

Principles and Practices in Sustainable Development for the Engineering and Built Environment Professions

Unit 2 - Efficiency/Whole Systems

Lecture 5: Efficiency – A Critical First Step towards Sustainability



Educational Aim

To reinforce the critical point that efficiency is a vital sustainability strategy. The rate of return on investment makes it economically viable to further investment in sustainability initiatives such as renewable energy, and recycling of water and materials. To achieve sustainability will involve a transition. Engineers have a critical role to help society find the most cost effective ways to achieve this. Engineers need to become better at communicating the multiple benefits of engineering sustainable solutions to business, government or any organisation they work with. The concept of efficiency will help engineers better communicate how cost-effective reducing environmental impacts can be. Businesses, governments and other organisations are embracing efficiency because it improves performance, reduces costs and pollution. This is also an important topic to cover since engineers play a key role in often both managing and implementing efficiency.



Required Reading

Five Winds (2005) *Eco-Efficiency*, Training Module and Downloadable Powerpoints, WBCSD, pp 15-26. Accessed 5 January 2007.


Hargroves, K. and Smith, M.H. (2005) *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century*, Earthscan, London:


1. Chapter 6: Natural Advantage and the Firm, 'What will be the major driver of innovation in the 21st Century?' (4 pages), pp 83-87.




Learning Points


2.


 1. Since achieving sustainability involves a transition, it is wise to find the most cost effective way to achieve such a transition. Efficiency – doing more with less for longer – has one of the best rates of return of any sustainability investment. This is because it is cheaper not to use as much energy, water and materials, all of which add to the costs of a business or any organisation.


 2. Engineers have shown that it is possible to re-design and re-optimised numerous everyday products to achieve up to as much as 90 percent energy efficiency savings, (but often at least 40 percent energy efficiency improvements.


 3. Businesses and organisations that have embraced efficiency have achieved remarkable reductions in environmental impact and also significant cost savings world-wide.^[1] Consider the following examples:

- Hewlett Packard in California reduced its waste by 95 percent and saved over US\$870,000 in 1998.
- In five years, SC Johnson increased production by 50 percent while waste emissions were cut by half, resulting in annual cost savings of more than US\$125 million.
- United Technologies Corporation's sites eliminated almost 40,000 gallons per year of waste water and saved over US\$50,000 per year with a fundamental change in the way it manages its test cells, underground storage tanks, and waste streams.
- 3M has implemented an efficiency program which has achieved a 95 percent reduction in volatile organic air emissions, 94 percent reduction in U.S. Environmental Protection Agency Toxic Release Inventory (TRI) Releases (U.S. only), 10 percent reduction in solid wastes, and a 39 percent reduction in greenhouse gas emissions.

 4. Efficiency is not limited simply to making incremental efficiency improvements in existing practices and habits. It should stimulate creativity and innovation in the search for new ways of doing things. Nor is efficiency limited to areas within a company's boundaries, such as in manufacturing and plant management. It is also valid for activities upstream and downstream of a manufacturer's plant and involves the supply and product value chains. Consequently, it can be a great challenge to development engineers, purchasers, product portfolio managers, marketing specialists and even finance and control.

 5. Companies can use efficiency as an integral cultural element in their policy or mission statements. They can also set efficiency objectives for their environmental or integrated management systems. And it is a useful tool for monitoring and reporting performance, and for helping the firm's communication and dialogue with its stakeholders.

 6. The World Business Council for Sustainable Development reports^[2] and efficiency training program^[3] will assist engineers to convince their colleagues and CEO of the benefits of pursuing efficiency programs not just for business but for any organisation to reduce costs and help the environment. Useful first steps for implementing a company/organisation wide efficiency program are outlined in the background reading.

 7. Efficiency means doing more, with less for longer. As discussed in 'The Role of Engineers in Sustainable Development A', such efficiency gains, though to be encouraged, are just the start because they can have negative rebound effects. Efficiency gains will need to be complimented by still further changes to operations to ensure they lead to truly sustainable outcomes. Efficiency is the first step. To achieve sustainable development companies and organisations also need to be doing more than simply using resources more efficiently.

