

**BRUNEL
INTERNATIONAL
LECTURES**



Entering the ecological age: the engineer's role

The Institution of Civil Engineers Brunel Lecture Series

Executive summary



An unsustainable future

In recent decades it has dawned on many of us that there can be no viable future for humanity without a healthy planet. Earth, water and air support the existence of an immensely complex living system, powered by the sun. We are part of this web of life. Within a few generations, we will be using up most of the earth's stored fossil fuel resources and their transfer from the earth to the atmosphere is significantly altering its composition. Our globalising economic system is destabilising the planet's life-support systems - the very systems that support us and the future of our children.

The direct impacts of this on human development, plus rising food and resource costs, mean that current economic growth is rapidly becoming unsustainable and a global transition is underway to the ecological age of human civilisation.

The Brunel lecture and accompanying paper analyse current global knowledge to see if, and how, we can reach a sustainable future. Its conclusion is that we could move to a sustainable way of living within environmental limits over the next few decades, allowing for continued human development and population growth, whilst adapting to climate change impacts.



Defining the ecological age

The requirements for the Ecological Age of 2050 are to have a reduction of 80% in CO₂ emissions in developed countries, an ecological footprint of 1.44 gha/capita and an increase in the Human Development Index.



Year
Hectares of land per capita

That assumes different socio-economic levels for different countries and aims to provide concrete solutions to release human development potential using much less non-renewable resources. In high income countries, such as the UK, infrastructure investments and approaches are needed to retrofit existing urban and rural developments. However, in low and middle income countries, such as China, these are the systems with which to develop new urban-rural developments.

Transport

- Mass transport with efficient, comfortable zero emissions
- Walking and cycling routes
- Intercity high speed rail passing through international airports
- Green logistics services from freight hubs

Water and waste

- Water capture, storage, recycling and separate potable and grey water mains
- Waste collection, recycling and anaerobic digestion
- Fitting of separating toilets and vacuum collection of solid waste
- Mining of construction materials from cities

Energy

- Large scale renewable energy, including desert solar power
- City combined heat and power and local heat and power grids
- Carbon capture at power stations
- Use of secondary biomass for energy and products

Food and communication

- Intensive food production in cities
- Broad band communications and tailored information

All of these systems are connected and form virtuous cycles that integrate the environmental, economic and social performance of different components of the built environment. Change in the design of one can lead to benefits in another.

Urban design principles

These are important in making places sustainable. By adopting smart, responsive simplicity, rather than rigid complexity we can dismantle the layered complexity of the fossil fuel powered systems of the industrial age and use clean, flexible, adaptable, and renewable systems to support life.

Setting sustainable development framework objectives and targets at a regional and local level will drive investments to meet ecological age principles. There are also many advantages in creating regional and local land use plans especially compact mixed use development with high density, especially around public transport nodes.

Biomimicry principles will provide the framework to guide design and implementation and support the virtuous cycles of benefit.

Resource flow loops for water, energy, waste and minerals between rural and urban systems can be closed.

Products have performance labels and are designed to be returned to the manufacturers for disassembly and re-use allow the waste to be used as a resource for future products. Secondary biomass and smart materials are used as raw materials.

And finally we need to combine adaptation and mitigation to climate change.

Harnessing technology

We need to support these sustainable urban design principles with smart and available developing technologies such as:

- LED lighting
- Electric and hydrogen fuelled transport
- Short carbon cycling using algae bio-reactors to collect CO₂ at power stations and coal gasification
- Anaerobic digestion of waste
- Intensive food production using hydroponics and nutrient feed
- Secondary biomass fuels for air travel



Policies to deliver the goals

In the ecological economic model, there needs to be a continuous adaption of the global economy to match the size of the supporting ecosystem. If the circulating resource use remains within the natural capacity of the ecosystem to absorb wastes and to regenerate resources, then the economy is sustainable and human development can continue. There are many examples of the way human development can be released from the shackles of industrial age problems in cities.

There are three key policy areas.

First, policies which drive towards the sustainable or optimal scale are needed to address the limiting of scale and the fact that previously free natural resources and services have to be declared scarce economic goods. These include energy feed-in legislation; polluter-pays taxes that are progressively introduced to drive public sector investments that also help the private sector; and tradable permits, with quotas set, so that the marginal social and business costs are equal to the societal benefits.

Second, as sustainability is the criterion for scale, justice is the criterion for distribution to ensure that there is fairness across society and globally. This will apply to national and regional land use plans; land value taxation so that we can redistribute value to the community; the bartering of human development benefits against environmental clean-up benefits; consider the contraction and convergence approach for carbon; and shrink and share for our ecological footprint.

Third, policy needs to ensure that allocation of resources is as efficient and cost effective as possible. National resource efficiency targets and circular economy laws are required to incentivise symbiotic manufacture and national policy is necessary to manage the rebound effect of improved resource efficiency.

Engineering our infrastructure

Radical transformation of the infrastructure that supports life on the planet is needed if we are to attain a sustainable future. It requires strong partnerships between public, private, NGO and community groups within national communities and global cooperation, but with existing technology.

Engineers have global experience, are adept at multidisciplinary team working, essential for success and can design and deliver these new infrastructure systems. However we recognise that resource levels are limited to undertake such an unprecedented challenge in a very urgent timescale of no more than 50 years. We will need to train and motivate young people to join this challenge and be the Brunels of the 21st Century.

A global network of sustainability institutes is being created to help speed up knowledge sharing and delivery capacity and a delivery model of using public, private partnerships with NGOs and community groups is proposed for retrofitting.

The Brunel 2008/9 lecture and paper is a first glimpse of a way forward and a credible vision of the future but it is only a modest start for a long journey. The Copenhagen Climate Summit in December 2009 will be the moment the world must get together and agree that we really know enough and are prepared for the direction that we need to take.

It is hoped that presenting the lecture programme will enable the global community of engineers to come together too and inspire young people to join us in this challenge, almost certainly the greatest humankind has ever faced.

Read the full report at
ice.org.uk/brunel

