

THE VEOLIA INSTITUTE REVIEW

FACTS REPORTS

2023

INNOVATION FOR ECOLOGICAL TRANSFORMATION



In partnership with

THINKING TOGETHER TO ILLUMINATE THE FUTURE

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The Veolia Institute Review - FACTS Reports is an international publication compiling diverse perspectives on topics at the crossroads between society and the environment.

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The interdisciplinary review is a vehicle for sharing the experiences and expertise of different stakeholders (researchers, academic experts, policymakers, companies, NGOs, international organizations, etc.), with the aim of taking advantage of a diversity of perspectives on a given topic, by combining feedback on best practices from the field and expert analysis.

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FOREWORD

Philippe Kourilsky

Honorary Director General of the Pasteur Institute and Member of the Veolia Institute's Foresight Committee

"Ecology is a moral science"



"Ecology is a moral science." This statement from a book by Amartya Sen¹ covers two propositions, both of which are significant: the first is that ecology is a science; the second is that it is a moral science.

Scientific ecology suffers from semantic ambiguity with the word "environmentalist". We all have the right, and no doubt the duty, to be environmentalists, and therefore

to hold militant opinions or positions on ecological issues. But opinions and positions are not science. The term "écologue" in French, sometimes used to describe professional researchers, is not very popular. So we stick with the term ecologist, which maintains the confusion between opinions – environmentalism – and scientifically established facts – ecology.

While the IPCC's audience is sufficient to counterbalance the ideological pressures of many decision-makers who are ignorant of science, the same cannot be said of public debate when it is not conducted calmly and seriously. For example, proper planning of the energy transition requires a scientific approach based on the best available knowledge. Relentlessly contesting everything on the grounds that this transition is always underfunded and always too slow can lead to inappropriate and sometimes disastrous measures being taken in a hurry.

What's more, let's say it loud and clear: to combat the environmental crisis, innovation is and will be needed. Innovation requires science, and lots of it. This is perfectly illustrated by this issue of FACTS, which shows just how broad the scientific approaches need to be to cover the immensity of the field. The social sciences will play an important role: technical innovations are and will be coupled with social innovations, if only to enable or facilitate the acceptability of the former, as illustrated by the scientifically foolish situation of GMOs in Europe.

Ecology is also a moral science, for two reasons.

There are many who seek to reconcile 'Nature' and Man, understood as an integral part of it, in a balance that respects both, but which has yet to be found. This approach is undermined by those who make 'Nature' sacred and give it a higher place than humans, who are seen as predatory and destructive. It is equally opposed by those for whom Nature exists only to be exploited and enslaved by Man.

To caricature: at one extreme, radical ecologists accused of declinism; at the other, unrepentant technophiles and supplicants of ultra-neoliberalism. We can all make our own assessments of the very different moral implications of these philosophical approaches.

But there is one approach, just as immediate and compelling, that transcends both, whatever the roles assigned to Man and Nature: that of *sharing*². We have reached a stage where we must share the ills as well as the global public goods. This is obvious when it comes to global warming. If, leading the way, only a few countries, and not others, reduce their greenhouse gas emissions, what will we achieve collectively? Perhaps the former will suffer less from a few local disorders, but they will suffer just as much from the major consequences of global warming. The same goes for pollution like plastic waste for example, and for finite natural resources, and so on. *There is no strictly local solution to the world's biggest problems.* The only way out is to share in actions and solutions, including innovations.

This sharing will require generosity on the part of the better-off. Both logic and ethics should convince us of this. But are we on the right track? The Covid19 pandemic would have been much worse without the major innovation of the messenger RNA vaccine. This was shared, albeit too sparingly and too slowly to prevent millions of deaths in disadvantaged countries.

It should be noted, however, that if the pandemic was relatively quickly brought under control, it was also because, outside living organisms, viral particles dry out and "die". As a result, the global virus did not grow through passive accumulation. Otherwise, exiting the pandemic would have been much more difficult. This will not be the case for global warming, nor for pollution caused by products with half-lives measured in centuries or millennia rather than days or weeks. The laws of biology and physics are not identical.

The conclusion is clear: we will not be able to solve environmental problems properly unless we share more and better. Sharing innovations raises specific issues (patents, for example) that we would do well to tackle more vigorously today.

