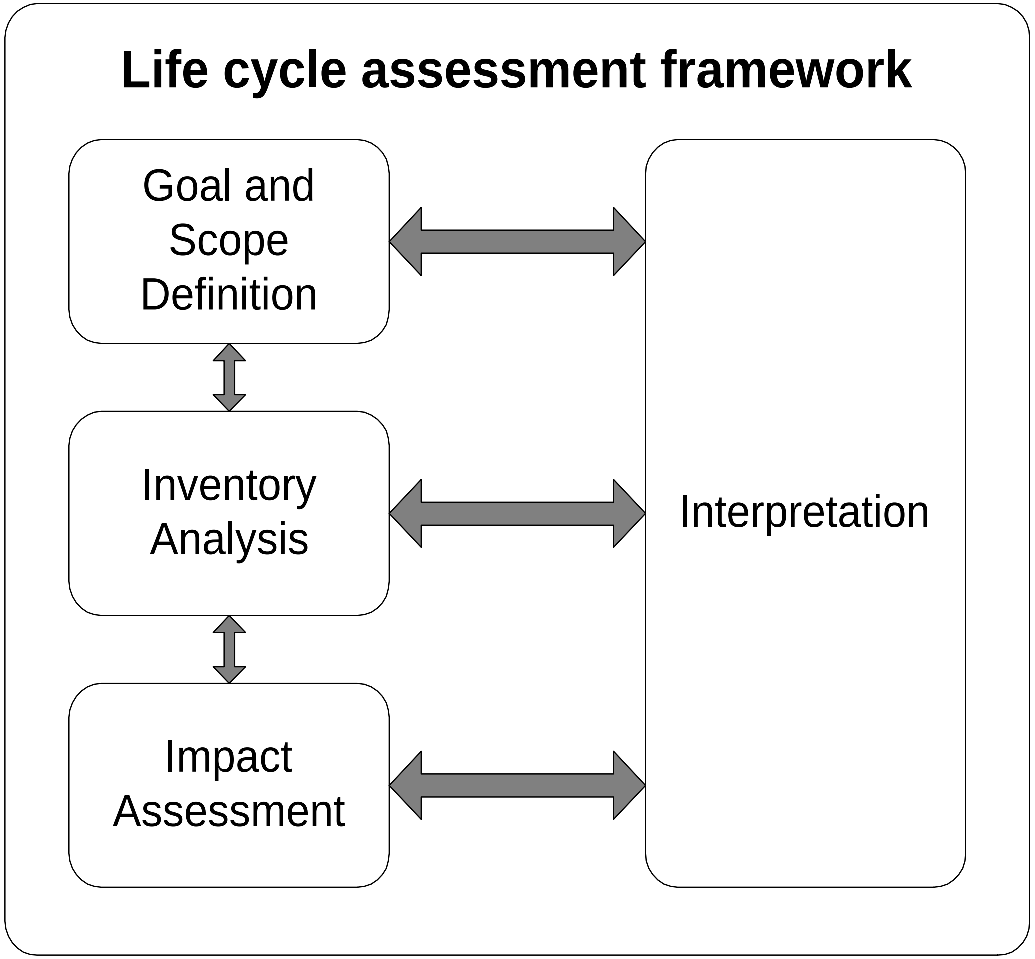
Standard Life Cycle Analysis

There is a standardized tool for conducting a multi-media, cradle-to-grave assessment

- ISO 14040 “Life Cycle Assessment – Principles and Framework” 1997
- ISO 14044 “Life Cycle Assessment – Requirements and Guidelines” 2006

