Autumn 2021

SEDA

Scottish Ecological Design Association

£7.50

Ecological Design for a Changing Climate

Fig. 27
Domestic
Carbon Capture
Bladder
(Keep away from
naked flames,
enormous pricks,
etc.)

CONTENTS

Autumn 2021

SEDA was formed in 1991. Our primary aim is to share knowledge, skills and experience of ecological design. SEDA is a network and links those seeking information and services with those providing them.

SEDA's membership comprises a large number of people involved, and with an interest in design, principally in Scotland. Members include academics, architects, artists, builders, planners, students, ecologists, landscape designers, materials suppliers, woodworkers, and many more whose work or interest involves design for a sustainable future.

SEDA is a charity and is run by a Board of Directors, who are elected at Annual General Meetings. The Board is advised by a voluntary Steering Group which meets 8 times a year for discussion and for planning the activities of the Association. All members are welcome to take part in these meetings. SEDA registered as a Company Limited by Guarantee in February 2011.

A SEDA membership is a great way to support ecological design in Scotland. As a member you will receive the SEDA Magazine for free, get discounted tickets to SEDA events, and have the opportunity to connect with a wide network of talented designers.

Editorial team

Nick Domminey, Viktoria Szilvas, Raina Armstrong and Janet Direen

With thanks to all our contributors, sponsors, and supporters.

What do you think of this SEDA magazine and its new layout? Do you have any disagreements or something useful to add to the issues covered? Do you have an idea for an article? Drop us an email at magazine@seda.org

Our upcoming events can be found throughout this issue.

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Cover image: Martin Rowson

Ecological Design...?

SEDA Specification

SEDA Solar

SEDA Land

SEDA Thoughts

images: COP26.org

UN CLIMATE CHANGE CONFERENCE UK 2021

IN PARTNERSHIP WITH ITALY

Editorial

Nick Domminney

This autumn Glasgow hosts COP26. The Conference of all the Parties is cited by many in the green movement as a make or break chance to decide, or many fear more likely not decide, what specific actions the "parties" ie countries, will take to reduce their CO_2 emissions in line with the IPCC 2018 "Doomsday" report and match the commitments given at the 2015 Paris Agreement. The coming months will feature national CO_2e, Net Carbon Zero, Nationally Determined Contributions (NDCs), Carbon Credits, Negative Emissions Technologies (NETs) and many other often arcane descriptions and prescriptions as nations haggle over their emissions.

What is Ecological Design?

SEDA's founding principle has always been that CO_2 emissions need to be cut to zero, of course, but, while the COP26 machinations are crucial, there are many equally crucial ecological factors which need to be tackled. We are, after all, an ecological design association. SEDA 2021 Conference, for example, heard GOES' Howard Dryden predict the end of life in the oceans with consequent devastation to terrestrial life, including humanity, unless humanity ceases production of killer chemicals and stops the release of microplastics into the seas. This edition of the magazine, therefore, considers "what is ecological design?"

It is a huge area, of course, so we can only touch on aspects. SEDA founder members, professors Sandy Halliday and Fionn Stevenson have helped collate a number of eminent contributors, who have kindly written gratis. Most noticeably, Guardian cartoonist, Martin Rowson, has given us his artwork as a cover image to set the scene.

This magazine has had a lot of articles about ecological building so we have eschewed architecture and asked contributors to think "what is ecological farming and food production, water supply and disposal, transport and infrastructure, health and landscape?" Space prevents us looking at other vital aspects such as energy; perhaps for another edition. Longtime SEDA member, Dr Ulrich Loening and Hutton Institute's Geoff Squire introduce the field by explaining what is human ecology.

COP26

Nevertheless, we have to recognize that achieving zero CO_2e will be top news for the next months. Leading climate scientist, Kevin Anderson warns, many NDC's (countries' quantified commitments to meet global CO_2e targets) include massive use of often untried NETs and off-setting. With SEDA Thoughts, on the back page, Ulrich Loening outlines the fallacies of off-setting.

The UN has allowed SEDA observers at COP26 proceedings so we hope to bring you warts and all reports in future editions of this magazine.

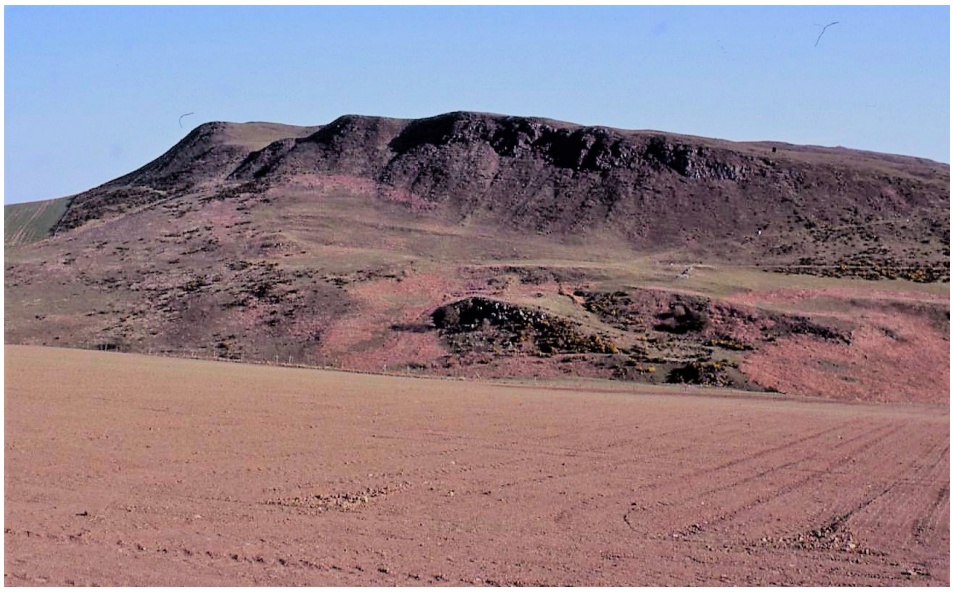
Regular Features

Our Autumn edition, however, also features a review by renowned building performance advisor, Bill Bordass, of a SEDA guide to indoor air quality in airtight homes written by Chris Morgan of John Gilbert Architects and eminent others. Chris also contributes a piece on Moisture in Buildings, following Alex Liddell's article in the Spring 2021 edition. Then we have reports from SEDA Solar and SEDA Land groups and our longstanding hands-on progress update from Griroscope's Hull self-build.

SEDA Magazine aims to cover the wide range of the association's activities but we may have missed your project, not addressed a pressing topic or perhaps you disagree with an article. If so, please email magazine@seda.uk.net. ■

Sustainable Design for Ecosystem Restoration

Geoff Squire: previously Principal Scientist, James Hutton Institute, Dundee



Examples of land still productive but degrading, Burma/Myanmar (below), and Scotland (above)
Images and Diagram: Geoff Squire

The UN's Decade of Ecosystem Restoration 2021-2030 began in June. The UN asks if global restoration is possible when ecosystems are still degrading. There is no choice but to try. The first step is design, and here restoration can take example from stable natural systems.

Ecosystem Stability Through Balanced Flows and Stores

Natural ecosystems evolved to balance their 'flows' and 'stores'. The big universal flows are those of solar radiation and water. Together they allow plant life to turn carbon dioxide in the air to living matter – the basis of an ecosystem store. Microbes and small animals feed on the plant products, creating a more diverse store and allowing it to combine with the earth's inorganic materials, to create soil or coral, for example. A balanced ecosystem can last for millennia, but the balance is delicate.

The main flows of energy and matter are very large compared to the stores and – though sustaining – they can be destructive. One of the crucial functions of an ecosystem's store is to regulate the flows that sustain it. In a perennial forest or grassland, high solar radiation is balanced by evaporation of water through vegetation to achieve an equable temperature, and layers of vegetation shield soil from the most intense rain. The store also allows a system to survive through adversity. In seasonally dry regions, life might wither above ground, but when water returns, the stores re-activate.

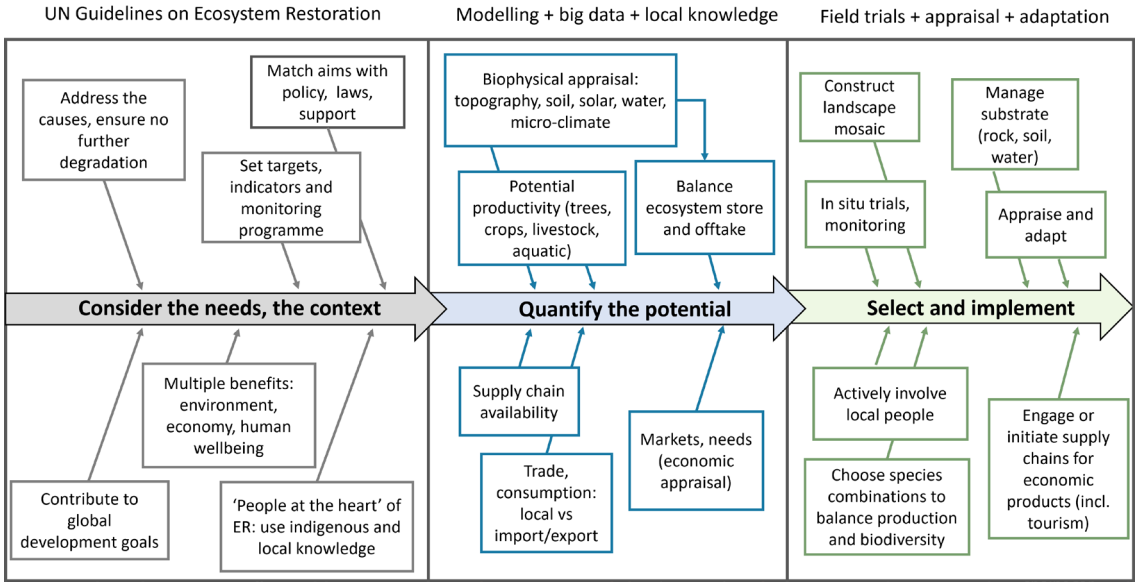


Diagram 1: Ecosystem design considerations

Destabilising Human Influence

Natural stores have mostly evolved to be very diverse – consisting of many different organisms. This variability – or biodiversity – channels energy and matter through multiple internal pathways and gives the store the capacity to resist and recover from a range of external influences. Recovery occurs even after volcanos, earthquakes, tsunamis, and storms. If a store is obliterated locally, it can regenerate from stores around it... so long as they remain in good condition. The problem of depleted stores intensified when hominids appeared. They might have nibbled at first, but then a nibble became bite, then an orgy. Stores are depleting everywhere and that capacity for global recovery is waning.

For most of their evolution, humans were part of the ecosystem store. In the last few hundred years, they have pressurised ecosystems, covered tracts of land and water with industry, transport, and housing, and increased the movement of materials. Industrialised interests (companies, countries) no longer depend on their home store, but mine external sources for food, timber, power and other raw materials. The waste from their activities, travels the world. The gases from burnt fossil fuels (themselves a previous living store) do not obligingly remain above the place that extracted them. The hunt for materials brings conflict, which the World Food Programme considers a greater cause of mass hunger and famine than climatic extremes.

Stabilising and regenerating ecosystems is now the priority in the long tale of human existence. There's no point just looking close to home. The UN's Decade is right by saying that if people want to regenerate their own ecosystem, they have to work together to regenerate all ecosystems. The first steps are to stop the culture of extractivism, resolve conflict and stop ecocide. Climatic shifts and extremes will add pressure to ecosystems, but whatever the future climate, degeneration has to be reversed.