² This is one of the conclusions of my latest book: Philippe Kourilsky, *Mes années Pasteur, l'âge d'or de la biologie moderne [My Pasteur years, the golden age of modern biology]*, Odile Jacob, 2023.

¹ *L'économie est une science morale [Economics are a moral science]*, La Découverte, 2004



INTRODUCTION

Nicolas Renard - Executive Director, Veolia Institute



To innovate or not to innovate, that is the question. And the answer is: innovate or disappear. This is the modern world's iron law, a world where innovation has become a culture, an ethical imperative, the condition for a business to survive.

Innovation can be disruptive or incremental, with enormous cumulative impacts. It can be open, frugal, clean, economic, social, and much more. Innovation has many faces. It never stops flowing, reconfiguring every human activity with its constant movement. It also drives ecological transformation, helping humanity rise to the critical environmental challenges of the 21st century.

And this innovation effort has delivered major successes. Examples include aircraft emissions per passenger-kilometer which have fallen almost threefold in the past 30 years; the emergence of zero liquid discharge and zero water intake factories, thanks to recycled process water; waste-sorting robots using technologies based on neural networks to boost sorting quality and, therefore, recycling; sensors able to instantly detect leaks in drinking water networks in large cities that cover many thousands of kilometers of water pipes; systems that recover calories from wastewater to heat swimming pools or housing, and hydroponic and aeroponic agriculture.

But innovation, even green innovation, has its blind spots and is often ambivalent. For a long time the focus was on low-carbon solutions, overlooking other core issues such as biodiversity erosion, natural resource scarcity, soil exhaustion, and so on. Although there is evidence at the global level of a decoupling of the link between growth in CO₂ emissions and growth in GDP, the same cannot be said for the volumes of raw materials used.¹ All too often, innovation either simply transfers pollution to other sectors of the economy, or fails to allow for effects at scale. What environmental impact will electric vehicles have once there are one billion of them on the roads?

We must not use innovation's weaknesses, limits or biases as excuses to abandon our efforts. No innovation is ever mature at the outset. But innovation must change because the world has changed. We can no longer ignore secondary effects since, once an innovation becomes mainstream, those effects will be far from secondary. This is why "technological discernment",

to borrow a phrase from France's Academy of Technologies, is important in making sure that the right tech is promoted, rather than simply focusing on high tech or low tech.

So, what criteria have to be met to ensure that innovation is constructive and fully aligned with genuine ecological transformation? Innovation's positive impacts must not be wiped out by the rebound effect. It should not relocate pollution or postpone harmful consequences. It must be more than just partially beneficial in ecological terms. Innovation must deliver solutions that are acceptable and affordable for all, including low-income citizens. It must be rolled out at speed: faced with the climate crisis, we must stop taking decisions based on cost-efficiency when what counts now is speed-efficiency. And finally, we must ensure innovation combines technological, social and economic progress.

How can we foster innovations that meet these criteria? How can we make innovation "better"? Although by no means exhaustive, several interesting ideas are emerging:

- Systematically carrying out complete lifecycle analyses of new solutions, and accounting for future at-scale effects in the event of mass adoption;

- Leaving space for "creative disagreement", combined with a genuine right to fail. "Natural innovation is so dazzling because it has no fear of mistakes";²

- Successfully navigating innovation's critical phases, particularly the so-called valley of death, the period during the scaling-up process when subsidies fall, risks rise and investors begin to question a project's profitability;

- Creating the ecosystems needed to encourage innovations to flourish and spread (third places, innovation labs, clusters, etc.). Managing innovations also involves managing the ecosystems that generate and propagate them.

Using like-for-like technologies, we will never achieve carbon neutrality, we will never limit raw material scarcity, and we will never slow down the loss of biodiversity. Neither will we achieve these goals if we continue with the same structures and types of behaviors that are dominant today. Solutions that ramp up efficiency are not enough; we also have to change our behaviors and economic structures so they become more frugal. Ecological transformation demands new ideas, new technologies, new economic models, and new ways of behaving. But not only that: it also demands committed new leaders and new leadership to champion it.