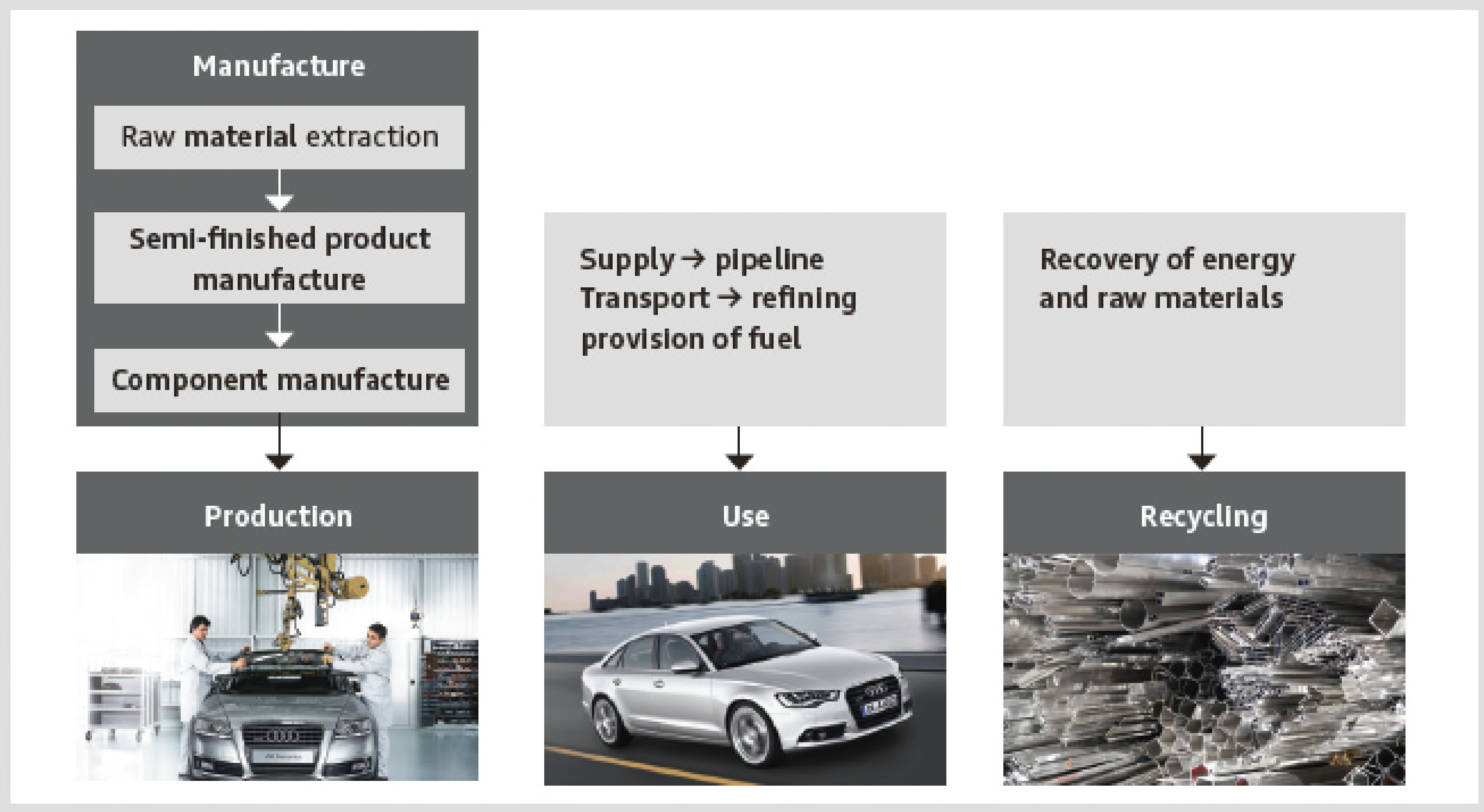
* ISO – International Standards Organisation

ISO 14040 Standards



- **Goal -** Implement a new product or process, Compare existing product or process to possible competitors, Determine the environmental friendliness of a product, Determine where to spend money on Environmental Improvement
- **Inventory** - Quantifying the energy and materials used, and wastes generated
- **Impact** - Assess the effects of the inventory.
- **Interpretation -** Systematic evaluation e.g. the environmental burden

