MODULE1

SUSTAINABLE DEVELOPMENT AND ROLE OF ENGINEERS

Introduction:

What is sustainable development

"Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs."

The concept of sustainable development can be interpreted in many different ways, but at its core is an approach to development that looks to balance different, and often competing, needs against an awareness of the environmental, social and economic limitations we face as a society.

All too often, development is driven by one particular need, without fully considering the wider or future impacts. We are already seeing the damage this kind of approach can cause, from large-scale financial crises caused by irresponsible banking, to changes in global climate resulting from our dependence on fossil fuel-based energy sources. The longer we pursue unsustainable development, the more frequent and severe its consequences are likely to become, which is why we need to take action now

So is it all just about the environment?

Living within our environmental limits is one of the central principles of sustainable development. One implication of not doing so is climate change.

But the focus of sustainable development is far broader than just the environment. It's also about ensuring a strong, healthy and just society. This means meeting the diverse needs of all people in existing and future communities, promoting personal wellbeing, social cohesion and inclusion, and creating equal opportunity.

If sustainable development focuses on the future, does that mean we lose out now?

Not necessarily. Sustainable development is about finding better ways of doing things, both for the future and the present. We might need to change the way we work and live now, but this doesn't mean our quality of life will be reduced.

A sustainable development approach can bring many benefits in the short to medium term, for example:

Savings - As a result of SDC scrutiny, government has saved over £60m by improving efficiency across its estate.

Health & Transport - Instead of driving, switching to walking or cycling for short journeys will save you money, improve your health and is often just as quick and convenient.

How does it affect me?

The way we approach development affects everyone. The impacts of our decisions as a society have very real consequences for people's lives. Poor planning of communities, for example, reduces the quality of life for the people who live in them. (Relying on imports rather than growing food locally puts the UK at risk of food shortages.)

Sustainable development provides an approach to making better decisions on the issues that affect all of our lives. By incorporating health plans into the planning of new communities, for instance, we can ensure that residents have easy access to healthcare and leisure facilities. (By encouraging more sustainable food supply chains, we can ensure the UK has enough food for the long-term future.

How do we make it happen?

We all have a part to play. Small actions, taken collectively, can add up to real change. However, to achieve sustainability in the UK, we believe the Government needs to take the lead. The SDC's job is to help make this happen, and we do it through a mixture of scrutiny, advice and building organisational capacity for sustainable development.

Why is sustainable development so Important?

The **Brundtland Report** was drawn up as part of the UN World Commission on Environment and Development in 1987.

  This over 300-page document aimed to shape national policies and sets out the key measures to be integrated in order to **protect the planet and human life**. Although this report on the technological process of sustainable development is titled, "Our Common Future", it is often referred to as the "Brundtland Report" after **Gro Harlem Brundtland**, Prime Minister of Norway at the time and Chair of the commission.

The concept of **sustainable development** was explained in depth in this report through the discussion of climate change, economic development, and global goals that should be implemented in order to achieve sustainable development.

The **definition** is as follows:

"Sustainable development is development that strives to meet the needs of developing countries seeking to achieve a more sustainable world. Sustainable development addresses the needs of the present moment without compromising current and future generations to meet their own sustainable lifestyles."

Sustainable development can be applied to **corporate policy** in the business world as it encompasses three key areas: economic, environmental and social. Sustainable development requires that a company must contribute to **economic growth, social progress** and promote **environmental sustainability**.
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What are the three pillars of sustainable development?

Social pillar 🤝

The social pillar of a company's sustainable development refers to **values that promote equality and respect for individual rights.** The social consequences of the company's social activity are then assessed in accordance to these issues, such as gender equality.

The principles upon which this pillar is founded are as follows:

- **Combat social exclusion and discrimination**: helping with reintegration, supporting gender equality, reducing the gender pay gap, promoting training, encouraging dialogue, and applying global social rights. In other words, the goal is to seek to aid the global population.
- **Promote solidarity**: helping to reduce social inequalities by collaborating with local and international associations and projects, and prioritizing fair trade products which guarantee an appropriate income for farmers and help to promote sustainable agriculture.
- **Contribute to the well-being of stakeholders**: developing social dialogue, encouraging the exchange of information and transparency, adapting working hours according to employee profile, and making premises accessible to people with reduced mobility.