Ecological transformation demands new ideas, new technologies, new economic models, new ways of behaving. But it also demands committed new leaders to champion it

¹ Pierre Veltz, *Bifurcations*, Éditions de l'aube, October 2022.

² Idriss Aberkane, *Le Point*, September 13, 2018.



1. WHAT IS INNOVATION FOR ECOLOGICAL TRANSFORMATION?



The nature of innovation is only one aspect of our understanding that should change in support of ecological transformation. We must also consider where innovation comes from, and what outcomes it supports for which people.

Ecological transformation requires us to consider many challenges and trade-offs at once. We are not facing one crisis but many. Among the environmental crises we face are climate change, resource use, pollution, biodiversity loss and many others; in each of these areas, we are close to or have already crossed critical planetary boundaries for a safe and liveable planet.¹

At the same time, social inequality, climate justice and a just transition must also be addressed; the same communities that have done the least to cause the environmental emergencies we face often stand to lose the most as a consequence of them.² In this context, innovation for the ecological transformation can, and must, mean many things.

This first section explores different models and definitions of innovation. It challenges us to think about why we innovate and how we innovate, inviting a more holistic and broader understanding of innovation. Grounding this conversation, **Armand Hatchuel** shares a history of the notion of innovation, tracking its evolution from early modernity through to current notions of “responsible innovation”.

Crucial to our progress is understanding the limitations of narrow conceptions of innovation. **Franck Aggeri** highlights the inherent challenges of techno-centric and short-termist approaches to innovation; highlighting the importance of approaches that make innovators more responsible for the long-term consequences of their projects, and that promote solutions that are more frugal, centering on transforming lifestyles and modes of production and consumption. In the same vein, **Jean Paul Raillard** shares how maintenance and renewal can be central pillars of new approaches to innovation, moving away from a focus on new inventions.

The nature of innovation is only one aspect of our understanding that should change in support of ecological transformation. We must also consider where innovation comes from, and what outcomes it supports for which people. Using the context of the Paris 2024 Summer Olympics, **Olivier Gilbert** shares examples of social innovation that enables grassroots communities to access jobs and other opportunities while meeting environmental goals and carbon budgets. **Professor Saradindu Bhaduri** highlights the power of wider understandings of innovation to include and empower communities that are not traditionally seen as part of innovation ecosystems, and shares reflections on the economic and legal reforms needed to unleash this potential.

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¹ Rockström, J., Gupta, J., Qin, D., Lade, S.J., Abrams, J.F., Andersen, L.S., Armstrong McKay, D.I., Bai, X., Bala, G., Bunn, S.E. and Ciobanu, D., 2023. Safe and just Earth system boundaries. *Nature*, pp.1-10.

² IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp.1-34.



THE METAMORPHOSES OF INNOVATION: systemic, intensive and responsible

Armand Hatchuel
Emeritus professor at MINES Paris-PSL



Armand Hatchuel is emeritus professor of management science and design theory at MINES Paris-PSL Université (CGS-I3). Working with Benoît Weil and Pascal Le Masson, he invented an innovative design theory, the C-K theory, which has had a significant scientific and industrial impact. His work with Blanche Segrestin, Kevin Levillain and the Collège des Bernardins inspired the creation of mission-led corporations in France (PACTE Law). He is a fellow of the Design Society and the European Academy of Management, and a member of France's Academy of Technologies.

This article offers insights into present-day challenges facing businesses by examining key stages in the metamorphosis of innovation. There are three clear phases: the pivot to modernity with the systemization of design (1860-1947); intensive innovation rooted in disruptive design and the formation of new ecosystems (1947-2010), and present-day responsible innovation (since 2010), which is rooted in new business models and the formulation of civilizational commitments. In each case, the focus is on sources of new knowledge, underlying principles, and the main actors involved. Furthermore, none of these phases can be a substitute for another. Each of them creates mechanisms that stay in place as the following phase emerges. The third phase, although it points to a new path, is founded on the two previous phases. Present-day businesses need to combine these different approaches if they are to meet stakeholder expectations.