Design of Sustainable Ecosystems

For any ecosystem, in any location, design involves establishing a general understanding of what the system is to provide and then using scientific and indigenous knowledge to create a system fitted to the locality - see diagram 1.

First, follow the UN's 10 Principles that Underpin Ecosystem Restoration to arrive at a general scheme that considers all sectors together – food, raw materials, power, etc. – and balances human needs and nature. The causes of degradation have to be understood and no further degradation is admissible.

Second, apply biophysical knowledge and modelling to quantify the main flows of energy and matter and the character of the ecosystem store. The exercise will reveal the general type and quantity of output (e.g. food, economy, culture, health) that can be supported sustainably. The result will vary with local topography, soil and climate.

Third, define the living organisms that will together re-generate the store and sustain the various outputs. Some of them may exist already and need to be encouraged, while others might have to be re-introduced. Principles and practice are well understood through groups such as the Society for Ecological Restoration and have been adapted to specific systems, for example, the use of native seed to regenerate grasslands through the NASSTEC project.

Transitions from degraded to restored ecosystems are beginning to apply such formal design in many parts of the world. In the UK today, however, many ecological transitions are going in the wrong direction and would fail to comply with the UN's 10 Guidelines. Biodiversity is still in overall decline. Soil is losing structure and eroding in intensively tilled arable land and in upland single species reforestation (2). Disputes are unresolved over growth of renewable power and desecration of unique landscapes (3). But as SEDA's Land Conversations repeatedly brought out, scientific and technical knowledge is not limiting - effective ecosystem restoration will proceed only when conflict and vested interests are replaced by inclusive policy and political action. SEDA Land has challenges ahead. ■

Where Next? Educating for the Future

Dr Ulrich Loening: Hon. Research Fellow, School of Engineering, Retired Director of the Centre for Human Ecology. University of Edinburgh uel@loening.com

Understanding the world has given us the power to master and dominate nature, to such an extent that we are now faced with a fundamental contradiction: the contradiction of our times is, how to reconcile the creative with the destructive forces of our civilisation. On the one hand we live with a quality of life that could not be conceived by earlier generations; on the other hand this has been achieved at the cost life on Earth and ever deeper divisions within society. Global warming and the covid pandemic are mere symptoms of what is going wrong. The basic reason lies in the disparities between human development and Nature. How? Where? and Whether? humans live on the Earth must underpin our culture and education.

Human Ecology

Human ecology is an appropriate phrase which brings together the many aspects of how we interact with each other and with our environment. It has grown in sophistication over the decades. The late 18th century Enlightenment began to see how everything we do and nature does is connected. And this awareness expanded in the 19th and 20th centuries, especially through the growing realisation of the need for conservation of nature. Now we see that our ecological behaviour depends as much on our culture, attitudes and habits, as on our physical needs; therefore, human ecology necessarily includes the arts and humanities. With that, it becomes undefinable, areas of thought and action that cover everything and are, therefore, difficult to handle or fit into any educational or university faculty structure. In spite of great advances in understanding, human ecology remains a fringe topic, on the margins of society's interests and of little concern in political thinking. As with any science, human ecology is always questioning and self critical; every aspect of our lives is open to question, and to re-thinking our basic assumptions. As such, it becomes 'inconvenient' and subversive to some of our norms. For instance, a major issue is the very nature of money and our financial systems. From its invention to replace barter, money has become an accounting system that fails to fully value natural assets. Our habits inevitably lead to global warming. We are left with the absurd situation that to 'solve' global warming, we have to put an arbitrary price on carbon emissions. Apart from this, while poverty, however defined, is as old as humanity, our financial system has resulted in the greatest disparities ever. Clearly new economic systems are called for, which will govern much of the customs of our lives. It is uncomfortable to face up to this basic contradiction built into civilisation, between the greatest of achievements and the destruction of life on the planet.

Although 'human ecology' provides an umbrella term under which to act, it is rarely used as such; for instance it is not used by the Club of Rome nor the `Limits to Growth' report to it, nor by the UN Stockholm 1972 Conference on Environment and Development, nor the founding of the UN Environment Program, nor by Footprint analyses, nor by the Brundtland Report of 1987, nor by the UN Habitat Conferences nor by most Universities and their academic literature. Why not?

There are indeed academic reservations. 'Ecology' has become something of a cult word, attracting many with vague hopes and little actual competence in human ecology. However, many of our habits and beliefs are based equally on 'cult' hopes, such as the

Below: Visitors from Sverdlovsk, (Ekaterinburg) USSR to a human ecology workshop, 1991
Left: Teaching human ecology is personal and informal; at Brno Republick, 2006
Images: Dr Ulrich Loening

conviction that technical solutions alone will answer our problems. The key conclusion from the science of human ecology is indeed that our present habits need to be questioned and re-thought.

New Enlightenment

For all this, 'human ecology' remains the most appropriate term to handle such diverse issues in global understanding. Human Ecology would and should, become part of basic education, as essential as any conventional subjects. It matters that, this most intelligent of all species itself, musters the intelligence to match its activities with the workings of nature. This demands integrating ecological sciences into old Enlightenment attitudes to create a new Enlightenment, essential for survival of life on Earth. This new Enlightenment must replace the older inappropriate beliefs and culture, creating a newer industrialised society, in equilibrium with nature. Promoting so big a change could be seen as 'subversive'.

This thinking and teaching must therefore combine the broad visions of the 18th Century with the rigour of the separated disciplines of the 20th. Universities excel at the latter, but find it difficult to embrace the former, with some exceptions: the College of the Atlantic in Bar Harbor USA, and the University of Göthenburg. Nevertheless, the subject is still current. There are even 2 or 3 Human Ecology Journals.

In 1972 the University of Edinburgh launched a Centre for Human Ecology (CHE) as a non-faculty body, offering free evening lectures from the large university staff and many international visitors. The M.Sc saw cooperation with other faculties, and lecturers and students effectively studied and learned together as a community. CHE was never formally recognised or staffed however, and it was closed when I retired as Director. It now limits its activities to the local community and visitors. The advantages of a large university has been lost, but freedom of thought has been gained.

Sustainable Development

Universities have taken up the idea of 'Sustainable Development.' It has become an established academic subject, many courses with that title thriving internationally. But sustainable development in most cases seeks to find ways by which our present ways of life can continue. Such courses do not challenge or question the bases of our beliefs. Questioning and re-thinking how and where we live continues to determine whether we live. That task is the domain of Human Ecology. ■

Ecological Farming

György Ängelkott Bocz MSc Agr Eng. PATE TAK Hungary, has a PhD in Agricultural Technology from the Swedish University of Agricultural Sciences and a B.Sc. in Management Sciences from Oxford Brookes University

Images: Shutterstock

In the last few decades different types of farming - first developed by grass roots enthusiasts - are now taking over even large scale agricultural production systems. They may take various forms from "low-tech-high-knowledge" to "high-tech-high-knowledge", have different focus and run under names such as organic farming, permaculture, regenerative agriculture, sustainable state policy driven and qualified farming methods, etc. but they are all found under the umbrella of ecological farming practices...

Holistic Approach

As a common denominator, they often use a bio-centric and holistic approach, instead of a singular anthropocentric view. Urban spaces are also included in food and raw material production, and are in turn highly valued for being near to customers and therefore reducing transport requirements. The educational, recreational and healing properties of ecological farming and natural environments are also increasingly recognized. As added value, in urban environments they have heat-island and urban vulnerability reducing capabilities.

Best of all, Ecological agriculture, focused micro-scale guerrilla-farming practices, have increased in many mega cities, and community building permaculture projects take over socially deprived urban suburbs from Mexico City and New York to Copenhagen… Even in conventional

farming, there's not a grower today, in the countryside, who doesn't recognize and act upon the importance of pollinators and biodiversity… So, when even a controversial petrolhead, the former Top Gear presenter Jeremy Clarkson gets into rewilding his Cotswolds estate on TV, this movement is now to be considered unstoppable...

Ecological Agriculture

But what is the difference between conventional and ecological agriculture? Is farming not natural and environmentally friendly as it is..? When all parts of the farming-process are considered as valuable, and focus is shifted from the single-produce based linear system approach-"The Place of the Money"- to circular no-waste, self-supportive and regenerative system thinking, ecological farming- "The Place of the Many"-will have created its impact. In this man-made natural-like biotope many products are presented and every participant is kept happy.

Methods like no till, swale design, solar "self-heating" greenhouses, erosion control, carbon/nutrient retention and humus building, multi-cover species and crop-strips together with improved water management regenerate local ecosystems, based on no, or low chemical use, crop rotation and integrated symbiotic animal-cropping systems, are not actually new, but in the way they're comprised into a whole are now presenting a revolutionary approach.

The Future is Green

So, what does the future hold for ecological agriculture..? Most probably its share of the production volume will increase, as consumers become increasingly aware. Even new unorthodox approaches such as hydroponics, aquaponics, aeroponics or mycelia based systems will become mainstream, as methods and materials develop in a more green and closed-loop direction. Hopefully, even one of the major current limitations of urban agriculture, such as it's only producing vegetables and perishables not any bulk-crop (such as cereals)- will be overcome by, for instance, using vertical farming or building integrated - partially or fully automated - growing systems.

The future is green. The future is ecological. The future is the eco-friendly farmer. ■

Image: Emmer wheat from Slovenia at Macbiehill, 2015

Gartneriet at Bygdø Royal Estate: Permaculture as Ecological Design Future of Life on Earth

Marianne Leisner: project leader for Gartneriet Bygdø Royal Estate since 2015, runs University courses for Schoolgarden teachers since 1997 and has been a Permaculture designer in Gaia architects, Norway, since 1987

A Story About How a Vision Became Reality

Plant and animal species are dying out, in step with a the changing climate. Ecosystems are collapsing and a generation is growing up with the gloomy news that they have to deal with both.

In 1987 I reached a turning point when I became acquainted with permaculture as a design tool. It has filled my life ever since. Permaculture design is a grassroots movement and works best bottom up. Today, there are projects all over the world where people listen to natural principles and plan and build settlements that produce more than they consume. Permaculture design is holistic and challenges us to reflect on our actions and change them so they fit into systems that strengthen ecosystems. Permaculture is not a cultivation system, but connects food production to settlements where people live. It is expressed in small-scale food production from the kitchen counter, on the house walls, in the gardens, on the fields and in the forest edges around human settlements. Cultivation methods and grazing systems adapted to the local conditions are used and it is recommended to study examples from permaculture-designed projects on YouTube or attend courses.

For example, our chickens are close to the café, which is close to the small fruit forest. The fruit forest is grazed by the chickens who eat fruit and berries on the ground. The chicken manure is important ingredient in the compost for the fruit trees and the leftovers from the cooking in the cafè goes to the chickens,- and it is all connected within 10-20 metres from each other. The chickens are also important in the education to convince teachers etc to establish a chicken house at their school, kindergarden etc. In this way of designing a system we save a lot of work and pollution and gain products without too much effort.

Involvements

For the last 6 years I have been involved in building up the gardens at Gartneriet, Bygdø Royal Estatein Oslo according to permaculture principles.

The vision was to create a centre for demonstrating and teaching urban agriculture where the cycles between soil, plants, animals and humans are central. A place of inspiration that spreads knowledge and joy about organic gardening, and the cultivation and processing of food. A place to become a vibrant green meeting place in Oslo. The plans for the area involved creating local cycles of nutrients and materials, a diversity of plants, animals and people, extensive courses and teaching activities and the serving of food produced and prepared on the farm.

People from different backgrounds were involved in the project from the start. We wanted as many people as possible to

Images: Nina Dreyer Hensley

participate in building a system that also produces hope and joy.