Economic pillar 💵

This pillar is based on companies' ability to contribute to economic development and growth. In other words, they must encourage and promote the protection of the environment by limiting the risks posed by their production. **The recycling of products and the use of renewable energy** are therefore fundamental aspects of the development of the **economic pillar**.

Furthermore, the **ISO 50001 standard** which is focused on energy efficiency, aims to improve energy performance, while **reducing energy consumption and therefore contributing to economic growth.** Effectively implementing of this standard leads to a certification, serving as a guarantee of optimal, affordable and clean energy use.

Environmental pillar 🌱

The environmental pillar is founded on a commitment to **protect the environment by reducing risks** and measuring the environmental impacts of companies' activities. The challenges for companies in this area are as follows:
- Saving and preserving natural energy or agricultural resources
- Assessing their carbon footprint and reducing total greenhouse gas emissions and further achieve sustainable development goals.
- Prevent water scarcity and reduce overall waste for current and future generations.

Companies must set targets to improve their performance on environmental issues. These goals are an integral part of Corporate Social and Environmental Responsibility (CSER).
The three pillars of sustainable development can be illustrated using a diagram to provide a clearer understanding of the greatest challenges facing humanity involved and how they impact one another.
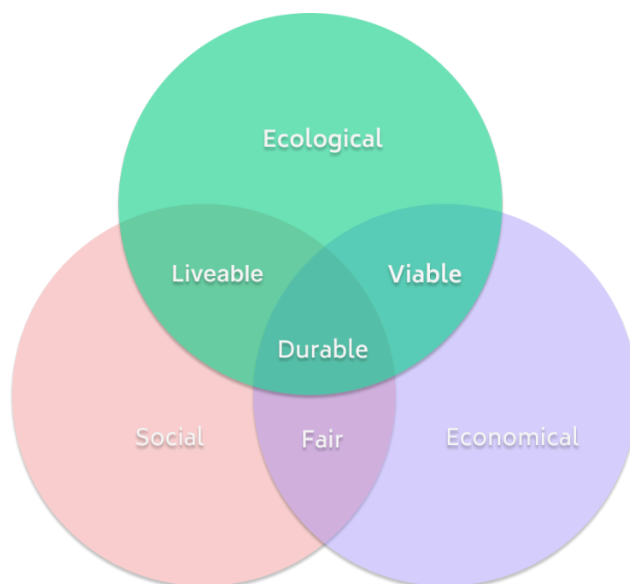
Why is a fourth pillar sometimes mentioned?

A fourth pillar is often acknowledged as a sustainable pillar of culture. For instance, culture can refer to the difference in sustainable lifestyles and carbon emissions in various places : such as New York or small island developing states. Though it is often not recognized as a core pillar to achieving sustainable development, culture is an important part of sustainable

development since it incorporates all three of the fundamental aspects of sustainable development described above.

Culture: a basic but central element of sustainable development 📚

The **Brundtland Report** delineated how economic growth, social inclusion and environmental balance are essential to create a sustainable development solutions network – utilizing local, national and global development strategies. However, these aspects alone cannot account for the full complexity of our current societies.

Organisations and events such as UNESCO or the World Summit on Sustainable Development (2002) have since advocated for **culture to be included** in this model. Culture is a complementary factor as it shapes our meaning of "development" and determines the actions of communities around the world.

The UNESCO Universal Declaration on Cultural Diversity (2001) and the Convention on the Protection and Promotion of the Diversity of Cultural Expressions (2005) define the **relationship between culture and sustainable development** in two specific ways:

- The development of the cultural sector in itself and its economic dimension (cultural heritage, creative and cultural industries, crafts, cultural tourism, etc.);
- The notion that culture plays a clear role place in all public policy, such as in the united nations – including everything related to education, economy, science, communication, environment, social cohesion and international cooperation.

However, the world is not only facing economic, social and environmental challenges. Creativity, knowledge and diversity are all key elements for creating a conversation to promote peace and social progress. These values are intrinsically linked to the ideals of **human development and freedom**.