INTRODUCTION

In 1918, Henri Fayol wrote: "Combining the efforts of academics and practitioners is not the easiest of tasks facing the business leader. There are countless obstacles to overcome: I cited them in my publication on General and Industrial Management; but at the same time I also proclaimed the indispensable necessity for industrialists to organize and make a success of the collaboration between science and the world of business. This notion so full of promise that is now in high regard has been close to my heart for many years, and I can affirm that, in this matter, my company has set an example"¹.

The author of these words, founder of the science of business administration, was entirely justified in flaunting his remarkable innovation policy. In 1896, his collaboration with Charles Edouard Guillaume (winner of the 1920 Nobel prize for physics) had resulted in the discovery of Invar steels that had extremely high dimensional stability. And the laboratory he entrusted in 1911 to Pierre Chevenard went on to become a leading name in precision metallurgy.²

¹ Henri Fayol, *Notice sur les travaux scientifiques de M. Henri Fayol* [Note on the Scientific Works of M. Henri Fayol]; Dunod, 1918.

² Pierre Chevenard, *L'installation et l'organisation d'un laboratoire sidérurgique* [Installation and organization of a steel-making laboratory], Mémoires de la société des ingénieurs civils de France, 1933.



Yet Henri Fayol never used the word “innovation”. In his famous treatise, he emphasized “improvement in every domain” as the first duty of an industrialist. His choice of words was far from insignificant, since during his century “progress in the arts and sciences” was considered to be the precondition for “human improvement.” These variations in vocabulary are instructive because they lead to a twofold observation:

- changes in innovation and innovation processes continue today;
- the knowledge, values and organizations involved in the design and implementation of innovations undergo constant metamorphosis themselves.

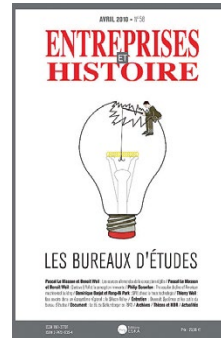
In this article we will look at the three main phases in the metamorphosis of innovation, because this evolution provides valuable insights into the methods and challenges of present-day innovation. We will consider three phases: the pivot to modernity (1860-1930); intensive innovation (1947-2008), and responsible innovation (today) which demands new civilizational commitments. In each case, we will focus on sources of new knowledge, underlying principles, and the main actors involved. Furthermore, none of these phases can be a substitute for another. Each of them creates mechanisms that stay in place as the following phase emerges. What we actually observe are processes rooted in complementarity and diversification: the third phase, although it points to a new path, evolves from the two previous phases.

PIVOT TO MODERNITY: THE SYSTEMIC DESIGN OF INNOVATION

It is an irony of history that current thinking about the start date of the Anthropocene – the era marked by human activity disrupting the planet’s ecology – points to the period (the early 19th century) when innovation became an activity that was systemic and organized. This systemization had a major effect, strengthening the close relationship between machine power and energy sources.

The exponential growth in the use of fossil fuels such as coal, oil, gas, etc. in the years from 1800 to 1930 was a direct consequence of this development. New industries systematically designed, again and again, new machines that simultaneously improved production of energy (steam, internal combustion, electricity, etc.) and production of the new goods and services (steel-making, metal-working, construction, chemical engineering) that used these energy sources. What was termed “industrial revolution” corresponds primarily to the amplifying impacts of these design and engineering activities.

The number one organizational innovation of the period was the creation of “design offices”, comprising groups of technicians and engineers capable of designing, building and testing machines, or assemblies of new machines (the new factories). As vital partners to design offices, the “testing and research laboratory” also came to the fore thanks to the need to develop



instruments able to validate materials, calculations and designs from the design office. Design offices and laboratories, whether third-party or in-house, mushroomed throughout the 19th and 20th centuries, and were responsible for innovations such as automobiles, airplanes, and gas, water and electricity networks (Cf. figure: special issue no. 58 of *Entreprises et Histoire*, 2010).

This pairing of design office and laboratory formed a unit that revolutionized and stimulated manufacturing’s two traditional main functions: upstream, the workshop or factory had to adapt and obey its instructions, while downstream, sales activities were tasked with supplying design offices with orders and information about their clients’ future needs. The modern company that crystallized in the period between the two world wars, and whose governance was theorized by Henri Fayol, was born of the process of systemic innovation that established itself at the interface of these three functions: commerce, design, and production.