We refurbished old furniture, wicker baskets, sowed, planted trees and shrubs, harvested and processed vegetables, fruits and berries. Organizations and associations planted heritage varieties of apple trees worthy of preservation. Diversity grew and the first berries were ready. Course participants were involved in digging, sowing and harvesting. Later, we started annual courses in pruning and grafting new fruit trees.

Greenhouses have been built with space under glass roofs for both plants and people. Roof water is collected and used for irrigation, and there is no extra energy for heating beyond direct light and heat from the sun. A greenhouse was built south of the old boiler house, where there is a kitchen preparing organic food from the farm and serves it to guests and course participants.

In the orchard there is an apiary that is run by the organization Bybi (Urban Bees). They also have beehives around Oslo and run extensive courses and other activities to train new beekeepers. The hens have their own small orchard and they are cared for by people who are in employment training at Gartneriet.

All year round, there are courses for school garden teachers from all over Norway, who build strong networks and inspire each other in the work of cultivating gardens and hope in children and young people. What is sown does not always emerge, and what does emerge is not always sown. This is how the place must develop at the same time as vegetables, fruit, berries, herbs and flowers are grown in abundance.

What is Ecological Design in a Changed Climate?

Ecological design in a changed climate must be holistic instead of controlling details. We are planning for climate change, but do not know what or who will be able to adapt to the changes that are expected. Connections between individual elements and their functions in a system must be strong and diverse. The time for vulnerable monocultures is over. Ecological design must allow for the unexpected. We must also nurture all parts of living ecosystems, also those unknown to us. This is how we must move into the future, with respectful reflection on people's place in creating sustainable settlements. Traditionally, the Maori people have a word for this deep relationship between humans and the natural world; Kaitiakitanga. Permaculture is a way into this connection, based on the challenges of our time.

If you would like to know more about Permaculture go to https://www.permaculture.org.uk/knowledge-base/basics

What is an Ecological Approach to Rural Transport and Infrastructure?

Duncan Bryden: chartered biologist; rural regeneration specialist, associate of the University of the Highlands and Islands; Cairngorms NPA Chair until 2015

Ecology is about the interrelationship of organisms and their environments. Transport is about, mainly, mechanised movement to enable interrelationships between people and place. Transport is an inherently good thing in our modern society as it enables systems to function. Connecting family and friends, business, and leisure activities with each other and delivering goods and services. Roughly 20% of people in Scotland live in rural areas and although they want similar things as urban dwellers, we all know transport and infrastructure has evolved here very differently.

So why is this the case? Peeling back the onion skins reveals why rural transport became organised in the way it has. In the past rural Scotland held many more people and was more self-sufficient than it is today. Here too, was abundant renewable energy, water, tide and wind power, a feature of Scotland for millennia, but surprisingly only recently exploited.

But governance and ownership rights had other ideas. Economic advantage, power and centralised government meant military roads from the cities to the glens forming our modern road network, while our Victorian rail infrastructure was created to exploit iron and coal and, crucially, feed urban populations. This legacy means a fossil fuel economy, and moving people and goods now accounts for 36% of Scotland's total GHG emissions and the private car makes up 40% of that proportion. Where people are scattered in rural areas this figure is probably higher.

Rural Movement

Movement in ecological terms, unless it confers advantage, generally wastes energy and is unproductive. An ecological approach suggests movement should firstly be reduced and secondly, if it must happen, be made more efficient and integrated. Nature abhors waste. Place making and 20-minute neighborhoods are people centric mechanisms to reduce movement, but head winds of dated land ownership, topography and demographics in rural Scotland mean, they are harder to apply than in urban areas. Lifestyle reassessment post Covid-19 is causing more people to want rural space around or near them along with investment in local services and leisure facilities. Homeworking and e-commerce technology may change business and community models, with active travel options becoming core to local development needs.

Encouragingly, changes in health, supply chains and consumer preferences mean that transport policy throughout Scotland has fundamentally shifted. The focus on sustainability in business practices, low carbon improvements in vehicle manufacture and alternative travel modes will help to reduce emissions.

Future Transport

Current shifts still tend to assume that our future transport patterns will be like current ones. The private car is far from obsolete, especially in rural areas. Short term Covid-19 has boosted the car's pole position and people have shunned public

Images: Duncan Bryden
Top: Portavadie to Tarbert Ferry
Bottom left: Off grid vehicle charging in Sweden
Bottom right: Beach landing on Barra

transport. But we must continue to see the world through the eyes of people who accept that climate change is a problem, but are struggling to get by in the here and now. As in ecology, the rural economy must have functioning accessible pathways. Bus, rail and ferries must seamlessly interconnect if people are to be persuaded out of their cars.

For a more sustainable society and economy an efficiently functioning transport system is needed. Through Mobility as a Service (MaaS) many people may not need a car sitting on the driveway, remaining unproductive for long periods. Even now, if they are available, taking a taxi or a bus is cheaper and produces less emissions than owning a car and fewer cars mean less road infrastructure.

The Scottish Government's commitment is to reduce private car mileage by 20% by 2030 and phase out sale of new diesel and petrol vehicles by 2030. EVs are rapidly improving, but not yet as cheap or as convenient. The International Energy Agency (IEA) expects, advances in battery technology and mass manufacturing of electric cars will continue to reduce their cost – decreasing the need for subsidies but straining a weak rural electrical grid system.

For a sustainable economy,biofuels, and electro-fuels (e.g., hydrogen) produced from renewable electricity will enable more renewable energy usage in commercial road transport, as well as in shipping and aviation. People abandoned Hallaig on the island of Raasay in the 19th century clearances. It is fitting then that the name MV Hallaig was chosen for the world's first hybrid diesel electric vehicle ferry now serving the island which is thriving once more. Global shipping is one of the world's most polluting industries, yet it delivers most of our goods. The scope for zero emissions ships is huge. Lifeline links to Scottish islands are also seeing the testing of hybrid electric aeroplanes, ideal for regular 'short hop' flights. Government policies in the 2020's will need to promote the introduction of low-carbon medium- and heavy-duty vehicles and greater investment in installing fast-charging infrastructure. A diverse portfolio of solutions is key to securing a rapid and cost-effective transition to a renewable energy future for transport that better connects our economy and society.

Doorstep to Destination

Ecology works through an integrated systems approach. The National Transport Strategy 2020 Sustainable Travel system emphasises active travel over the private car. Walking and cycling at the top and the private car at the bottom. Electric vehicles and a growing network of charging points located throughout Scotland raises questions regarding where electric vehicles sit within the system. We need to revisit the rural economic and social systems and ask how they may function with more integrated, effective, and equitable transport and infrastructure provision. From doorstep to destination people must be able to walk, cycle and use public transport safely with inherent comfort and reliability if net zero is to become a reality. ■

What is an Ecological Transport Policy?

Daisy Narayanan, Senior Manager, Placemaking and Mobility,
The City of Edinburgh Council

The way people, goods and services move around any city is vital to the local economy and key to meeting local and national climate targets. And with this, Edinburgh is no exception.

Edinburgh has set an ambitious target of net zero emissions by 2030 – 15 years ahead of the national goal. And as a historic, compact capital city, with a unique landscape and a world-beating cultural scene, our response to the climate emergency must be custom-made and meet the needs of the people who live and work here.

Edinburgh's Challenge

Transport currently accounts for 31% of Edinburgh's emissions, and, if things continue as they are, that figure will keep rising.

Poverty rates vary considerably across the city, yet average weekly travel costs are more than £80 – that's 14% of a typical weekly budget. Meanwhile, congestion significantly impacts daily journeys, adding up to 41% to travel time during peak hours. And our population continues to rise, with a forecast growth of 12% to 600,000 by 2043.

Encouraging more people to choose active and sustainable travel for their daily journeys will be key to addressing these issues. It will also help improve local air quality, enhance biodiversity, encourage wildlife along traffic-free routes and create a greener, safer, net zero, climate resilient city to live and work now and for future generations.

Images: Getty Images

Creating More Sustainable Travel Choices

The way people choose to travel is determined by ability, affordability, accessibility, safety, and convenience. So, both local and national governments need to make it as safe, easy and affordable as possible for people to move away from private, fossil-fuelled cars and to other forms of travel.

Edinburgh's City Mobility Plan will create more people-friendly streets, protected cycle routes and spaces for people to relax and stroll. It will improve public transport provision, introduce flexible and affordable public transport fares and promote cleaner vehicles, helping people make sustainable choices.

As a compact, walkable city, where 45% of households don't own a car we want to facilitate 20-minute neighbourhoods and build on our network of walking, wheeling and cycling routes.

Plans to expand the city's tram network and improve bus routes will further support the transition from private car journeys. 'Mobility hubs' in communities and a city operations centre to monitor traffic will be pivotal to reducing the impact of polluting vehicles and congestion. Meanwhile, 'green' active travel routes will also help encourage wildlife and support the city's approach to water and flood management.

From completing 95km of off-road cycleways and walkways 1995-1999 to launching Edinburgh Trams in 2014 and becoming the first Scottish city to implement a citywide network of 20mph routes in 2018, Edinburgh has been at forefront of sustainable transport development, with enhanced transport systems and investment in our streets and public spaces.

As we move forward with the next ten years of transport and mobility in the capital, we want, and need, to be just as bold, and invest in net zero action and ensure our young people inherit a thriving, resilient city which is a cleaner and healthier place to live and work. ■

Is your Shower killing the Polar Bears?

Cath Hassell, ech$_2$o
http://www.ech2o.co.uk/

There are three types of water we need to consider when looking at sustainable solutions for water supply and disposal in the UK. They are:

1. The water that comes into the building – water supply
2. The water that exits the building – wastewater/sewage
3. The water that falls on the building – rainwater

All three present different problems and require different solutions, yet are inextricably linked, so solving the issue of one can have a positive effect on the others. Hard engineering solutions, e.g. more reservoirs or desalination plants and larger pumps in the mains supply so that future droughts will not impact on ever-rising water consumption, or huge underground attenuation tanks so that future rain events will not result in floods, is not the way to go. Just as we cannot engineer our way out of the climate crisis, we cannot engineer our way out of the effects of floods and droughts.

'Is your shower killing the polar bears?' is a question I have asked many school pupils and design professionals. Whilst the correct answer is not *"the shower from your water is hot and it flows out to sea and melts the ice floes which are supporting the polar bears"* or, *"shampoo is not good for polar bears because it gets in their fur and stops them swimming very well"* it's not that far off the mark. Using less water is important to reduce the environmental impact on both a local and global scale. Locally it reduces the pressure on rivers and groundwater, and results in less wastewater to treat. Globally, using less hot water means that CO_2 emissions from heating the water are reduced.

A few shower facts. 2 billion litres of water are used in the UK's showers every day. Heating hot water at home results in 6% of the UK's CO_2 emissions. The average shower lasts 7.5 minutes.

There is a UK wide campaign to reduce showers to 4 minutes. A few facts about CO_2 emissions and their effect on the North Pole. Every 1 tonne of CO_2 into the atmosphere means 3m^2 of summer sea ice is lost in the Artic. Summer sea ice is vitally important because ice reflects the sun's rays whilst sea water doesn't and absorbs most of the heat. A 10 minute shower a day for a year is 0.6m^2 of ice gone.[1]

For rainwater we need front of pipe solutions, especially towns and cities where combined sewers take both sewage and rainwater. Sewage treatment plants are sized for dry weather flow so when it rains heavily untreated sewage is discharged directly into rivers or seas. Sustainable Drainage Systems (SuDS) attenuate, treat and dispose of stormwater to reduce pollution and local flooding incidences and can provide biodiversity as well as controlling stormwater run-off. SuDS solutions are many and varied ranging from source control, e.g. green roofs, rainwater harvesting, permeable paving, through to disposal solutions such as SuDS basins and ponds. The simplest and easiest SuDS to incorporate in urban centres are rain gardens. Packed with plants that thrive even when their roots are intermittently submerged in water, they are sited where rainwater downpipes connect into surface water drains, thus decoupling the link between rain events and rainwater entry into

1 Figure calculated using a 7.5 minute shower a day with a flow rate of 7.5 litres/minute from a shower heated by gas or a 7.5 minute shower a day with a flow rate of 5 litres/minute from an electric shower.

the sewer system, as well as attracting bees and other insects into the city.