8. Efficiency has value because it allows business, government, other organisations and homes to not only use resources more efficiently but also helps organisations to afford to take the steps towards sustainability, such as sourcing energy, water and materials from renewable and sustainable sources. The company Interface Ltd is a great example of the value of focusing on efficiency savings as a first step on the road to sustainability. Interface Ltd focused initially on efficiency savings and then, with the money saved from efficiency investments, they have been able to also focus on re-designing their products, their processes and where they source their raw materials from. Their case study is discussed in the background reading.

9. Many words are used virtually interchangeably to sum up efficiency initiatives. Eco-efficiency, resource (or eco-) productivity, resource efficiency, and resource intensity are all terms that are used in this field, and can be seen as specific indicators of the broader concept of efficiency,^[4] although in some instances resource efficiency is interpreted as a measure of resource productivity.^[5] All these words have slightly different meanings. Their definitions are discussed in the background reading.



Brief Background Information

There is overwhelming evidence^[6] for the business case for efficiency investments. Companies which have implemented efficiency strategies have experienced excellent and rapid returns on their investments in efficiency. Efficiency initiatives can also help unleash creativity, improve reputation and increase competitiveness. Consider the following examples:^[7]

- **Manufacturing:** General Electric's 'Ecomagination' program to improve the efficiency of products and appliances is now worth US\$10 Billion in sales per annum. In May 2005, General Electric, one of the world's biggest companies with revenues of US\$152 billion in 2004, announced 'Ecomagination', a major new business driver expected to double revenues from cleaner technologies to US\$20 billion by 2010. This initiative will see GE double its research and development in eco-friendly technologies to US\$1.5 billion by 2010, and improve energy efficiency by 30 percent by 2012. In May 2006, the company reported revenues of US\$10.1 billion from its energy efficient and environmentally advanced products and services, up from US\$6.2 billion in 2004, with orders nearly doubling to US\$17 billion. In 2005, the company's wind energy business was worth US\$2 billion, estimated to rapidly reach US\$4 billion. In five years, GE expects that alternative energies will comprise more than 25 percent of all energy equipment revenue.
- **Car Manufacturing:** Toyota has invested heavily in hybrid car and fuel efficient car designs and in 2006 posted record profits. At the Academy Awards in 2006 the car park for Hollywood Stars was full of just one type of car, hybrid cars. In the US hybrids sell at US\$22,000. This is very affordable for the family and can cut the family fuel bill in half. There is now up to an 8 - 12 month wait for anyone wanting a hybrid in the US such is their popularity. In 2005, Toyota profits reached over \$14 Billion more than GM or Ford due to a focus on energy efficient cars like the Hybrid Prius. Standards and Poors in 2005 downgraded GM and Ford's rating to junk bond status. GM and Ford had ignored the hybrid car market in the 1990s and banked on people wanting to keep on buying SUVs. GM and Ford now have hybrid cars available.

- Wal-Mart: In October 2005, the world's largest retailer, Wal-Mart, announced a US\$500 million climate change commitment. These initiatives included: reducing greenhouse gas emissions by 20 percent in seven years; increasing truck fleet fuel efficiency by 25 percent in three years and double it in ten; developing a store that is 25 percent more energy-efficient within four years; pressuring its worldwide network of suppliers to follow its lead; and operating on 100 percent renewable energy. With US\$312.4 billion in annual sales and more than 6,400 stores and facilities worldwide, Wal-Mart's climate change commitment is of international business significance.