The same period saw the development of public institutions devoted to scientific research, using equipment that benefited from business’ newfound design capabilities. These institutions made a great many discoveries and drove the internationalization of academic research. In a handful of cases (military activities, major infrastructure, medical projects), the design prowess of the private sector and the research strength of the public sector combined to give rise to previously unseen achievements. But fruitful collaboration between these two innovation regimes remained problematic and as early as 1918, as we have already mentioned, Henri Fayol described this question as the major challenge facing modern industry.

In the years following the Second World War, innovation was all too often thought to involve public research alone, whereas conceptual and technical revolutions originating in the business world were already appearing. These revolutions would have an impact across society as well as on academic research itself.

This systemization of innovation strengthened the close relationship between machine power and energy sources

INTENSIVE INNOVATION: DISRUPTIVE DESIGN AND NEW ECOSYSTEMS

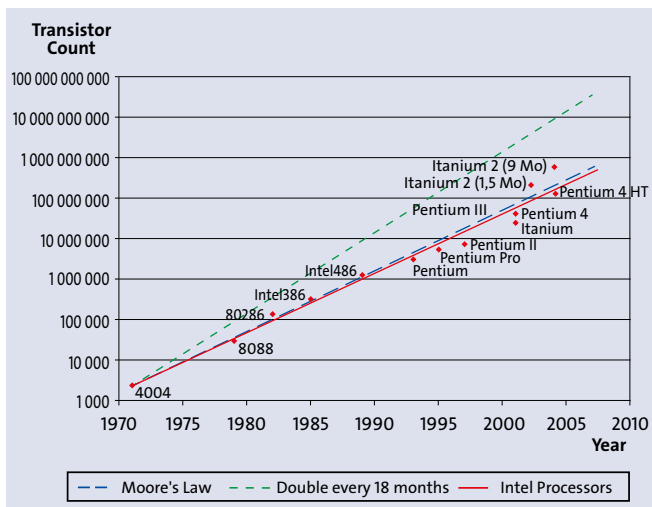
Between the wars, the telegraph, radio (also called the wireless), telephone, record player, photography and the cinema radically altered how news, advertising and culture were presented and consumed.

Then the new information processing machines that arrived in the wake of the 1947 discovery of the transistor paved the way for waves of successive disruptions that swept across every conventional technical system. The fact was that all social and societal practices, public and private alike, were revolutionized. The previous design system, centering on design office and



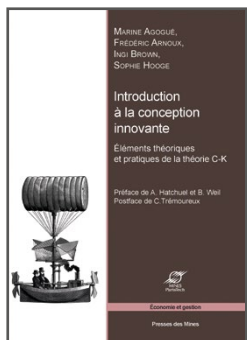
laboratory, could now be opened up to new sciences and new techniques. However, it nonetheless struggled to justify – via conventional financial analysis – and organize the exploration of an unknown multitude of new concepts for products and services, made conceivable by the new information-processing techniques.

This unknown territory led to the 1965 observation by former Intel head Gordon Moore of what would become known as Moore’s law, which posited a constant rate of microprocessor miniaturization (see fig.).



This was in fact simply a self-fulfilling prophecy concerning future innovation. However, it encouraged a number of projects and companies to collaborate to ensure their survival, ensuring that the prediction became a reality (laptop computers, cellphones, internet, social media, and so on).³ This orchestration of innovation led to products and ecosystems that had never previously existed! Innovation would henceforth become intensive. All actions in an individual or collective life could potentially lead to the creation of new tools or services connected to personal devices. This effervescence also triggered a tidal wave of startups, some of them going on to become giants of the internet.

This new intensive innovation regime revolutionized the foundations of culture, commerce, politics, and businesses



It was a quest that resulted in the uptake of new design-related approaches. Initially, these approaches were not sufficient to adapt design principles to the unknown, encourage scientific research that drew on more distant fields, and manage these diverse explorations coherently. A substantial research effort went into formulating a design theory (known as C-K theory) and design methods

suited to the continuous disruptive design of objects and business models and collaboration with the academic world (cf. image, M. Agogue et al. *Introduction à la conception innovante [Introduction to Innovative Design]*, Presses des Mines 2013).