The world's cultural challenges are too complex to be considered in the same manner as the other three original aspects of sustainable development. This fourth pillar is strongly linked with the other three dimensions of sustainable development, and is complementary to each of them.

Culture is thus a driver of social values (cohesion, solidarity, fundamental freedom, human settlements, etc.), it contributes to global economic sustainability and is as important as the environment to humankind because of the heritage it represents.

Why integrate culture into the pillars of sustainable development? 📌

As previously discussed, culture should be integrated into the pillars of sustainable development predominantly because it encompasses **social and economic dimensions**. But that is not the only reason. Culture can also be employed as an **effective strategy to support the three fundamental pillars**. It plays a socially-binding and facilitating role in the face of economic, societal and environmental challenges.

Furthermore, the **culture of sustainable development** (its foundations, its history, its evolution) is often overlooked within companies. More importantly, raising awareness of this culture would provide a better understanding of the issues at stake when implementing management policy (particularly in terms of corporate social responsibility) and encourage greater involvement: such as to eradicate poverty, ensure access to needs for youth, and to provide under-developed countries with basic services that could help to mitigate climate action or decrease the emission of fossil fuels.

Finally, culture can have a positive impact within a company insofar as it **unifies and consolidates human activities**, i.e. **"the set of distinctive spiritual, material, intellectual and emotional features of society or a social group [...]"**: This is an essential element of the company's overall functionality.

Therefore, it could be said that sustainable development is not defined by three fundamental pillars, but through four major dimensions: social, economic, environmental and cultural.

Social pillar: ensure the well-being of your employees 👥

Governance that conveys social values is conducive to the well-being of your employees and associates. A company is more likely to prosper if its employees feel happy in their work. They will certainly stay with the team longer and the work dynamic will be better. For a company, taking ethical action means implementing a reference model of good practices for a more virtuous society. Therefore, the social pillar plays a critical role in achieving sustainable development.

Economic pillar: optimise your budget 💰

Adopting a more responsible approach to production by encouraging recycling, limiting waste and using renewable raw materials can considerably reduce your current expenditure while still promoting sustainable consumption. Better resource management and

the integration of waste into a second line of production or sales channel are good practices for optimizing your budget and natural resources. The economic pillars plays a key role in sustainable development as it opens more doors for success in the other pillars of sustainable development.

Environmental pillar: improve your CSR strategy 🌳

Integrating environmental targets into the management of your company is essential from a corporate social responsibility (CSR)perspective. Already a legal obligation for companies with over 500 employees, a CSR strategy is also recommended for other businesses that want to invest in an eco-friendly way while improving their brand image. The environmental pillar is imperative as it creates a more sustainable world for future generations, and overall helps to mitigate climate change.

Cultural pillar: boost cohesion and support among stakeholders 📖

Integrating the cultural role is an essential component of any company. As a unifying force, culture helps to build real social ties, which result in more dynamic exchanges, better group work and, therefore, an increase in the productivity of your employees. Moreover, culture boosts motivation and education through intellectual stimulation. Overall, the cultural pillar of sustainable development plays a crucial role the individual performance of your company's stakeholders.

What Is the Paris Agreement?

The Paris Agreement is a landmark international accord that was adopted by nearly every nation in 2015 to address climate change and its negative impacts. The agreement aims to substantially reduce global greenhouse gas emissions in an effort to limit the global temperature increase in this century to 2 degrees Celsius above preindustrial levels, while pursuing the means to limit the increase to 1.5 degrees. The agreement includes commitments from all major emitting countries to cut their climate pollution and to strengthen those commitments over time. The pact provides a pathway for developed nations to assist developing nations in their climate mitigation and adaptation efforts, and it creates a framework for the transparent monitoring, reporting, and ratcheting up of countries' individual and collective climate goals.

History of the Paris Agreement

Hammered out over two weeks in Paris during the United Nations Framework Convention on Climate Change's (UNFCCC) 21st Conference of the Parties (COP 21) and adopted on December 12, 2015, the Paris Agreement marked a historic turning point for global climate action, as world leaders came to a consensus on an accord comprised of commitments by 195 nations to combat climate change and adapt to its impacts.