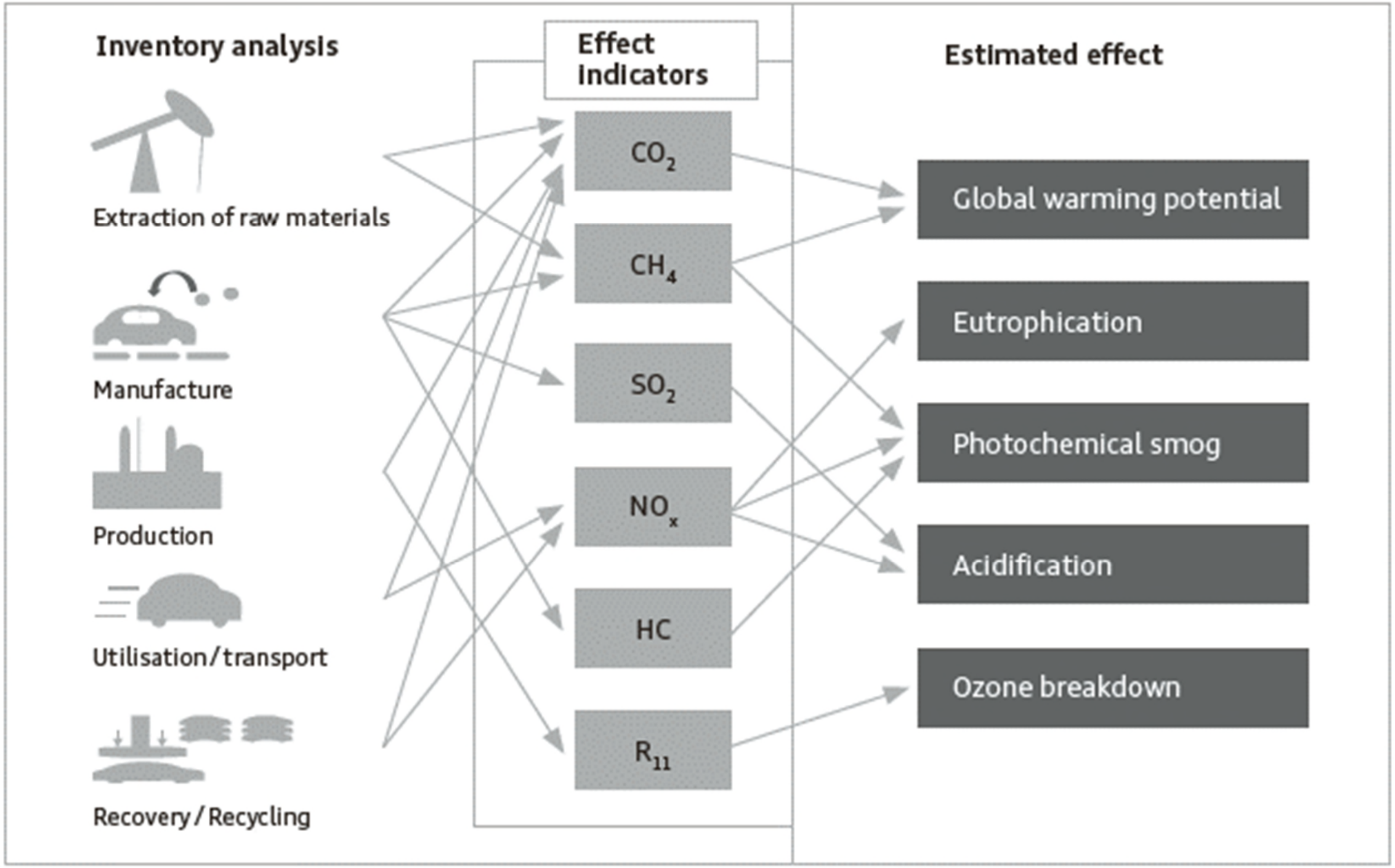
Example: Life cycle analysis of car



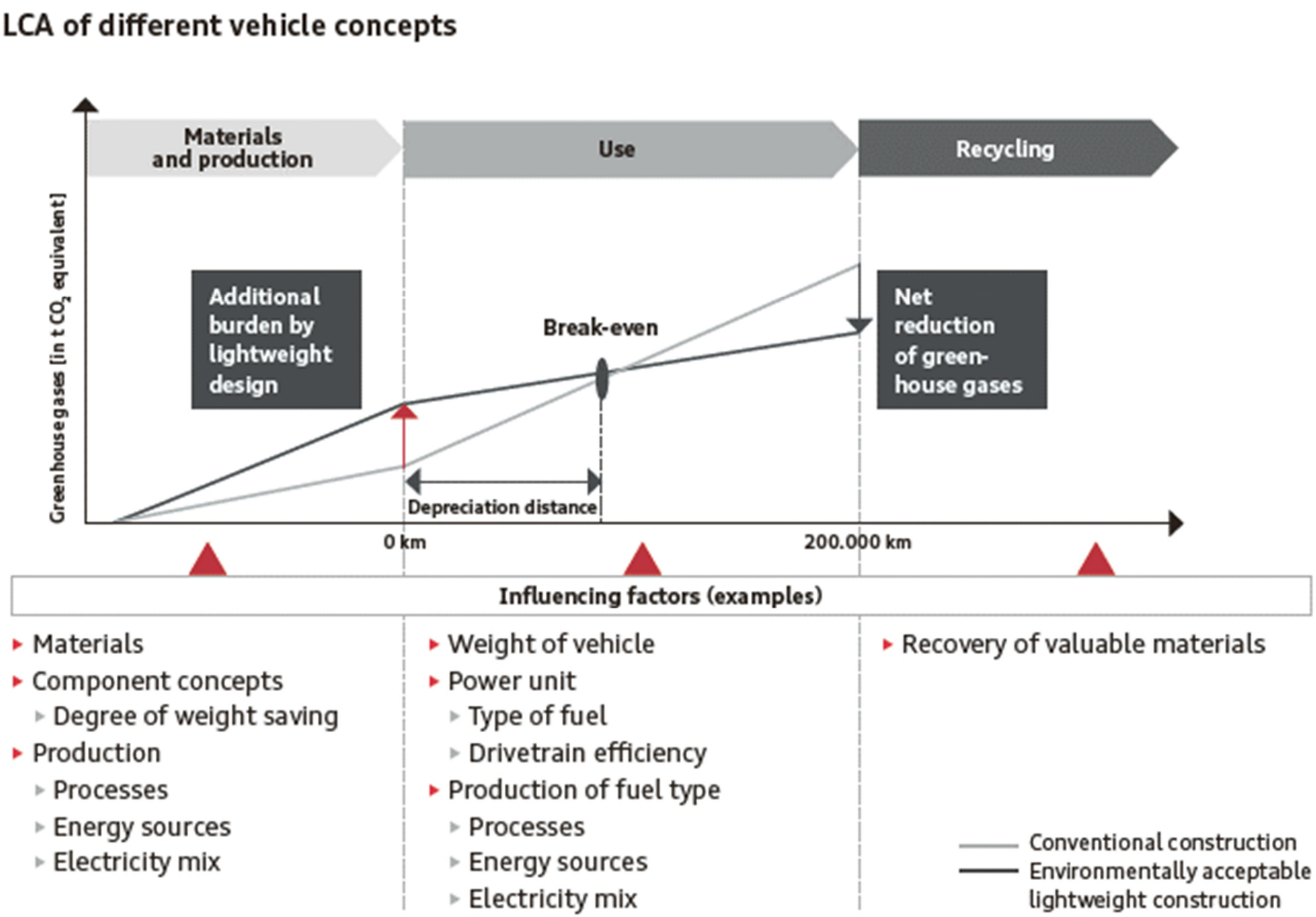
= product system

Example: Life cycle analysis of car

Effect of substances on the environment



Example: Life cycle analysis of car



Aluminum Can LCA

Aluminum Ore extraction

Energy Savings Recycling

- Energy D = 66.43 kw hr/kg
- World aluminum can consumption ~200 billion every year.

https://www.theworldcounts.com/counters/world_food_consumption_statistics/aluminium_cans_facts