By organizing guided innovative design workshops, these approaches helped to consolidate the creative capacity of design offices, testing laboratories, and marketing teams. What they did in particular was move away from the usual product and business models, helping to build new consortia for exploration and innovation partnerships with other businesses as well as universities and public bodies.

This new intensive innovation regime revolutionized the foundations of culture, commerce, politics, and businesses. It resulted in the emergence of a new world, with innovation incorporated into all regimes of existence and action. But it would be wrong to think it signaled the disappearance of the systemic design model. This model was called on more intensively and more stringently, but it also had to find its place among vaster and increasingly digitalized technical and social transformations. Connected cars still need high-quality tires, but the wheel now has new features and is a component of new control and monitoring mechanisms. For most objects and machines, intensive innovation means multiplying their modes of existence and interaction with the rest of the world. We could say that the spheres most dramatically affected are the arts and the workplace: the production of audiovisual works has undergone major changes in how they are accessed and experienced. And we are all now familiar with the opportunities and threats of working from home. Additionally, the digital world has provided artificial intelligence with fertile ground, allowing it to take root and spread.

The combination of systemic design and innovative design is pushing out the organizational boundaries of innovation. Businesses are turning to in-house startup mindsets, but a startup ecosystem can spread far beyond its initial parent company. France’s Dassault Systèmes, world leader in digital engineering and the 3D experience, began life as a Dassault Aviation startup, but is now also a front-runner in biological engineering and medical data.

RESPONSIBLE INNOVATION: THE NOTION OF CIVILIZATIONAL COMMITMENTS

At first glance, phenomena such as the recent awareness of the importance of ecological issues and the dangers of unregulated digital globalization seem likely to put a stop to innovation that ignores its negative impact on human life and the planet.⁴

³ Le Masson, P., Weil, B., Hatchuel, A., & Cogez, P. (2012). Why are they not locked in waiting games? Unlocking rules and the ecology of concepts in the semiconductor industry. *Technology Analysis & Strategic Management*, 24(6), 617-630.

⁴ Franck Aggeri, *L'innovation, mais pour quoi faire? [Innovation, for what purpose?]*, Seuil, 2023.



But it is a mistake to think that the resources constraints or social considerations curb innovation. Rather, they can act as powerful stimuli for innovation, with the proviso that design methods and ecosystems are suitable for these leaps into the unknown. In the Middle Ages, monasteries had to be built in isolated and hostile places which called for self-sufficiency. These obstacles fostered a series of innovations in construction, the use of water power and a variety of mechanisms, and farming and medicinal activities. To achieve their aims, monks looked for all potentially useful knowledge and expertise, including from the non-Christian world. Their inventions and libraries fed the “industrial revolution in the Middle Ages” and the Renaissance that followed.⁵

Innovation, on a significant scale, is vital in an era of frugality⁶, decarbonization, and the dangers of the climate emergency. What we call energy, environmental and ecological transitions do not point to *any known destination*. Even drastic frugality cannot justify a decline in healthcare, the abandonment of pets, or the absence of heating in winter. Our era therefore calls for a ramping up of both systemic design and innovative design.

- Ramped-up systemic design because the eco-design approach, applicable to most products, requires the revision of all supplies, procedures, packaging and distribution processes used until now. Many of these links in the chain will become less dangerous to communal life.
- Ramped-up disruptive design in several cases: the use of CO₂ as a raw material is an area that remains to be explored, while wind and solar energy production techniques must continue to develop. As for research into new materials that are recyclable and less energy-intensive, or new sustainable farming models, this already needs innovative, intensive, and eco-systemic design. The achievements of systemic design and innovative design are therefore a major benefit when it comes to tackling contemporary innovations.

The current phase differs significantly from the previous two. In the past, innovation was rarely a collective imperative. Society looked to talented researchers, risk-hungry businesses, and avant-garde consumers. However, these forms of stimulation are no longer enough to spontaneously guide innovation efforts toward ecologically sustainable solutions that offer no guarantee of profitability. The state therefore must multiply the indispensable frameworks – although ecological planning can only apply to known products and services and the state will not itself be able to lead the required innovations. Nor must we forget the essential pioneering work on climate justice.