Saving the polar bears requires an understanding that it is hot water in the UK that has the greatest environmental footprint and that just like energy efficiency we should address water efficiency first and foremost. To mitigate flooding events we need front of pipe solutions for the disposal of rainwater that both reduce the amount of runoff into our storm drains and, at the same time, increase the biodiversity in our town and city scapes. So, my two top tips for ensuing that ecological design of water supply and disposal can contribute to quality of life as well as mitigating against the loss of biodiversity are shorter showers and rain gardens, a combination of behaviour change and soft engineering solutions. ■

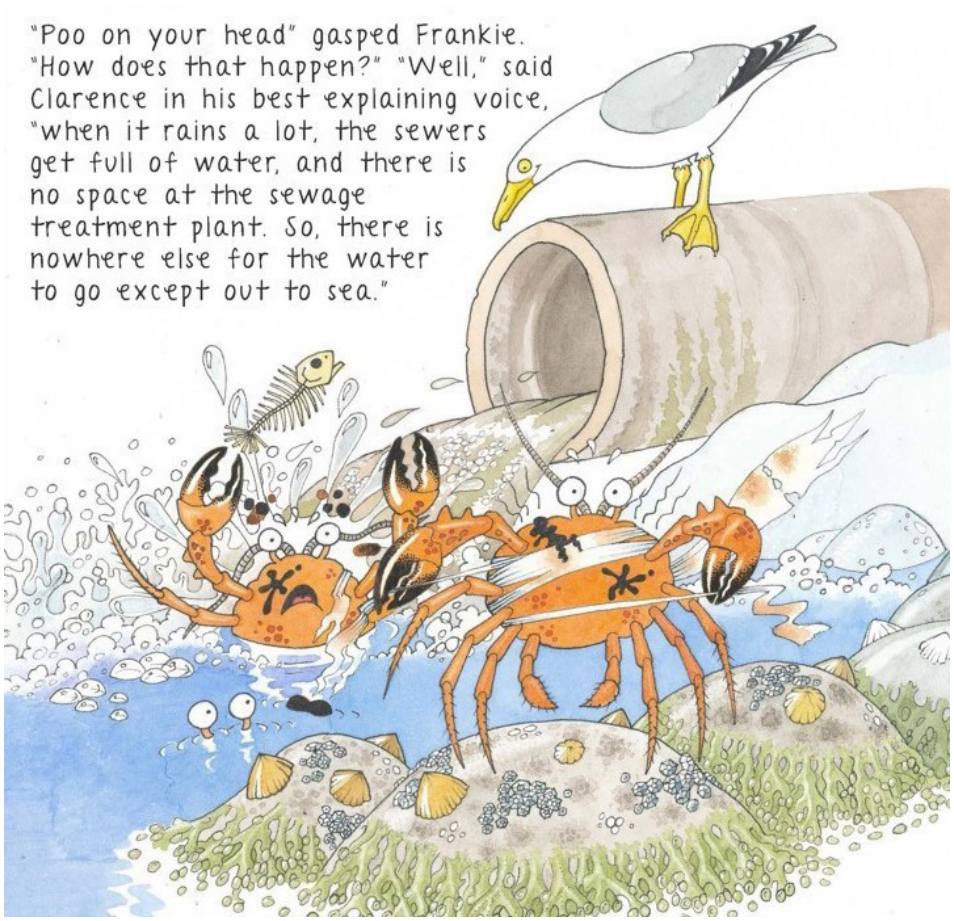


Photo (left) by Andreas Weith: https://creativecommons.org/licenses/by-sa/4.0
Image (right) from: http://www.ech2o.co.uk/the-mysterious-case-of-the-sinking-flamingo

Ecological Wastewater Design in a Changed Climate

Féidhlim Harty is an environmental consultant and the author of Permaculture Guide to Reed Beds, Towards Zero Waste and other books on practical ecological change: https://www.wetlandsystems.ie/

Windsurfing in Cork Harbour was my introduction to ecological interconnections. In the mid-1980s the answer to the sewage problem in our local town was a longer pipe. That pipe brought untreated sewage closer to my front door. One still day, as a novice windsurfer, the wind dropped to nearly nothing and as I watched the scum ripple and fold on the water in front of me, the connection with 15,000 local toilets wasn't lost on me. To say that I saw my future mapped out there and then would simply be untrue, but in hindsight I see that moment as the spark of inspiration that guided the next 25 years of work with ecological wastewater design and waterway restoration.

Sewage treatment

There are many methods and technologies that are used for sewage treatment. One way or another they tend to revolve around settlement of solids followed by aeration of the remaining liquids. Standard methods (such as now used in Cork) involve bubbling air through tanks of effluent to reduce the pollution potential prior to discharge. Constructed wetlands and reed bed systems can do the same work without electricity inputs, with plants rather than pumps adding in oxygen. In common with mechanical systems, these nature-based solutions offer cleaner water for discharge, doing so with zero energy input, offering carbon sequestration by plant uptake and providing habitat space for local wildlife.

As a way to reduce the pollution potential of sewage and protect local waterways, such methods are invaluable, but even reed beds and wetlands don't go far enough for the changes that are now needed. Rather than seeking the cheapest or even lowest carbon way to provide sewage treatment, we need to step back and examine our assumptions about effluent treatment in the first instance. Even the language we use is problematic: "sewage", by definition, is a mixture of water, faecal biomass and nutrients. Separately these are valuable resources; together they become expensive and cumbersome to treat, wasteful of nutrients, polluting and dangerous.

Better solutions

Fortunately, there are solutions in abundance. Perhaps their slow uptake is due to the need for a certain openness to the reality of ecological interconnectedness and the application of joined-up holistic design. If the engineering brief is to "design a village-scale sewage treatment system", with cost and ease of implementation as the main considerations, there is a requirement to answer some valuable questions. How do we recoup fertilisers and compost from this resource? How can we sequester atmospheric CO_2? Can we create a local park or wildlife haven in the process? What other regenerative enterprises can be helped to spin off this project at the same time?

On a domestic scale it is easy to use a compost toilet for humanure cycling to soil. This captures all the nutrients and also sequesters twice as much carbon as composting sewage sludges. At either domestic or municipal scale, source separation technologies can be used to remove solids (e.g. in-sewer Aquatron

All images: Féidhlim Harty
Above: Constructed wetlands and reed beds can be attractive wildlife habitats as well as a zero energy way to treat wastewater, as shown here in Co. Cork, Ireland.
Bottom: Willow filter systems can recycle nutrients, protect groundwater and sequester atmospheric carbon from existing urban areas without changing any of the flush toilet infrastructure, shown here in Denmark.

separators) and/or urine (e.g. Dubbletten toilets). These need to be retrofitted or installed as part of new-build projects, but happily there is an easy way to work with our existing infrastructure.

For existing urban sewage discharges, however, we can make use of land down-gradient of the treatment system or settlement tank and install a large willow plantation to mop up nitrates and phosphates from the water. This also sequesters CO_2 from the air, so even though we're not recouping humanure, we're getting the carbon sequestration via the growing trees. Biomass willows thrive on the abundance of nutrients and water in sewage effluent. They are typically harvested on a 3-yr rotation basis as biomass fuel. By using local district CHP (combined heat and power) units we can generate electricity and use otherwise waste heat to warm our homes. There is also an opportunity to make biochar in modified CHP burners, thus converting atmospheric carbon into a stable, solid form that can enrich the soil and create multiple ecological benefits as well as generating local employment.

Humility, Human, Humus

When we remember our place in the interconnected ecological unfolding of our local river catchments and wider world, we begin to realise that for land mammals to poop in rivers and seas simply doesn't work. Instead we can build the soil, recycle nutrients for plants in our fields, protect our freshwaters and seas and remember our own place here as living beings in a living habitat.

Above: Dry toilet units at a wildlife park in southern France where conventional sewage treatment was deemed to be too damaging to the local waterways.

Humility, human, humus all come to mind in this context and help shine a light on fundamental, but taboo question: Where do you shit? When you do, does it pollute the water in your local river catchment or does it build rich soil in the fields?

In our own homes and out in our wider communities we have a choice: will we continue to tweak the edges to look a little greener in the next annual report, or will we take our global health prognosis seriously and completely transform our attitude to how we design our lives? Will we seek out and implement fully regenerative designs for growing our food, providing our shelter and addressing sanitation?

If we are to treat climate breakdown and mass extinction as the emergencies that they are, these are the questions we need to answer with care. These are the questions that need to inform the designs we draw up for a future that works. ■

What is Ecological Landscape Design?

Felicity Steers is a director at erz Landscape Architects, Glasgow
https://www.erzstudio.co.uk/

Whilst ecological design can obviously mean using native plants, local materials, investing in the circular economy - it necessarily means investing in a more strategic way of looking at landscape. No landscape design operates alone and a systems-based method ensures that landscapes deliver across a range of ecological and social issues. Critical to success is high quality design input – beautiful local materials are only a good investment if the spaces and places work and are enticing to people to use.

In recent years at erz, we have been using a systems-based approach to landscape design that weaves a network of ecological and social considerations into a system for designing multifunctional landscapes that deliver on:

- Biodiversity/ecology
- active travel,
- sustainable water management,
- woodland creation,
- health and wellbeing,