President Obama was able to formally enter the United States into the agreement under international law through executive authority, since it imposed no new legal obligations on the country. The United States has a number of tools already on the books, under laws already passed by Congress, to cut carbon pollution. The country formally joined the agreement in September 2016 after submitting its proposal for participation. The Paris Agreement could not take effect until at least 55 nations representing at least 55 percent of global emissions had formally joined. This happened on October 5, 2016, and the agreement went into force 30 days later on November 4, 2016.

How Many Countries Are in the Paris Agreement?

Since 2015, 197 countries—nearly every nation on earth, with the last signatory being war-torn Syria—have endorsed the Paris Agreement. Of those, 190 have solidified their support with formal approval. The major emitting countries that have yet to formally join the agreement are Iran, Turkey, and Iraq.

What was agreed?

- To "pursue efforts" to limit global temperature rises to **1.5C**, and to keep them **"well below" 2.0C** above pre-industrial times
- To limit greenhouse gas emissions from human activity to the same levels that trees, soil and oceans can absorb naturally - known as **net zero** - between 2050 and 2100
- Each country to set its own emission-reduction targets, reviewed every five years to **raise ambitions**
- Richer countries to help poorer nations by providing funding, known as **climate finance**, to adapt to climate change and switch to renewable energy.

Why is it so significant for COP27?

Some of the key discussions in Sharm el-Sheikh, Egypt will be about whether and how countries are building on what they promised in Paris.
When the agreement was signed, governments admitted the targets set would not be enough to limit global warming to 1.5C.

At the COP26 climate summit held in Glasgow in 2021, some countries brought forward new targets. But even with these pledges, global warming would still only be limited to 2.1C, according to the independent **Climate Action Tracker**.
Parties were again asked to submit more aggressive targets for reducing emissions before COP27 to align with the Paris goal, but only 25 of the 194 have come up with improved commitments.

It is expected that South Africa and Indonesia will announce funding plans to phase out fossil fuels, and it is hoped that more countries will sign up to the methane, finance and deforestation pledges drawn up at COP26.

COP27 will also host one of three technical reviews as part of the "global stocktake" (GST). This is where countries review whether their plans are strong enough to prevent temperatures rising above 1.5C, using analysis prepared by UN officials and scientists.
It is hoped the process will strengthen the case for further action.

What about promises to help poorer countries?

The Paris Agreement restated a commitment made in 2009 that the world's richer countries should provide $100bn (£87bn) annually by 2020 to help developing nations deal with the effects of climate change, and build greener economies.

Did the Paris Agreement go far enough?

Although the Paris Agreement laid out a clear target point, it did not contain the specific detail on how to reach it.

The ambition is to create a "net zero" world by 2050. That means reducing greenhouse gas emissions as much as possible, and removing any remaining emissions from the atmosphere, through natural or artificial processes.

Scientists argue it is vital to assess the progress being made towards that goal every year.
The UN group of climate experts, the IPCC, has estimated an annual budget of carbon emissions the world can release before temperatures rise above 1.5 degrees, measured in gigatonnes of CO2 equivalent (GtCO2e).

In 2018, **the IPCC estimated** that the world should only release 25-30 GtCO2e per year by 2030.
It currently emits 36.3 GtCO2e per year, **according to the IEA**.
The priority of COP27 will be to develop a specific plan of action to bring that figure down, and - as in Paris - secure international support for the way forward.

Paris Agreement and Role of Engineering

Global climate change is one of the greatest environmental threats facing the world. Human activities such as the burning of fossil fuels and deforestation over the past 150 years have led to the emissions of massive amounts of greenhouse gases (eg carbon dioxide and methane). These gases are increasing the amount of heat trapped in the atmosphere leading to changes in climate faster than at any time since the transition from the last ice age 10,000 years ago [1]. The consequences will be grave: large rises in sea level causing widespread coastal flooding; more severe weather (droughts in some areas, storms in others); and major threats to agriculture and natural ecosystems. Those affected most will be those already vulnerable today: people in poorer countries and endangered wildlife.

The choices that society makes on the use of engineering today and in the near future will be instrumental in determining whether we successfully tackle the problem or not. In this paper I briefly outline some of the main technical options for dealing with climate change, and highlight the ethical dilemmas that surround these options.