We therefore need to innovate on a *civilizational* level, i.e. to redefine individual and collective commitments and

It is a mistake to think that the resources constraints or social considerations curb innovation. Rather, they can act as powerful stimuli for innovation

turn ecological imperatives into goals that are *as natural* as profit-seeking.

Signs of this shift are visible in the emergence of new company law, as illustrated by two recent pieces of French legislation: the 2017 duty of care law, and the 2019 PACTE law. In both cases, companies are now responsible for their social and environmental impacts in France and throughout their international supply chains. They can also make specific commitments by publishing a statement of purpose in their statutes, or adopting the official status of mission-led corporation.⁷



This transformation of corporate missions and governance requires a new type of eco-systemic innovation, since it involves formulating a company's many purposes in consultation with its constituent parties and stakeholders (cf. image K. Levillain, *Les entreprises à mission [Mission-Led Businesses]*, Vuibert Frege 2017. It also involves promoting approaches rooted in design-led management⁸ where exploring the unknown is accepted, encouraged and shared.

The switch to electric vehicles is an example of this type of transition. Long before the European commitment to halt ICE (Internal Combustion Engine) vehicles, Tesla and Renault began developing different innovative design strategies. But the transition to a complete electric mobility ecosystem that is both sustainable and accessible to the middle classes remains

a work in progress. In the agricultural world, one of the biggest cooperatives, InVivo, has chosen to become a mission-led corporation and become involved in designing new food industry systems. Mutual insurance companies like MAIF (a mission-led corporation) or banks such as Caisse d'épargne Normandie (a purpose-led corporation) have committed to making substantial changes to their

investment policies (decarbonization, territoriality, supporting the most vulnerable, etc.). Veolia (a purpose-led corporation) played a very active role in the PACTE law reform and has implemented an original management strategy that uses *multi-faceted performance*, focused on accounting for the interests of all its stakeholders in all its activities.

These are just the first steps in a system of innovation facing many unknown factors, but they prove that the current innovation phase is under construction, using the building blocks of the three design regimes: systemic, intensive, and civilizational.

⁵ Jean Gimpel, *La révolution industrielle au Moyen-Age [The Industrial Revolution of the Middle Ages]*, 2016 (reprint), Points histoire.

⁶ We have chosen to translate in this review the French word "sobriété" by frugality but could also be sufficiency, simplicity, efficiency...

⁷ <https://www.entreprisesamission.org/>

⁸ The notion of design-led management was propounded by Pascal Le Masson and Benoit Weil in a project presented at the ICED 2023 conference (Bordeaux, July 2023) as part of the design theory symposium.



ECOLOGICAL TRANSFORMATION: pathways to frugal and responsible innovation¹

Franck Aggeri
Professor at MINES Paris-PSL



An ice stupa is a type of artificial glacier designed to combat the water shortage caused by global warming in the Himalayas (Ladakh).

Franck Aggeri is a professor of management at MINES Paris-PSL and researcher at CGS-i3, UMR 9217. He is co-director of the *Mines Urbaines* chair on the circular economy and co-director of the Sciences of Decision, Organizations, Society and Exchange Doctoral School. His research interests and teaching focus on responsible innovations, the circular economy, CSR and ecological transition in businesses. Regarding innovations, he recently published *L'innovation, mais pour quoi faire? Essai sur un mythe économique, social et managérial [Innovation, but for what purpose? Essay on an economic, social and managerial myth]* (Le Seuil, March 2023). He also co-authored, with Helen Micheaux and Rémi Beulque, a short guide to the circular economy, *L'Économie Circulaire [The Circular Economy]*, published by Editions de la Découverte in March 2023. He is a columnist for the French magazine *Alternatives Économiques*.

¹ This article is inspired by a recently published book: *L'innovation, mais pour quoi faire? Essai sur un mythe économique, social et managérial [Innovation, but for what purpose? Essay on an economic, social and managerial myth]*, Franck Aggeri, Seuil 2023.