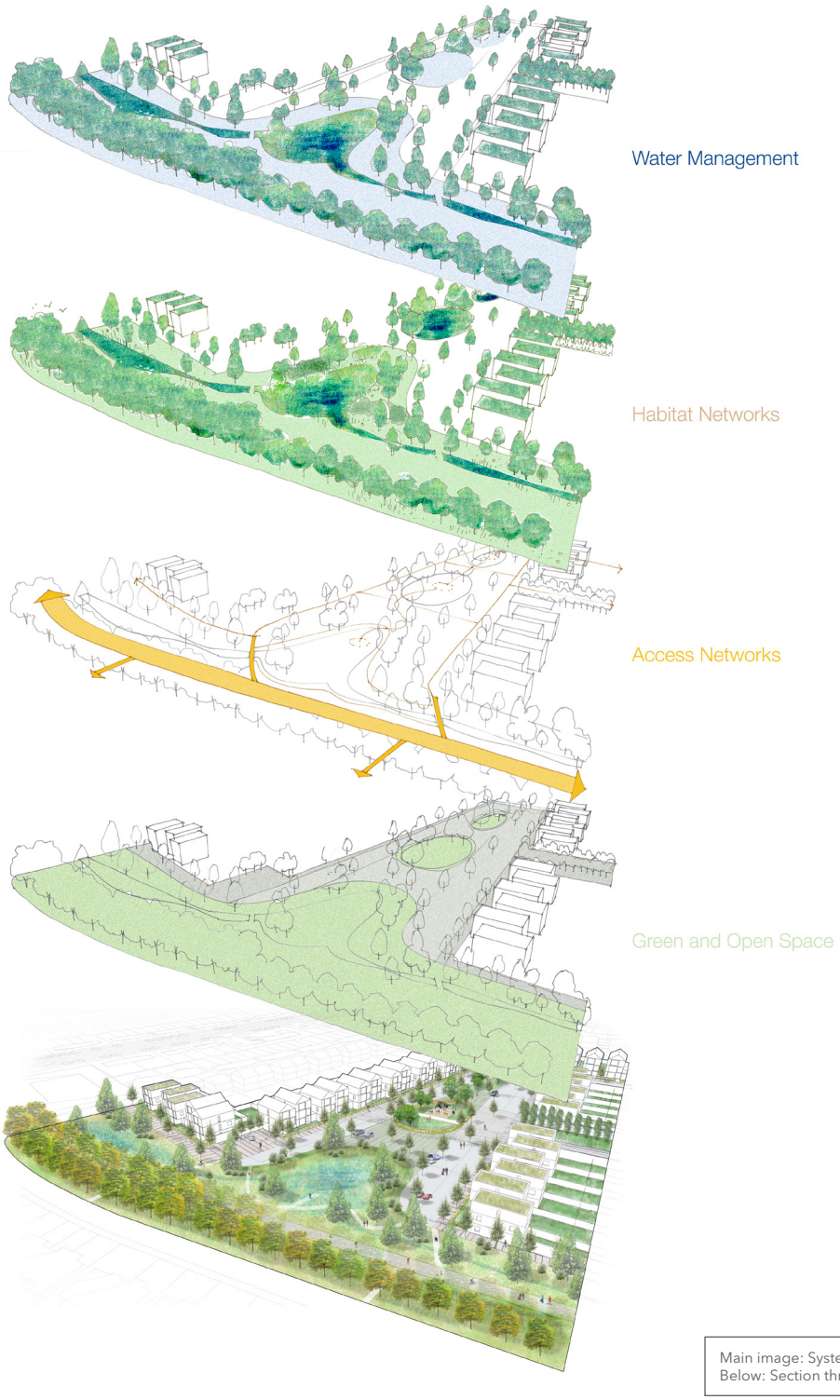
and also - fundamentally – creation of useful and inviting places that people want to use and inhabit. Ecological landscape design is not just about ecology – a biodiverse landscape can and should fulfil a multitude of needs. Ecological landscape design should use manmade and natural systems to deliver simultaneously on ecological issues such as water management or habitat creation AND human needs such as play, parks and sustainable transport. The main systems that are explored in this approach are shown in the diagram below:

- Water management systems – natural and man made watercourses, waterbodies and drainage
- Habitat networks – for flora, fauna and for people
- Access networks – for people and vehicles but focussing on walking, cycling and wheeling
- Green and openspace networks, including developed, amenity, derelict and vacant land

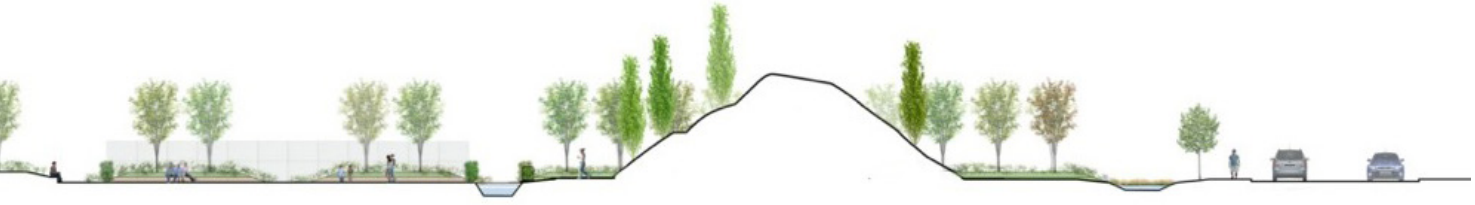
The most common name for this type of approach is "Integrated Green Infrastructure" but we consider it to be simply best practice landscape architecture.

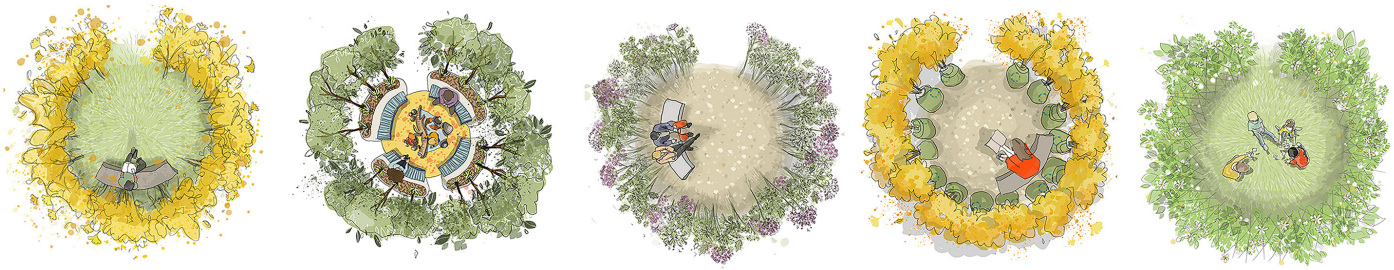
Ecological Examples

For example, at Barrowfield Park in the East End of Glasgow a wider area IGI strategy by erz led to the delivery of a new park, which included reclamation and remediation of a derelict and contaminated bus park; new woodland and tree planting; sustainable urban drainage designs that help manage water whilst creating new habitats; outdoor sport and adventure play and a much-needed community greenspace for a deprived neighbourhood – tackling issues of social justice and ecology. Wildflower meadows are the most obvious "ecological" enhancement here – but the park offers huge amenity value, and acts as a beacon of change in an improving neighbourhood.



Main image: Systems based approach to landscape design (erz 2020)
Below: Section through Barrowfield park showing swales and planting





In another example we have launched a strategic health and wellbeing project called HALO Garden that seeks to punctuate hospital grounds with tiny circular pocket gardens designed for socially distanced rest and respite. The main purpose of these is conviviality and interaction – basic human needs in times of stress. Enabling this to happen in a green space adds enormous value, as does being outside in the fresh air. In addition, the use of native plants and trees of local provenance, not only adds biodiversity value – it also resonates strongly with the users of the gardens. Plants and trees are imbued with meaning through stories, myths and cultures, in commemorations and celebrations, rituals and ceremonies. The HALO Gardens add to the ecology of the hospital campus, and arguably to the "ecology" of the hospital community.

Ecology and Human Activity

In fact, there is no fine differentiation between human need and ecology. Design of any landscape happens in an ecological context. The recent COVID lockdowns highlight the continuous push and pull between ecology and human activity – with our reduced activities allowing deer to roam our Scottish city centres and the waters of Venice to clear of mud. People are taking up outdoor swimming, using parks and wild places more, investing in gardens, courtyards and any available outdoor space. In crisis we turn to our natural habitats for solace.

Ecological restoration or protection is essential, but in our cities it has to be designed within the context of human inhabitation. Good landscape design marries ecology and humanity to mutual benefit. ■

Top: erz HALO Garden protoypes 2021
Middle: Social spaces and play reclaiming a contaminated site at Barrowfield (erz 2016);
Bottom: Urban wild flower meadows at Barrowfield helping people in habit derelict land

An Ecological Approach to Health in Buildings

Janice Foster BEng Hons, MSc Arch, CEng, MCIBSE, Researcher MEARU, Glasgow School of Art

Poor housing conditions are one of the mechanisms through which social and environmental inequality translate into health inequality with the young, elderly and infirm being most at risk. Incredibly, most people are unaware that poor quality buildings can negatively impact their physical and mental health, despite sick building syndrome and building related illness being widely reported since the 1970s. The COVID-19 lockdown highlighted existing housing inequalities and inefficiencies in ventilation of buildings. Ventilation is promoted as the key to improving indoor air quality, however, adequate ventilation in isolation does not foster health in buildings.

Sick Buildings

Indoor air pollution (IAP) is connected to a wide range of non-communicable diseases, harms respiratory and cardiovascular health and may trigger allergic and irritant reactions in the susceptible. The pollutants include dampness, mould, smoking, cooking, combustion of fossil fuels, dust, migration of outdoor pollution and chemicals from building materials. IAP can be exacerbated by efforts to eradicate fuel poverty and reduce carbon dioxide emissions from new and existing buildings through the more recent issue of 'overheating' and inadequacy of ventilation.

The evidence base linking health effects to IAP is a growing subject among the research community. However, buildings are still being constructed that contribute to poor health. But other aspects of buildings can affect health, including; accessibility, inflexible floor plans, lack of internal space and privacy, noise issues and volatile organic compound off-gassing from building materials, finishes, furnishings and cleaning agents and cosmetics used by the occupants.

For almost nine years, I have been working as a researcher in building performance evaluation on new and existing buildings. Buildings' energy consumption, heat loss and indoor air quality are routinely assessed and compared against benchmark criteria. The results highlight a clear performance gap where in-use energy consumption is far greater than predicted and overheating and poor indoor air quality increasingly problematic. There is a pressing need to reduce physical, chemical and biological hazards in our buildings.

Energy, Comfort & Health

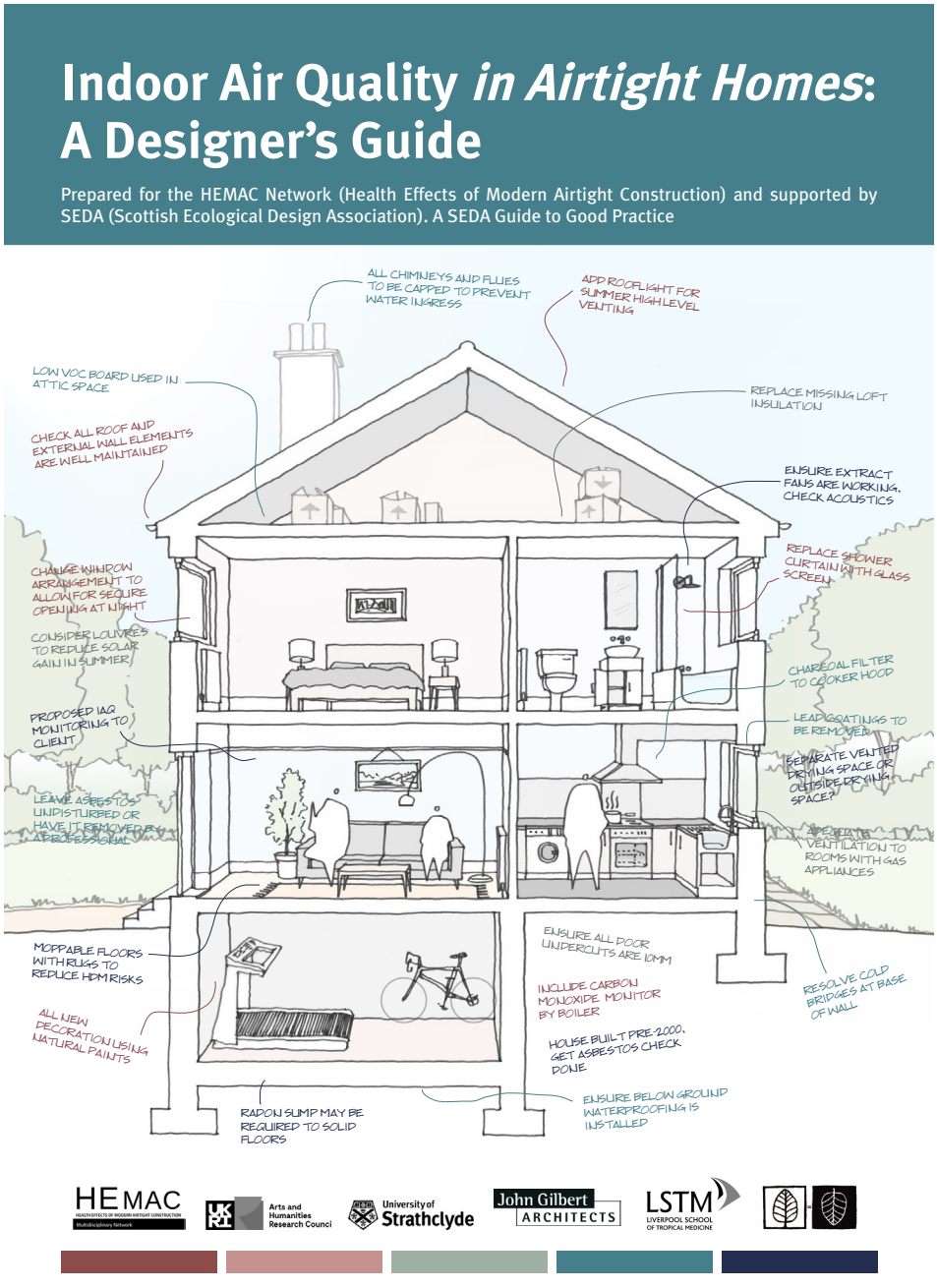
An ecological design approach involves consideration of energy, comfort and health equally. None of these design techniques are new. While many designers are familiar with the importance of energy efficiency in buildings, this is often reduced to a question of insulation and airtightness. Orientation, shelter, adequate glazing ratios and massing are equally critical. Comfort in buildings extends beyond thermal comfort, including visual and acoustic comfort. It is closely linked to health, which covers a wide range of design factors including space, accessibility, daylight, warmth and an environment free from pollution. The last of these requires source control and a well-designed and installed, controllable ventilation strategy. Lastly, education of design intent is vital for the building users.