Reducing Greenhouse Gases

Because so many human activities result in emissions of greenhouse gases (GHGs), there is a very wide range of possible ways of reducing these emissions. Here I focus on three areas of particular importance to engineering:

- Changes in energy production

- Improvements in energy-efficiency by technical means

- Reducing GHG emissions by social means

Changes in energy production

Energy production can be changed in several ways to reduce emissions. For a start we can switch away from coal and oil to gas, as gas emits only half the CO_2 of coal and two-thirds the CO_2 of oil per Joule of energy used. A further way is to expand the use of Combined Heat

and Power (CHP or cogeneration) plants. Such plants use the waste heat from electricity production to provide space heating or hot water for local buildings. Whereas conventional plants producing electricity work at efficiencies of about 35% to 45%, CHP plants work at efficiencies of up to 85%.

Improvements in energy-efficiency by technical means

The potential for technical change to lead to energy efficiency improvements as a way of reducing GHG emissions is very high. For example, most buildings in the UK are not well insulated due to (up until recently) low energy efficiency standards being followed in the building industry. Since most buildings are heated using fossil fuels, either directly or indirectly, a large amount of GHG emissions are needlessly produced. Large-scale deployment of building insulation will thus yield significant savings. Further, the recent improvements in the energy efficiency standards governing household appliances is beginning to have an effect.

One of the largest sources of GHG emissions in the UK is from motor vehicles. The recent introduction of the first 'hybrid' cars, which use a combined petrol-driven motor with an electric motor, can reduce fuel consumption by up to 50%. The promise of using fuel cells (see above) to drive motor vehicles has the potential to reduce GHG emissions further.

Reducing GHG emissions by social means

It is also important to consider social changes which could reduce GHG emissions. For example, if more people were to switch transport mode, from cars to public transport or cycling they could make very large savings in their personal energy consumption and hence reduce emissions. Of course, the ability of people to make such changes depends on many factors, such as how far they live from work. But if such changes encourage people to live closer to work, they could reduce their emissions further. Indeed basing more of our economy on local activity, eg buying locally-produced food or other goods and services, could reduce GHG emissions quite substantially.

Ethical dilemmas for engineers

There are four main ethical questions I will tackle in this section:

1. Will nuclear power cause more problems than it solves?

2. Is CO_2 capture & storage an acceptable option?

3. Are improvements in technical efficiency just undermined by more consumption?

4. Will reducing GHG emissions conflict with international development?

IS CO_2 capture & storage an acceptable option?

CO_2 capture and storage (CCS) raises a number of ethical issues. The first is whether the CO_2 injected into the ground will leak out. Current research indicates that the CO_2 will

remain, but it is still a technology in the early stages of development. Further concerns include the way in which it will support the continued use of fossil fuels. The extraction and transport of fossil fuels have significant non-climate environmental and social impacts, eg oil tanker spills and damage to ecosystems during oil extraction. Perhaps the strongest concern is that it will continue to exacerbate geo-political problems, eg in the Middle East. Related to this is the concern that R&D in this area will divert finance away from renewable energy.

Are improvements in technical efficiency just undermined by more consumption?

When energy efficiency is improved it obviously leads to a drop in the amount of energy that can be sold by suppliers. To compensate (which is the same for any business whose sales fall), the suppliers try to lower the price so that people are encouraged to consume more. Unfortunately, such a response can undermine the original energy savings. The simplest way around this is for energy prices to be increased by the use of taxes. The particular taxation method of most relevance to climate change is carbon taxes, whereby the tax is determined by the emissions of CO_2 per Joule of energy. Unfortunately, many large businesses involved in energy generation and use oppose such taxes because of the potential cost to their business. However some businesses have more progressive environmental policies and support such taxes.

Will reducing GHG emissions conflict with international development?

A criticism which has been levelled by some of the developing world is that, if they are forced to reduce GHG emissions, this may increase the costs of energy and hence undermine their efforts to tackle poverty. Hence it is crucial that the richer industrial nations assist in the transition to cleaner energy generation and use. One aspect of particular benefit to poorer communities is simpler 'intermediate' technologies. These technologies, which include some renewable energy technologies like small-scale hydro and wind, tend to be easier to maintain and cheaper.