7.3 kw hr/kg **0.07 kw hr/kg** **16.6 kw hr/kg**

Aluminum production → **Sheet production** → **Sheet transport** → **Can production**

70.4 kw hr/kg

0.07 kw hr/kg

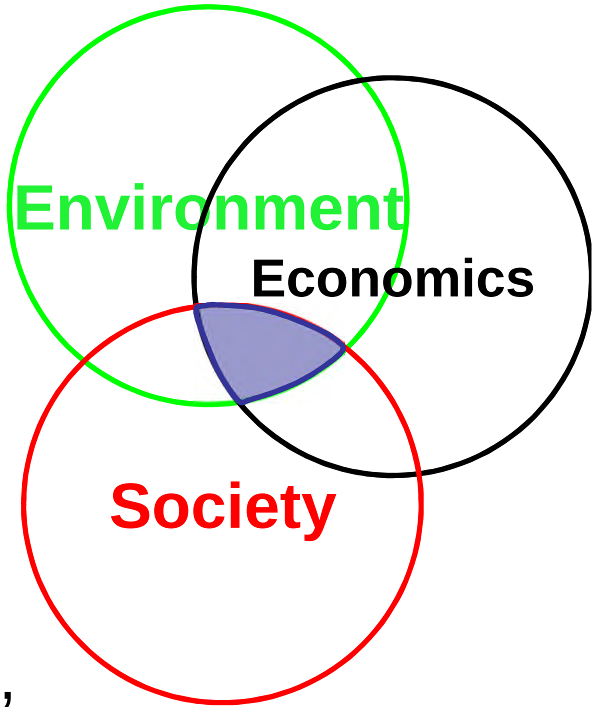
Ingot production ← **material transport** ←

Recycling

3.9 kw hr/kg

Decision analysis

‘Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.’
The Brundtland Report



We have seen that in order to achieve sustainability, we must take account of economic, environmental and social factors.

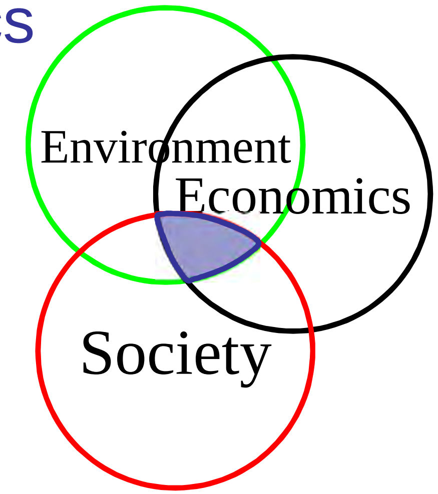
These factors can be measured as metrics, but can they guide our actions?

Can we decide whether one project or product is “more sustainable” than another?

Decision Analysis

Firstly, decide which metrics to use?

- The relevant ones for the case and the purpose
- They should cover all three aspects of sustainability (otherwise you are only doing a partial assessment)
- How do we balance (weight) the metrics and how do we make a decision:



Multi Criteria Analysis

Example: Decision Analysis

Example: For taking children to school, we want to compare two cars (Land Rover Freelander, Toyota Prius), the bus, and the bicycle.

Possible indicators might be

Environmental (**kg $\mathbf{CO_2}$** per 10 mile trip)
[data LR: 20.4 miles per gallon; Prius 62.4 miles per gallon, 1 gallon petrol yields 11 kg CO_2]

Social (Child **safety**, contribution to road **congestion**)

Economic (**cost** per 10 mile trip)
[data: Prius £5.80, LR £8.60, bus £1.40, bicycle £0.40]

Example: Decision Analysis

The methodology:

1 **Score the indicators on a scale** (in the same sense, eg 1= bad, 10= good). Sometimes they can all be reduced to a money basis.

2. Use the scores to identify “good” and “bad” options. Many techniques are possible, such as pairwise comparison, or **weighted totals**.