Specific guidance on aspects of ecological design are available on SEDA's website and the Building Biology principles presented in SEDA's summer conference are a good introduction to the importance of including health and comfort in energy efficient buildings. ■

Images: Jenny Brierly (above), MEARU (below)

Indoor Air Quality in Airtight Homes – A Designer's Guide

Published for HEMAC by SEDA as a Guide to Good Practice, October 2021, available to download here: https://www.seda.uk.net/design-guides
SEDA Magazine is indebted to building performance adviser and troubleshooter Bill Bordass of Usable Buildings, www.usablebuildings.co.uk for this review



Introduction

Following the 1973 oil crisis, some countries pushed to make their building envelopes very much better. For example, the 1975 Swedish Building Code introduced insulation and airtightness standards that most British buildings would fail to reach today. It then emerged that these buildings could overheat and have poor indoor air quality (IAQ), so mechanical systems were often added. By 1988, Sweden had learnt how to put buildings together better and no longer required routine pressure tests. While the UK tightened its insulation regulations in the 1970s, it took until the 2000s for airtightness to appear… and so now overheating and IAQ in dwellings are pressing issues. Energy performance gaps also persist.

In the 1980s, the UK had IAQ-related problems in mechanically-conditioned public and commercial buildings. Initially known as Sick Building Syndrome (Tight Building Syndrome in North America), it turned out to be largely a disease of deep-plan buildings with poorly designed, operated, managed, maintained or cleaned spaces and systems. UK dwellings had problems too - typically from condensation and mould, and often following insulation upgrades, window replacements, and removing fireplaces and open-flued boilers.

Cover image: HEMAC/SEDA

Why is the UK so poor at learning from experience overseas, and even the advance warnings from our own case studies? In response to the Climate and Environment Emergency, we need a massive culture change: a focus on outcomes, undertaking continuous improvement, and feeding back the lessons quickly to both practice and regulation. The Grenfell Tower analogue is a salutary example of how unintended consequences can pile up otherwise.

The Guide

This background makes the SEDA Guide to IAQ in airtight homes not just timely, but long overdue. It draws on a range of case studies and consultations by members of the HEMAC[1] network, supported by the Arts and Humanities Research Council. Where was EPSRC[2]? Is there a lesson here? In my experience, multi-disciplinary research into in-use performance of buildings seldom seems to match physical science funding criteria, being regarded as either unnecessary, insufficiently rigorous, or too difficult, with case studies seen as anecdotal. *Flyvbjerg*, a social scientist, forcefully describes[3] how mistaken this is.

The clearly-written 68-page Guide has four main chapters: Introduction; Source Control; Ventilation; and Occupancy and Monitoring. A final Resources section includes references and links to organisations that can provide further advice and guidance.

The Introduction outlines the myriad health problems that poor indoor air (which may also have come from outdoors) can trigger or aggravate. These are subject to major uncertainties, because symptoms can take a long time to develop and little is known about how multiple causes interact. And the more we learn the worse it gets. Some people – including children, the elderly, and the genetically predisposed - are also much more vulnerable than others. The Guide's underlying approach is therefore of prevention being better than cure. It encourages designers to avoid excess moisture, unwanted heat gains and losses, cold spots, and unsuitable materials and finishes that may outgas, harbour dust, wildlife or pathogens, and contain or promote allergens.

Chapter 2, Source Control, is the longest - not surprisingly given the Guide's precautionary approach. It has four Sections: Overheating & Moisture; Biological & Natural (including Radon and viruses of course); Combustion products & Particulates; VOCs (volatile organic

1 Health Effects of Modern Airtight Construction
2 The Engineering and Physical Sciences Research Council
3 B. Flyvbjerg, Five Misunderstandings About Case-Study Research, Qualitative Inquiry, 12 (2) 219-245 (2006)

compounds) & Chemicals. Each Section is consistently organised to assist the reader - first outlining the issues and problems, and going on to identify potential solutions. Each Section contains two similar annotated cross-sections of a house: one presenting the risks, the other possible solutions. The chapter finishes with tables of commonly-used materials and finishes, identifying the risks they present and suggesting potential alternatives.

In 1992, BRE's ventilation experts drew attention to the far greater airtightness of Swedish buildings[4] and introduced the maxim "build tight – ventilate right". Many UK buildings continued to do neither. As airtightness has gradually improved, shortcomings have come to the surface,- and not just with natural ventilation. Instead of offering assured performance, case studies show that far too many mechanical systems in dwellings are poorly designed, installed, commissioned, controlled, understood, operated or maintained.

Chapter 3 outlines shortcomings in ventilation that case studies repeatedly expose. It then outlines five ventilation strategies widely used in UK housing: Natural ventilation with intermittent mechanical extract; Passive stack; DMEV (Decentralised mechanical extract); Central mechanical extract; and MVHR (Mechanical ventilation with heat recovery, as used in Passivhaus). Each system is introduced with its pros and cons; its components identified; and best practice guidance given.

Chapter 4, Occupancy & Monitoring, is really three appendices. It starts with checklist tables to help occupants keep their own pollution to a minimum (including selecting and using DIY and cleaning products), operate systems effectively, and alert to any shortcomings; and how designers can assist in their specification and by providing written guidance. It then outlines what monitoring equipment occupiers and landlords might consider, and the standards against which any monitored values might be compared.

Conclusions

As Professor Tim Sharpe says in his Foreword, we need to get all this right and to get it right now. This concise and well-founded Guide will definitely help designers to do this. It is also readable by almost anybody, not least clients, occupiers, managers and students. Personally, I would have liked to see more practical details, but this would have made the Guide longer and the audience narrower. I would also have welcomed more about procurement: instead of diverging from good intentions; we need a new culture that makes buildings work by converging onto good outcomes. I was also concerned by some of the standards advocated, in particular where tighter control was regarded as better. From the perspective of climate justice, we in the West may not be entitled to what we aspire to. ■

4 E Perera & L Parkins, 'Build tight – ventilate right', Building Services Journal 37-38 (June 1992)

Giroscope Self Build, Hull - Part the Seventh

Duncan Roberts, architect

There has been much crawling under the houses of late, so we hope the air-tightness problems have now been dealt with, but it has been a horrible job and an issue that needs to be better thought through for future projects.

In Hull the balance was to make the houses high enough off the ground to be above any likely future floodwaters, but low enough to avoid making the ramped access to each house too long. In most situations the natural slope of the site can be used to ease access to the area below the floor but in Hull the site is dead flat so there is no difference between one side of the house and the other.

Much of the rest of the work lately has been on the electrical and plumbing installations. The decision made early on to make the houses all-electric still seems a sound one, but the reality is that about 40% of England's electricity is gas-generated so recent issues around gas prices and supply security will have an impact on the residents. Another early decision to exclude wood-burners might have to be re-visited!

Externally, the houses are substantially complete, but await the construction of the decks, ramps and steps that will connect them to the surrounding landscape. Work has also been progressing on the two rainwater catchment ponds that are designed to hold stormwater and release it slowly to the public drainage system, thereby helping to avoid the surges that have, historically, triggered flood events in Hull. ■

Image: Duncan Roberts

Moisture in Buildings

Chris Morgan: director John Gilbert Architects and author of several SEDA Guides

Above: Allows moisture in the wall to escape back into the room, especially when combined with good ventilation.
Below: The use of hygroscopic insulation, like this wood fibre board on the inside of a stone wall.
Image Credit: Chris Morgan

In the Spring edition of this year's SEDA magazine, Alex Liddell discussed hygrothermal modelling and the need for a centralised source of knowledge and guidance. We agree that something like this is needed, but hygrothermal modelling is very much the 'expert' end of a much broader and more basic awareness and understanding of the roles moisture plays in buildings.

It is ironic that in rain-soaked Scotland the building industry has little more than a passing interest in the most expedient basics of moisture necessary for regulatory compliance.

Given that we're not required to know much about moisture in buildings, what are the advantages of gaining and applying this knowledge? There are three.

The first is that moisture is the main cause of damage to the fabric of buildings. Left to accumulate in the wrong place, vapour can turn to water and water can create damp, condensation and mould, leading to decay of organic materials, rust in metal, and spalling through freeze / thaw in masonry. Conversely, understanding moisture means we can confidently design buildings that will last indefinitely.

The second is that same moisture, whether as vapour in the air or water in the building fabric can negatively affect the health of those in the building, either directly or indirectly. Conversely, with a good understanding we can actually improve the health of occupants, or at least improve the conditions in which they live.

The third is that Scotland is going to get wetter with climate change, so understanding these issues is only going to become more important.

Nobody would suggest that making buildings energy efficient should lead to buildings decaying, and create conditions that damage the health of the most vulnerable occupants, yet that is exactly what we often do.

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I think the kernel to this understanding is accepting that in the world around us, moisture is permanently on the move. Most of us remember the water cycle in which water evaporates from the oceans to form clouds. These drift over land and are forced to drop their moisture which falls as rain or snow. This then seeps through the ground and forms smaller, then larger rivers, returning eventually to the ocean where it starts again. The key thing is that it is always on the move, supporting life wherever it goes.

If we look at traditional buildings, we can see, more or less, the same thing happening. Moisture was free to move through the building both within the fabric and within the air. Older buildings were designed to keep off the worst of the weather and through natural materials, drafts, chimneys, opening windows and such like to store, moderate, disperse and manage moisture.

I am not arguing that older buildings necessarily got everything right, nor that we haven't improved comfort levels since, but from the point of view of moisture, they operated according to natural forces of air and moisture movement and were, in effect, slightly more convoluted microcosms of the world outside.

It is difficult to say with certainty if this was fully understood by all of the designers and builders of older buildings, but what we can say with certainty is that that way of designing buildings is no longer the way it's done.

In modern buildings, keeping out the rain and wind is handled in the same way, but the moisture we create in our homes, from breathing, drying clothes, washing, boiling water etc. represents a real threat to the integrity of the building and so we commonly put a polythene layer across the whole inside surface of the home, and, for good measure, we extract the moist air from our bathrooms and kitchens to ensure that that moisture is sucked out before it can cause any trouble.