To ensure that a business or organisation is not left behind there are some useful steps to implement an effective efficiency strategy:^[8]

- Assess the current situation - include any challenges or barriers in the organisation with respect to the decision-making process in question.
- Identify a set of conditions that would need to be in place to achieve the optimum results possible from efficiency initiatives.
- Identify the actions, including tools, information and human or financial resources required to ensure the actions are taken.
- Create a 'Efficiency Strategy' business case for the CEO to support.
- Get support from the CEO or otherwise head of your organisation.
- Select relevant Indicators of performance and ensure that they not only indicate performance but identify areas for improvement and innovation (such as the Global Reporting Initiative (GRI))
- Undertake audits, i.e. energy, water, resource, waste, pollution audits.
- Undertake Life Cycle Analysis (LCA) to understand where the largest resource and energy usage and environmental impacts are occurring.
- Collect and interpret data.
- Communicate results.
- Bring together relevant teams within the company to workshop targets, goals for efficiency and then a strategy to achieve them.

Efficiency as a First Step towards Sustainable Development

Case Study: Interface Ltd.^[9]

As discussed in 'The Role of Engineers in Sustainable Development A' such efficiency gains, are just the start because they can have negative rebound effects. Long term efficiency gains in business will need to be complimented by still further changes to processes, products and services, and supply chains to ensure they lead to truly sustainable outcomes. Efficiency is the first step. To achieve sustainable development companies and organisations also need to be doing more than simply using resources more efficiently. The company Interface Ltd is a great example of the value of focusing on efficiency savings as a first step. Interface Ltd focused initially on efficiency savings and then, with the money saved from efficiency investments, they have been able to also focus on re-designing their products, their processes and where they source their

raw materials to achieve sustainable development. By focusing on efficiency, Interface Ltd found areas where highly cost effective gains were possible.

The original gains were quick and effective; in one particular plant they were able to increase energy efficiencies by 92 percent simply by resizing the pump and redesigning the piping between the pump and the equipment.^[10] Interface Ltd concentrated initially on those areas where cost effective gains could be made and is now saving over US\$200 million per annum with their efficiency initiatives, which is then paying for sustainability orientated initiatives. These financial savings from resource efficiency have allowed Interface to try improvements that have started affecting the company on a much more fundamental level.

Now they have replaced petrochemical based carpets with carpets made from renewable biomass such as corn waste that can be recycled with little loss of quality. The new carpet is the first certified climate-neutral product in the world; that is, all of the climate impact of making and delivering it has been offset before it gets to the customer. The carpet is so non-toxic that it is certified as being edible thus eliminating OH&S concerns. Rather than owning the carpet the customer leases it from Interface who then collect the worn out squares for recycling. In the first four years of this business model and wringing out waste in its own operation, Interface say they more than doubled their revenue, more than tripled their operating profit, and nearly doubled their employment, all at the same time. Overall they have achieved a 97 percent total reduction in materials used while providing a better service in every respect.

Interface has gone further than Factor 10 and is on the way to achieving Factor 100 and becoming the first genuinely 'Sustainable Corporation' on the planet. With sustainable development being the overall vision in this case, Interface has integrated 100s of efficiency initiatives and other new forms of innovation in accounting and product delivery, and in so doing climbed so far towards sustainability that it will take its competitors years to catch up.

Clarifying Definitions^[11]

Many words are used virtually interchangeably to sum up efficiency initiatives which help the environment. In this course *efficiency* means the same as the traditional engineering definition of *resource efficiency* which in layman's terms is simply 'doing more, with less for longer'. Eco-efficiency, resource (or eco-) productivity, resource efficiency, and resource intensity are all terms that are used in this field, and can be seen as specific indicators of the broader concept of efficiency.^[12] All these words have slightly different meanings.

Resource Efficiency

Resource efficiency is defined as a basic ratio of useful resource output R_o , per total resource input, R_i :

$$R_o/R_i = \text{resource efficiency}$$

Hence energy efficiency is simply useful energy output, E_o , per input of energy, E_i :

$$E_o/E_i = \text{energy efficiency}$$

Eco-Efficiency

The word 'eco-efficiency' was first used by the World Business Council for Sustainable Development (WBCSD) in their 1992 publication *Changing Course*,^[13]

Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological

impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity.