3. **Examine sensitivity** (other indicators, weightings, scores, can a bad score be mitigated …)

Example: Decision Analysis

	CO_2 w =	safety w =	congestion w =	cost w =	total
Prius	2	8	3	2	
LR	1	8	3	1	
bus	4	9	9	3	
bicycle	10	3	9	10	

Scores are on the scale: 10=good, 1=bad

Prius (Toyota Prius car)

LR (Land Rover Freelander car)

Example: Decision Analysis

	CO_2 w = 0.5	safety w = 1.0	congestion w = 0.5	cost w = 0.8	total
Prius	2 **1**	8 **8**	3 **1.5**	2 **1.6**	**12.1**
LR	1 **0.5**	8 **8**	3 **1.5**	1 **0.8**	**10.8**
bus	4 **2**	9 **9**	9 **4.5**	3 **2.4**	**17.9**
bicycle	10 **5**	3 **3**	9 **4.5**	10 **8**	**20.5**

Scores are on the scale: 10=good, 1=bad

Multi-criteria Decision Analysis

In this example the bicycle is the preferred choice. We must now test the robustness of our choice by looking at the effect of changing the criteria or weightings (sensitivity analysis).

This whole methodology is known as **Multi-criteria, or Multi-attribute, Decision Analysis.** Many books have been written about it.

The advantage of the methodology is that it structures the decision making process, making it transparent. If attitudes or circumstances change, the decision can be revisited.

It does not reconcile differences of opinion, just clarifies them!

Decision-making in a complex world

The Mark III Engineer recognises the need for sustainability, must deal with uncertainty in the decision making process, and consults and engages with stakeholders.

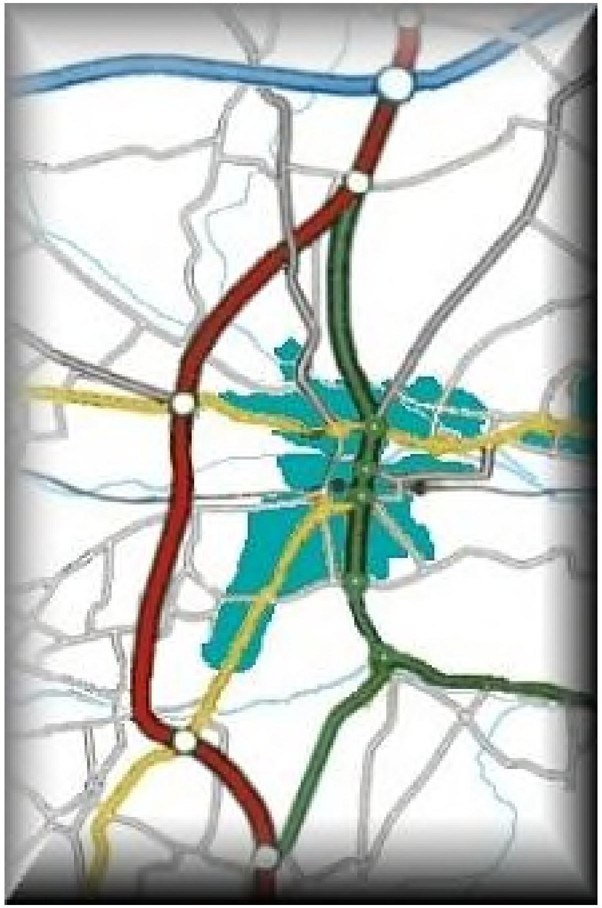
→Multi faceted decisions, trade off monetary & non-monetary benefits. Role as informed expert in public debate & decisions.

Dealing with a range of criteria is an enormous challenge, e.g. the Newbury bypass dilemma:

> **how do you balance the loss of natural habitat against an improvement in town environment shorter journey times (and possibly less emissions)?**

The Newbury bypass dilemma

Constructed 1996-1998



"The Newbury bypass in Berkshire, UK, was at the time of construction, one of the most infamous road developments in the World - debated and argued about by all types of people, politicians and environmentalists - locally, nationally and even internationally.