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But why has this moisture suddenly become a threat? It isn't a mirage - moisture genuinely does represent a threat because of the way we design and building buildings nowadays.

Firstly, we use a lot of materials which cannot store moisture, nor can they allow moisture to move through them. In other words, they are impermeable to vapour and have no capacity for hygroscopic storage. We also design buildings with lots of layers, some block moisture some don't, but all in

all it gets complex and if we're not careful, moisture ends up in places where it can only collect and cause trouble.

Secondly, we keep our buildings a good deal warmer than we used to. We achieve this using lots of insulation. This is largely a good thing, especially for those who are vulnerable to the cold, but it has implications. The main one of which is, that it sets up much more of a temperature differential between indoors and out. Temperature and moisture are intimately related, so this in turn means that if, for any reason there was to be a problem with moisture, we've made it much more likely.

Third, and probably most importantly, we now seek to keep modern buildings airtight and so we have closed off the drafts that leaked heat, but also safely dissipated moisture.

Lastly, we do have a 'get-out-of-jail card' for moisture - mechanical ventilation - but in the broadest terms, the importance of ventilation is not understood, it is not taken seriously enough and on the whole it is designed and installed inadequately.

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Logically, the solution lies with simply not doing the above things. Unfortunately, this is not possible due to the demands of energy efficiency. But the good news is that we don't need to throw all of the babies out with the bathwater.

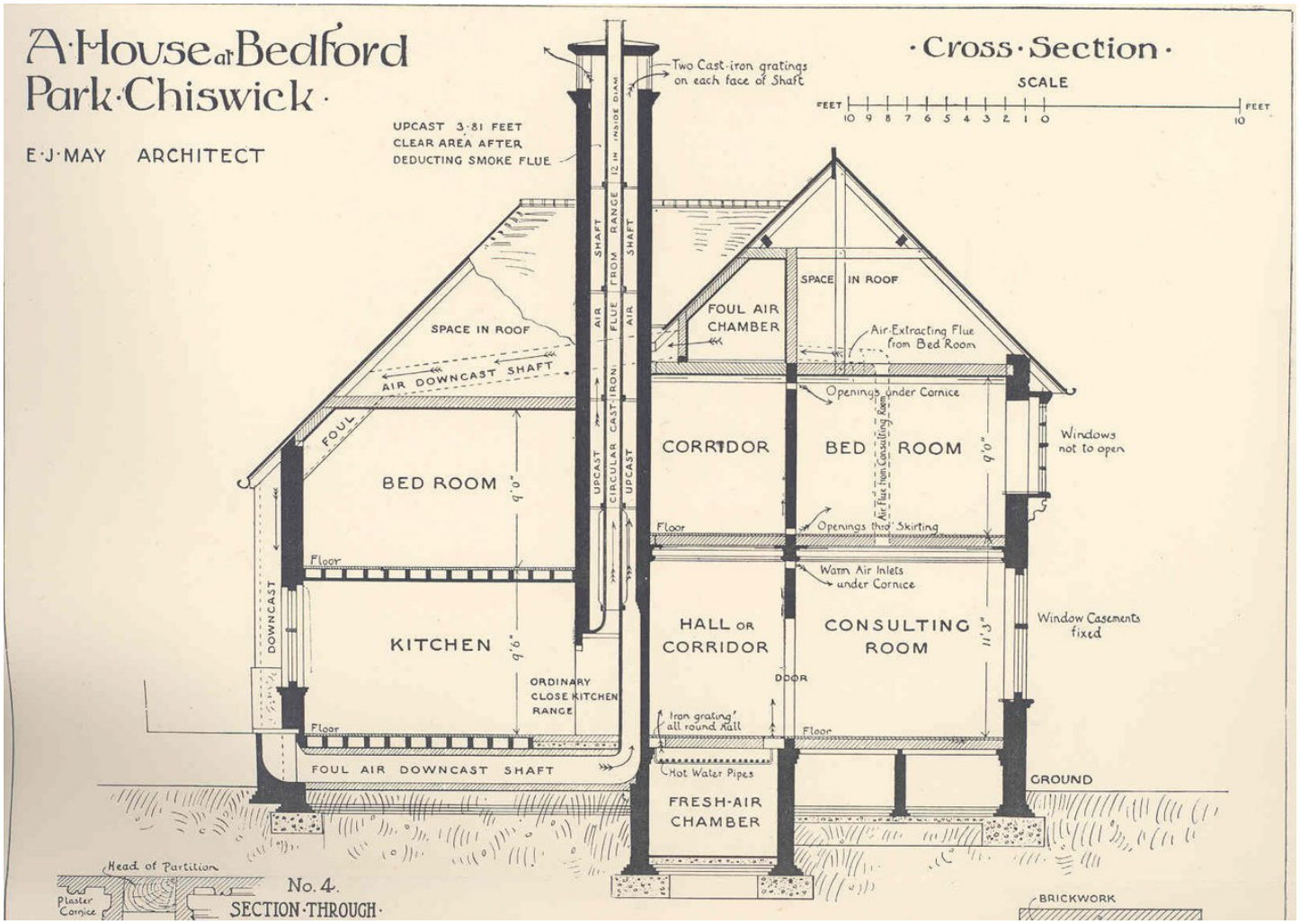
We do need to keep buildings more consistently warm and airtight, but there's no reason we can't simplify building construction and use vapour permeable materials, which also store moisture. In addition, we can take ventilation more seriously. Between these three, lies the solution to addressing moisture whilst also addressing our climate change and fuel poverty targets.

Helpfully, these apply equally to new building and working with older buildings.

The most common new-build option in Scotland is an insulated timber frame with a ventilated cavity and rendered outer blockwork or brickwork. If moisture, acting under vapour pressure from warm and moist internal spaces got into the timber frame, it would work its way through the timber and insulation and find itself trapped against the outer sheathing. Now on the cold side of the insulation and trapped against the vapour impermeable plywood or OSB, it would condense and, held in place by mineral wool, eventually lead to decay.

The universal solution to this has been to introduce the polythene (or similar) vapour barrier on the inside, but arguably a more obvious solution to this would be to replace the impermeable outer sheathing with a vapour permeable board so that if moisture did get in, it could just as easily get out. This outer sheathing normally provides racking strength, but some of the vapour permeable sheathing options can also do so. Where this is inadequate, the racking strength can be provided on the inner face of the frame. Replacing this outer sheathing is the first move in any "breathing wall", but a fully breathable wall would replace the mineral wool with a fully hygroscopic insulation like sheepswool, wood fibre, cellulose, hemp, jute, sisal or similar material, which is equally capable of absorbing and desorbing moisture. An additional benefit is that the timbers are no longer at risk from decay and so do not need to be treated with toxic chemical preservatives.

Traditional house image



Similar principles are at work when working with older buildings, but it can get complicated. Putting external insulation on the outside of solid walls, or insulated cavity walls is relatively risk free from a moisture perspective and avoids disturbing occupants, but has significant aesthetic and heritage implications, so we are likely to see a good deal of internally insulated walls in the near future, and therein lie a number of moisture-related problems.

The commonly used calculations which assess energy, do not mind where you put the insulation in a wall - you get the points anyway - and in many retrofit projects, where only the most cursory overview is taken, the moisture risks of internally applied insulation are effectively invisible. However, placing insulation on the inside of a wall means you have to work within and around existing walls and floors, which almost inevitably lead to gaps in your insulation. Both heat and moisture will flow out of these and condense in walls - and timber joists embedded within these walls - that are now more or less permanently damp. We face the real threat of floor joists failing across the many tens of thousands of properties that will be retrofitted over the coming years.

The most important aspect of all of this is to raise awareness of the issue generally, and across the industry, but even at the 'expert' end of the subject, and coming back to Alex's proposition, there is still much to be learnt, particularly in relation to robust retrofit internal wall insulation detailing, which has the potential to be a major problem in years to come. ■

Solar Active and Passive Storage: SEDA Solar Summer 2021

Gloria Lo & Colin Porteous
https://www.seda.uk.net/seda-solar

SEDA Solar's 2021 summer solstice seminar was probably the first Scottish meeting for some years to deal with the critical issue of thermal/electrical energy storage and featured a distinguished line-up of speakers.

Thermal Storage in Buildings

Dr. Manuela de Castro, formerly of the Mackintosh Environmental Architecture Research Unit (MEARU), kicked off with energy-storage in housing: an academic research project, funded by the Engineering and Physical Sciences Research Council (EPSRC), steered by the Energy Systems Research Unit (ESRU) at Strathclyde University together with MEARU; also involving longstanding SEDA member Chris Morgan of John Gilbert Architects.

The academic skills-mix together with practice is indicative of a positive partnering and knowledge-transfer trend that is apposite today, especially with COP26 imminent. Moreover, there are important socio-economic undercurrents to such work – e.g.'fuel poverty' and poor indoor air quality stubbornly prominent.

Manuela structured her presentation around three aspects, entitled *Fully Integrated Thermal Storage (FITS): taxonomy of FITS; FITS concepts; materials for FITS*. The first covered different typologies within active, passive and hybrid categories – embracing coupled and decoupled systems, temperature ranges and thermal or electrical sources.

The second had nine main architectural variants, with integral vertical and horizontal components and some systems with subsets. More specifically, concerning architectural form and construction, were examples such as under-floor thermal labyrinths, vertical equivalents such as central walls, external wall mass components, including water containers, or horizontal elements (ground floor and/or intermediate); all potentially served by heat pumps.

Her third theme indicated a large range of possible materials related to high (>90°C), medium (50-90°C) and low (<50°C) temperature categories, including some controversial economic choices with high embodied energy (e.g. concrete) and ones as basic as rocks, or as sophisticated as aerogel or vacuum insulators; along with relative costs.

Manuela's intrinsic architectural approach comprises components which are essentially multi-functional, underpinned by science and dynamic computer modelling. The architectural results are popular new-build private and public sector low-rise forms. Her modelling techniques also offer transferability to less carbon-transport-intense housing types and to the key area of urban retrofitting.

MCS: The Battery Standard

Chris Roberts explained the *Microgeneration Certification Scheme (MCS)*, on *MIS 3012 – The Battery Standard*, focussing on the important issue of developing an industry standard for batteries. He started with the historical grid context, large power stations away from urban centres post-WW2 and the grid's 'high spinning inertia' of 50Hz. Chris thinks this may 'wander' as 'big power' declines in

TESLA Powerwall, 6.4 kW discharge with nominal 8
Image Credit: Colin Porteous

3kW Lithiium-ion battery

favour of 'smart networks' and dependency on renewable energy. He, therefore said 'no' to a new large generation but 'yes' to procurement of 'balancing services' and 'virtual capacity'. This gives rise to a new technical jargon; 'virtual power plant' (VPP), enabled via techniques such as 'demand side response' (DSR) and 'arbitrage' (time-of-use tariffs). Solar PV is part of this within today's renewable energy mix.

Chris then moved specifically to his *Microgeneration Certification Scheme (MCS)*, and *'MIS 3012, The Battery Standard'*. He and the University of Loughborough estimate a typical house requires 1,500-6,000kWh electricity annually with potential 40-50% PV self-consumption without storage battery, but 60-70% self-consumption with storage. Trial assessments with certification bodies NICEIC and NAPIT are underway, entailing an updated version of MIS3012 based on feedback, and full certification anticipated by the end of 2021.

Effective Utilisation of Solar Energy

Finally, Dr. Wolf Früh of Heriot Watt University described his current work on new variable renewable energy sources, centring on optimising hybrid systems for the *Effective Utilisation of Solar Energy*.