In short, eco-efficiency is concerned with creating more value with less impact. It seeks to encapsulate the idea of using fewer resources and creating less waste and pollution while providing the same or better services. Since then, it has been the subject of considerable discussion and analysis, i.e. in DeSimone and Popoff's book *Eco-efficiency. The Business Link to Sustainable Development*,^[14] where it was defined as relating to 'activities that create economic value while continuously reducing ecological impact and the use of natural resources'.

The problem with the term eco-efficiency is that the use of the prefix 'eco' may imply that efficiency is enough to be 'green' and achieve sustainable development when it is actually one of the first steps. Greater efficiency does not necessarily lead down a path of ecological sustainability. For example, technological advances have made it possible, through greater efficiency, for fishing fleets to catch fish, timber companies to harvest trees and mining companies to extract non-renewable resources at unsustainable rates. In other words, such advances in efficiency have made these businesses in many ways more unsustainable.

Also efficiency gains can lead to negative rebound effects. Hence, for efficiency to lead to sustainability, such efficiency initiatives need to be complimented by still further sustainability orientated changes to business processes, products and services, and supply chains. To achieve sustainable development companies and organisations also need to be doing more than using resources more efficiently. The example of the company Interface Ltd illustrates this point. Hence in this course we simply use the word efficiency without the prefix 'eco' to make it clear that efficiency is but a first step towards being 'green' and ecologically sustainable.

Resource Productivity

Productivity, in the field of economics, refers to the production of some kind of welfare, or more simply put, the production of some other useful output by an input. Productivity can be measured by economic output, Y_o , hence resource productivity then is the economic output per unit of natural resource input R_i :

$$Y_o/R_i = \text{resource productivity}$$

Or economic output per input of energy:

$$Y_o/E_i = \text{energy productivity}$$

This definition of resource productivity provides a measure of the effectiveness with which the economy value is created from natural resources.^[15] For analysis of resource productivity trends at the firm level, a range of indicators has been suggested (see WBCSD^[16]), while at the sectoral and national levels the choices are more constrained.

Resource Intensity

Resource Intensity is the inverse of resource productivity. In other words resource intensity is measured as R/Y_o , and energy intensity as E_i/Y_o . It can also refer to the production of some undesirable output (often resulting in pollution) by some other factor, for example carbon dioxide output, C , per unit of energy input.

Any of these indicators provides only a relative measure, and needs to be supplemented by measures of absolute trends in resource flows. When environmental impacts - or resource flows - increase less fast than economic output, or are reduced, then decoupling is said to have occurred.



Key References

- The following ESSP Critical Literacies Portfolio modules can be used as key references to support the content contained within this Lecture:
- The Role of Engineers in Sustainable Development A Unit 2: Learning the Language. Lecture 5.
- DeSimone, L. and Popoff, F. (1996) *Eco-Efficiency: the Business Link to Sustainable Development*, MIT Press, Cambridge MA.
- Five Winds (2005) *Eco-Efficiency*, Training Module, WBCSD. Available at [here](#) and [here](#). Accessed 5 January 2007.
- Hawken, P., Lovins, A.B. and Lovins, L.H. (1999) *Natural Capitalism: Creating the Next Industrial Revolution*, Earthscan, London, Chapter 3: Waste Not. Available at <http://www.natcap.org/images/other/NCchapter3.pdf>. Accessed 5 January 2007.
- Schmidheiny, S. (1992) *Changing Course: a global business perspective on development and the environment*, MIT Press, Cambridge, MA.
- von Weizsäcker, E., Lovins, A.B. and Lovins, L.H. (1997) *Factor 4: Doubling Wealth, Halving Resource Use*, Earthscan, London, Chap 1: Twenty Examples of Revolutionising Energy Productivity.
- WBCSD, (1999) *Eco-Efficiency: Creating More Value with Less Impact*, WBCSD, Geneva.
- WBCSD (1999) *Measuring Eco-Efficiency: A Guide to Reporting Company Performance*, WBCSD, Geneva.