An ethical agenda for engineers?

It is very difficult to define exactly what an ethical approach to tackling climate change is. Rather than make pronouncements that any particular technology or approach is ethical or not ethical, I make a series of recommendations of which areas deserve the most attention from engineers.

- Given that there are options for tackling climate change which have clear benefits, working in these areas should be a priority. These options are:

- renewable energy technologies because they produce zero GHG emissions during operation;

- power storage technologies, including hydrogen technologies, which can assist in the deployment of intermittent renewable energy sources;

- large technical changes in efficiency, eg CHP or fuel cells;

- technologies that support social change, eg buses/bikes rather than planes/cars;

- intermediate renewable and energy efficiency technologies that will be of particular value to communities in poorer countries.

- Seek employment with organisations with strong environmental and social policies, including supporting eco-taxes.

The Engineer's Role in Sustainability

Development can be called the sum of our products and projects, i.e. our application of technology. In these applications engineers carry out, influence or decide the options evaluated, the decisionmaking criteria, the decision and the detailed design and implementation/production.

For development to become 'sustainable', engineers must incorporate 'sustainability' into all our planning and engineering of products and projects. Technology is neither good nor bad in itself - how we choose to apply it determines whether a good balance is achieved.

Engineering integrates with all aspects of society; it takes concepts from maths and sciences and puts them into context through social and economic considerations before implementing them as tangible outcomes in society. It is essential that engineering understands social and environmental constraints and does not just conform to economic necessities. The purely business influence has been the paradigm norm of engineering, which has led to the problem soutlined above.

Bill Kelly describes how social responsibility is key to an engineer's role:

"Social responsibility is not a new issue for the engineering profession. It is fundamental to defining engineering as a profession. Following the concept that the outward part of an engineer's social responsibility is affecting public policy, the engineering profession is challenged today to help define social responsibly as part of defining the principles and practices of sustainable development. "

> ***Engineering: The art of directing the great sources of power and Nature to the use and benefit of Man.***" -**Thomas Tredgold,** 1818

"**Engineering is defined as the discipline, art, skill and profession of acquiring and applying scientific, mathematical, economic, social and practical knowledge, in order to design and build structures, machines, devices, systems, materials and processes.**"

The Engineering Council in the UK has produces a guidance on sustainability, which defines 6 principles that engineers should adhere to:

- Contribute to building a sustainable society, present and future

- Apply professional and responsible judgement and take a leadership role
- Do more than just comply with legislation and codes
- Use resources efficiently and effectively
- Seek multiple views to solve sustainability challenges

Sustainability Concepts

Factor 4

Definition

The Factor Four concept visualizes a quadruple increase in resource efficiency using existing methodologies whilst avoiding negative impacts on the overall quality of life. The concept aims for society to last twice as long or enjoy twice as much whilst using half the resources and placing half the pressure on the environment.

Main Features

Factor Four moves away from labour productivity and towards resource productivity and sustainability. By using best available technology, advanced engineering and improved production methods, fewer resources are required to produce more products and services. As a result, the life span of resources is stretched and future generations provided for. In other words, four times as much wealth can be extracted from the resources we currently use.

Factor four is used in decision making; production; and product-oriented environmental protection. Fundamentally, Factor Four is an economic idea. Reducing resource use by a factor of four is not a fixed target. Rather technologies and processes should aim to increase resource efficiency.

Case Studies and Examples

1. Recycling Carpets
Most used carpets in Europe are sent to landfills or waste incineration plants. However, several European companies collect, sort and identify used carpets according to fibre type.

The carpet or carpet components are then reused or recycled into underlays, insulation, cement clinker, synthetic vehicle components, fuel pellets, new carpets, etc.

The benefits of automated carpet sorting and recycling/reuse include:

- Less energy - recycling carpets consumes less energy than manufacturing new carpets.
- Less virgin materials - new products made from recycled carpets require less virgin material (by a factor of 4).
- Materials diverted from landfill - saving land use for landfills by a factor of 4.
- Environmental protection - recycling halves the greenhouse effect, acidification, nutrification and toxicity of carpeting and reduces the ozone-emitting-potential by 80%.
- Financial savings - automation makes the sorting and identification process economically feasible.
- New jobs are created.
- Market advantage - recycling and the recyclablity of carpets gives manufactures a completive advantage.