- One of the major bones of contention was the total lack of an Environmental Impact Assessment (EIA) at Newbury. This route was very controversial because it ran through three Sites of Special Scientific Interest, English Heritage, and National Trust Nature reserve.
- This staggering disregard of EU law by the then Conservative UK Government so infuriated some local residents that they petitioned the matter to the European Parliament in Brussels." (The Newbury Bypass Project – local monitoring group)

The Newbury bypass - the case for it

The A34 is a **strategically important route** connecting the Midlands and the North with the South Coast ports. It is part of the Trans European Road Network. When completed the 13.4km dual carriageway bypass **will take the heavy through traffic (including some 400 HGV an hour at peak times) out of the congested town** and off the only remaining section of single carriageway on the route.

Significant economic, environmental and safety benefits are expected

... Extensive steps have been taken to relocate affected wildlife, protect high quality rivers, reduce noise by use of a porous asphalt road surface, and to replace wooded areas with many more trees than were lost.

Department of the Environment Transport and the Regions (Roads Review Consultation document)

The Newbury bypass - the case against it

“The Government has recognised the superb wildlife value of the rivers Lambourn and Kennet [designated SSSI’s]. Now the Department of Transport plans to build a trunk road across these sites. **English Nature must stand up for wildlife and challenge the proposed damage to these beautiful rivers**.” Tony Juniper, Friends of the Earth

The two rivers have been described as "unique" by the National Rivers Authority. English Nature has found that the stretches of both rivers in the Newbury area have a **"particularly diverse flora, comparable with any river in England".**

But "English Nature is not a campaigning organization, but rather must present the nature conservation case at Public Inquiry and then abide by the decision made." - a position that many campaigners found disappointing.

The Newbury bypass dilemma

http://www.charlessturge.com/newbury/main.htm

The Government maintained, and the European Commission confirmed, that at the date when consent was given, an EIA was not needed. EIA's were only needed after 3/7/88.

The Newbury bypass dilemma

After many protests, the road was opened in 1998.

"The tree I was in during the eviction was still there, next to the road at the old Sea View Camp. It was the only thing that lifted my spirits. The landscape has changed beyond recognition. I feel gutted, it really has happened."

"how do you count the cost of devastation to nature reserves, sensitive eco-systems, archaeological sites and water meadows."

The Newbury bypass dilemma

HIGHWAYS AGENCY news release

“The £104 million Newbury Bypass was today opened by Highways Agency Chief Executive, Lawrie Haynes. Construction of the 8.5 mile (13.5 kilometre) road was completed within its 26 month contract and within budget.

The total cost, over and above the tender price of £74 million (plus a standard ten per cent contingency for civil engineering projects) is as a direct result of protest action.

We estimate that it will remove 20,000 vehicles a day from Newbury and save 28 lives over the next 30 years.”

The Highways Agency 17/11/1998

The Newbury bypass dilemma

'Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.'

The Brundtland Report

Was the Newbury bypass an example of Sustainable Development, or Sustainable Engineering?

How would you have handled this problem?

Engineers on the site were daily confronted with angry protesters – were they right to go on working on it?

The Highways Agency, and many local people, and many other road users are pleased with the bypass. Are they right?

What criteria should have been included in the assessment, how heavily should they have been weighted?

Should there have been more consultation? With whom?

Summary

- Life cycle analysis and multi-criteria decision analysis can be useful tools in assessing the sustainability of different projects.

- However, it can be difficult to reconcile opposing points of view
  - Consult the stakeholders, but what if they disagree?

References and Suggested Reading

Sustainability Indicators, Measuring the immeasurable? ***Bell and Morse 2000, ISBN 1-85383-498-X Earthscan***

Analysis for Optimal Decisions ***Derek Bunn 1982 ISBN 0-471-10132-X, John Wiley***

Decision Analysis: an Integrated Approach, ***Golub, A.L., 1997, ISBN 0-471-15511-X John Wiley***

Websites:
http://www.dtlr.gov.uk/about/multicriteria/
http://www.globalreporting.org/GRIGuidelines/
http://www.sustainabledevelopment.gov.uk/indicators/index.htm
http://www.highways.gov.uk/info/corpdocs/annrep/07.htm