He pointed to the rapid drop of prices for electrical battery storage and to thermal storage, comprising relatively low-technology solutions such as phase change material (PCM). Wolf explained the technologies and challenges of inherent variability in both the daily and seasonal cycles of solar capture and use and hence the criticality of storage to smooth out fluctuations. Always keeping in mind the objectives of reduced CO_2 footprint, environmental sustainability and self-sufficiency.

Wolf outlined the constraints of grid connections, their dependence on a consumer's geographic location, requirements and energy-balancing methodology for heat and/or electricity ie. its import/export from/to the grid.

He finished up describing two theoretical examples in Scotland for wind plus PV solar.

The first was a hypothetical distillery on a Scottish west coast island, with a PCM heat storage as well as an electrical battery. Here the demand was assumed to average 1MW with a peak of 3.6MW; with a PV 'capacity factor' of 15% in the range of 0-10MWp. He assumed an average PV yield of some 60%, with an upper limit of 70-80%. Wolf illustrated predictive results graphically using these metrics for both PV and wind.

His second example was a small township near Oban, close to the end of the grid network and so with poor capacity to add renewable energy. He ended this briefer résumé with a warning that storage always has a limit, depending on the nature of the resource and the technology use.

Solar Storage Part 2

This was another enlightening seminar in the Solar series, and the audience were very appreciative, not only of the speakers' knowledge but also SEDA Solar's organisation.

Winter's SEDA magazine will carry a report from our 11th October seminar on *Storage: Grid capacity, Scale, Financial and Smart Models*. ■

SEDA Land Launched

Gail Halvorsen, architect and co-founder of SEDA Land: https://www.seda.uk.net/seda-land

SEDA Land was launched on the 6th September, along with a report based on "A New Vision for Land Use in Scotland: Six Conversations" (more about this in the SEDA Magazine Summer 2021 article). The report concludes with eight policy recommendations, which we believe the Scottish Government should implement, if it is serious about reaching its target of "net zero" by 2045.

Chris Powici opened with a poem commissioned for the event "Paying Heed" – a collection of haikus describing Scotland on the mend.

"sheep bleat, stonechats chat
on the drystone radio
lichen just listens"

Image: Shutterstock

Independence

As with the Conversations, SEDA Land will position itself as an independent interdisciplinary and cross-sectoral forum. Our strength lies in SEDA's independence. It has no affiliations with the land sector – a surprisingly divided political arena, with many sectors and bodies not speaking to each other. Our vision is to help improve land use in Scotland to achieve both a healthy ecology, dynamic economy and empowered community, including tackling issues such as biodiversity loss, depopulation, health, carbon storage and, of course, climate change, while avoiding any entrenched political positions. We do not want to duplicate what existing organisations are doing, but there does seem to be a need for a strategic approach that embraces all sectors.

We have set up a steering group consisting of speakers from the Conversations, including SEDA member and owner of MAKAR, Neil Sutherland, the University of Glasgow professor of economics, Ronald McDonald, and food policy expert, Mads Fischer-Moller, from Scotland's Rural College.

Although, our primary goal is to influence policy around land use in Scotland, SEDA Land also wants to share cross-sectoral knowledge and broaden awareness of the many and varied ways in which land use in Scotland can be improved. We will test land use proposals against a matrix of benchmarks such as health and wellbeing, biodiversity and employment. I would also like SEDA Land to consider creating a database of interactive maps showing the most suitable land for each sector in the same vein as Ian McHarg, famous for his pioneering work on the use of map overlays.

The John Muir Trust recently asked SEDA Land to work with them on their Carbon Land Tax proposal, which is similar to our Climate Impact Certificates recommendation. We will be holding our next Conversation about this during COP26, and we hope it will be a precursor to many such collaborations in the future.

Get Involved

If you would like to get involved with SEDA Land, please contact us. Thanks to all those who have already offered to volunteer.

Sophie Cooke ended the launch event with another beautiful poem "Here Together – in this Place".

This rye is almost 2 metres tall. It is mesmerising as it dances in the slightest of breezes and it graces a landscape that is a pleasure to behold as well as being good for our 'mental health' – very different from the monocultural desert that is intensive cereal farming.

You can read the full report and the complete poems by Sophie and Chris here: https://www.seda.uk.net/seda-land-conversations/report Hardcopies are also available.

To find out more about SEDA Land and watch the video of the launch, go to https://www.seda.uk.net/seda-land ■

Here Together in this Place

[extract]

This place and the way we live
will be joined, and different
as every place is different, each twist and rise
and nook; the things that are around us -
lignin, bracken, wool -
stretched to furnish many needs.

Swedish organic evolutionary rye
Image credit: Andrew Whitley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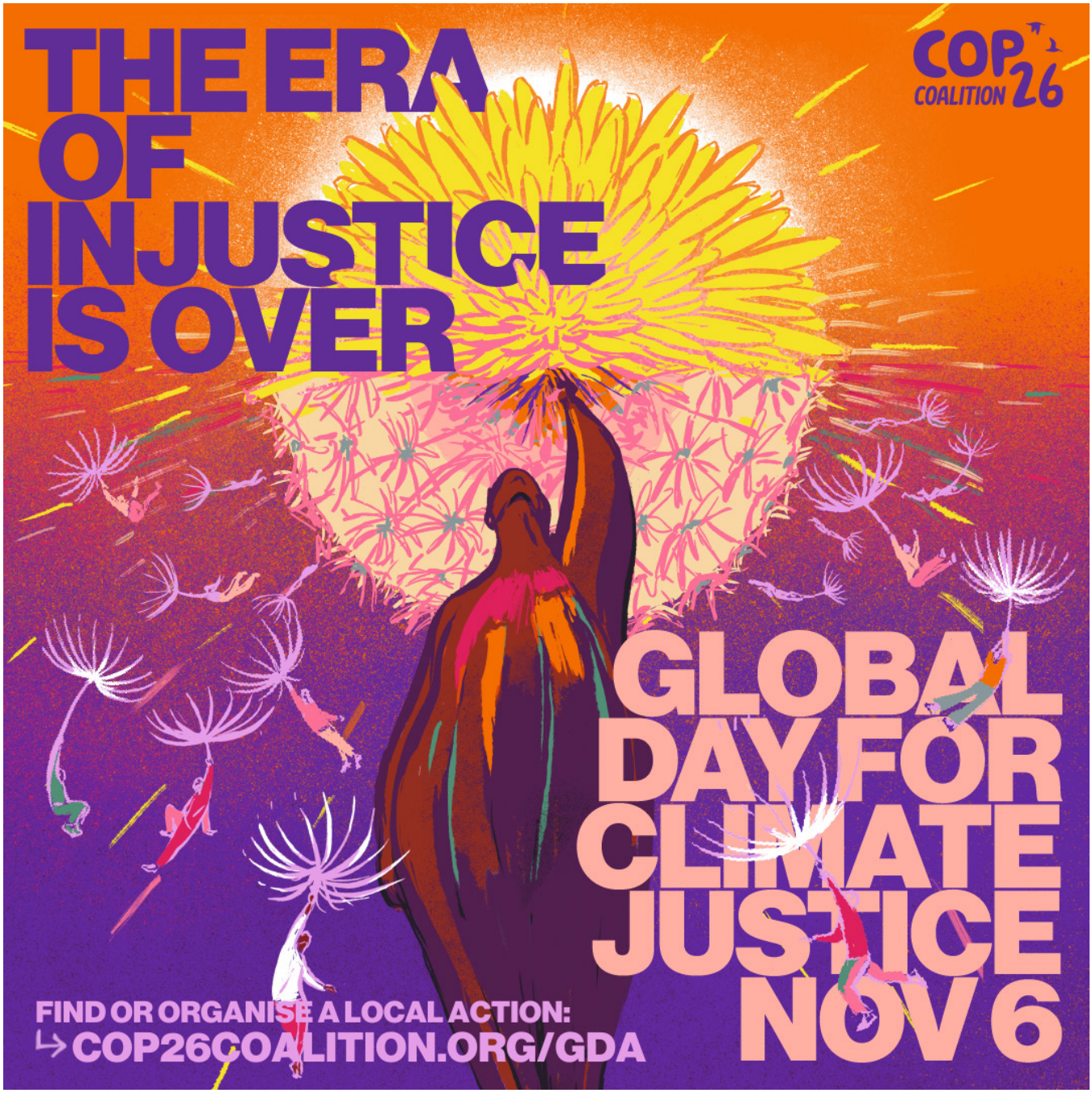
THE ERA OF INJUSTICE IS OVER
COP26 COALITION
GLOBAL DAY FOR CLIMATE JUSTICE
NOV 6
FIND OR ORGANISE A LOCAL ACTION:
COP26COALITION.ORG/GDA

The Fantasy of Offsetting and Biomass Energy

Dr Ulrich Loening: Hon. Research Fellow, School of Engineering, Retired Director of the Centre for Human Ecology. University of Edinburgh uel@loening.com

It's comforting to think that we can get new trees and woods to sequester the carbon dioxide we emit into the atmosphere. Many industries have schemes that charge for their products to become 'carbon neutral' by planting trees to soak up their carbon. A carbon-offset market is being developed by Mark Carney, the former governor of the Bank of England, and Bill Winters, the chief executive of Standard Chartered Plc., which could be worth $100 billion... If these offsets depend on biomass, that hope becomes a fantasy. While restoring forests can only be good, being a vital part of the world and can alleviate climate warming, but offsetting does not actually make sense. Here are some of the arguments:

1) The timing does not work. To be of any use to offset carbon emissions now, the trees would have to have been planted 50 years ago.
2) Offsetting by planting trees is actually taking out a carbon mortgage. After some 3 decades, when your trees are beginning to be useful, you will in the meantime have emitted 3 decades worth of more carbon.
3) The forests should have been there anyway. Dependence on offsetting is asking the world's forests to absorb carbon far beyond the normal balance they have with all humans, animals, fungi, most bacteria and all trees at night.
4) There is nothing that connects your trees with your carbon emissions. The biosphere cannot know that the new trees were yours, or another polluter's or anybody's. The offset is in our minds.
5) Avoiding forest felling rather than planting new forests, is not offsetting your activity. No new carbon sequestration is involved. The practice leads to the ridiculous situation that a forest owner can claim compensation for not felling trees.
6) Use of annually cropped non-food waste can reduce emissions by being anaerobically digested to give methane and compost. However, it is not an offset as the methane only provides a replacement gas supply without emitting more carbon than would have been if the waste had decomposed.
7) There is a distinction between renewable energy and perpetual energy. Solar power, wind and waves are perpetual and continue whether we use them nor not; but biomass is renewable, but may suffer delays in renewing; perpetual energy is physics, immediate and immutable.

Conclusion: We are left with stark choices. 'Greenhouse' gases have to be greatly reduced but Net Zero claims are often a fudge. The only two approaches are land use changes and carbon capture and storage. The latter involves shifting nearly 4 times the weight of gas as coal burnt and in addition it has to be compressed and pumped deep in the earth. Land use change is vital anyway. A change to agroecology in place of 'conventional' farming has multiple benefits, carbon capture, more resilient food supply, healthier food, better biodiversity.

Further reading:

- The days of simply planting trees are over:: FT Special Report Europe's Climate Leaders 2021: https://www.ft.com/content/52c51902-f770-4c2e-9166-47def2bcf76c
- 10 myths about net zero targets and carbon offsetting, busted: https://www.climatechangenews.com/2020/12/11/10-myths-net-zero-targets-carbon-offsetting-busted/
- Can Tree Planting Really Help Mitigate ClimateChange? Geophysical Research Letters; https://eos.org/research-spotlights/can-tree-planting-really-help-mitigate-climate-change