2. Dirt Repellent Surfaces using Nature as a Model

Many plants have leaves with a rough surface that naturally repel water. As water runs off the leaves in little beads, it also washes away dirt. Technological advancements allow scientists to replicate this water-repellent effect in materials such as house paint; tiles; glass panes; plastic sheets; and roof tiles. The result: materials that naturally repel dirt and are therefore self-cleaning or require minimal effort to clean.

The benefits of this process include:

- Less water and cleaning products utilised.
- Surfaces are more durable and scratch resistant, thereby requiring less repair work, maintenance, replacement, etc.
- Surfaces stay dryer longer, thereby preventing algae.
- Surfaces last longer and age better.
- Surfaces are more aesthetically pleasing and take much less time to clean.
- When used on vehicle windshields, visibility is improved.

Target Sectors / Stakeholders

The main stakeholders of Factor Four are industry, research institutions, governments and consumers. Developed nations are targeted more than developing nations.

Scale of Operation

Factor Four is applicable world-wide, however, it is best implemented at a business level.

Factor 10

Definition

Factor 10 states that over the next 30 to 50 years (one generation) a decrease in energy use and material flows by a factor of 10 and an increase in resource productivity/efficiency by a factor of 10 is required to achieve dematerialisation. That is, to attain sustainability and environmental protection we need to reduce resource turn over by 90% on a global scale, within the next 50 years.

Main Features

Countries around the globe are consuming resources at an untenable rate, with developed nations consuming more than they should. Schmidt-Bleek et al (1999) note that developed nations account for 20% of the global population yet consume 80% of the world's resources. As such, developed nations are promoting an unsustainable model of development. Consequently, if nations want to ensure they do not exceed the planet's carry capacity and want to provide adequate resources for future generations, a change in resource use and development models are required. The Factor 10 concept can help achieve this.

Based on sustainability, Factor 10 focuses on materials and the input side of the economy. It requires new technologies; policies; services; and manufacturing processes, as well as socio-cultural change to create and do more for longer periods of time with fewer resources.

Factor 10 is a long-term concept and as such, governments or business working to short term plans may have difficulty achieving factor 10 reductions. Since Factor 10 aims to decrease energy and resource use, it helps governments work towards multi-lateral environmental agreements.

Business and governments implementing the Factor 10 concept have used tools such as eco-efficiency, environmental purchasing design for environment, policies and environmental taxes.

Case Studies and Examples

1. Household Appliances
Environment Enterprise @ RMIT (Australia) investigated emission and resource use reductions through partial or full replacement of existing household appliances with equipment using best available technology. Behaviour modification was not considered. The

study found that technological advancements had reduced material and resource use in appliances by a factor of 1.6 to 3.4, depending on appliance. The study noted that further technological advancements might result in a big jump in eco-efficiency.

2. Transport and Housing

Open University (UK) examined the potential for Factor 10 reductions of environmental impacts for personal transport, housing and higher education over the next 50 years. The study found that some sectors could reduce their environmental impact quicker than others. The study argued that a combination of eco-design, new product services and production and consumption modifications are required to reduce environmental impacts.

3. Factor 10 Strategies

The International Factor 10 Club noted that the Austrian and Norwegian Governments have adopted a Factor 10 strategic goal. The World Business Council for Sustainable Development (WBCSD) has asked businesses to adopt a strategic target of factor 20 for resource productivity increases.

4. Plastic Bags

A tax on plastic bags in Ireland resulted in a factor 10 (90%) reduction in plastic bag usage.

Target Sectors / Stakeholders

The main stakeholders of Factor 10 are governments, industry, research institutions, non-government organisations, businesses and industry groups. Consumers and the insurance industry drive Factor 10 through purchasing or insurance policies that require energy and resource efficient products.

Factor 10 clubs and institutes, established either nationally or internationally, utilise a multi-disciplinary approach to promote and bring about the realisation of the Factor 10 concept.

Scale of Operation

Although Factor 10 is a global issue, it is predominantly targeted to developed nations. Factor 10 is best implemented at a national level by businesses and governments.