Innovate, constantly and at an ever-growing pace. This is the order given to individuals, businesses, and states alike. When it comes to ecological transition, this blind faith in innovation's benefits has a name: "green" technological innovations (electric cars, renewable energies, and so on). These innovations are presented as pre-conditions for green growth, a model that promises to create financial wealth free from negative environmental impacts. But this model is dangerous for three reasons: it fails to properly estimate pollution transfers between lifecycles; it fails to allow for the effects of scale and the systemic effects associated with mass adoption of these innovations, and it leads people to believe they can maintain their lifestyles and consumption habits because technology will solve the ecological crisis. The negative effects of these technological innovations are proven, so how can we innovate differently to avoid undesirable impacts and help create a society that is truly sustainable? This article explores two complementary approaches: making innovators more responsible for the long-term consequences of their projects, and promoting innovation projects that are more frugal, centering on transforming lifestyles and modes of production and consumption in ways that are compatible with planetary boundaries and the needs of future generations.

INTRODUCTION

Electric cars, positive energy buildings, renewables from wind turbines, and photovoltaic panels: in the collective imagination, environmental transition is generally thought to center on the adoption of a bouquet of so-called green technologies. This techno-optimism is echoed not only in the media but also by policymakers and businesses that present technological innovations as the solution to present-day environmental problems, the climate emergency in particular. This blind faith lies at the root of the green growth model that claims economic growth without environmental impacts is possible via the mass adoption of these innovations. But this vision of the future is problematic as it underestimates pollution transfers resulting from the widespread adoption of these high-tech innovations during their life cycles and because it overlooks the question of frugality, the changes in lifestyles needed to avoid overconsumption caused by the frantic race for innovations.

Does this mean pulling the plug on innovation? Such a choice would not be sensible, as it would result in upholding the status quo, i.e. the current economic model, which is incompatible with planetary boundaries. In that case, how can we innovate differently? After highlighting the blind spots of green high-tech innovation, this article explores two complementary approaches: making innovators more responsible for the long-term consequences of their projects, and promoting innovation projects that are more frugal, centering on transforming lifestyles and modes of production and consumption in ways compatible with planetary boundaries and the needs of future generations.



THE BLIND SPOTS OF GREEN HIGH-TECH INNOVATION

Why should we doubt the benefits of green technological innovations? To understand the cognitive bias we are prey to, we must first set out the criteria used to define whether an innovation is “green”. On release to market, an innovation has to successfully pass a process of technical standardization to ensure it complies with regulations and standardized environmental assessments. Standardization processes vary by product and sector. But the focus tends to be on certain types of emissions (atmospheric pollutants, CO₂ emissions, recyclability, etc.) while ignoring other aspects, such as material footprint (use of resources) and biodiversity. Furthermore, they rarely examine the complete lifecycle of a product or infrastructure, only looking at specific phases such as production, use and end-of-life. Lastly, assessments are systematically limited in scale to each individual technology, meaning they fail to examine scaling effects linked to the mass uptake of a particular innovation. The problem with standardization is not only to do with bias; it is also reliant on guidelines that are often badly out of date and unsuited to the challenges raised by modern-day innovations.

In the collective imagination, environmental transition is generally thought to center on the adoption of a bouquet of so-called green technologies

For instance, in the automotive world, electric vehicles are said to be “zero emission” because regulations focus on the phase when the vehicle is in use, which is where most pollution by internal combustion vehicles occurs. But this assessment does not include emissions linked to the extraction and transformation of materials, vehicle manufacture, or production of the electricity used to power it, which may be more or less decarbonized depending on each individual country’s energy mix. What are the blind spots of green technological innovation assessments?

POLLUTION TRANSFERS

The first assessment blind spot: pollution transfers. If we were to change the guidelines used so that in future we considered all emissions over the entire lifecycle, using lifecycle analysis (LCA) methods, the environmental balance sheet for these green technologies would look very different. This type of multi-criteria lifecycle assessment would then highlight pollution transfers between pollutants as well as between lifecycle phases. The production of so-called green technological innovations consumes more resources (raw materials, energy, water, land, etc.) than the conventional technologies being supplanted. For an equivalent power output, it takes far more concrete, steel and land to manufacture and erect wind turbines or solar power plants than a thermal power plant. Similarly, electric cars are considerably heavier than equivalent internal combustion vehicles as they have to carry a heavy battery, weighing at least 250 to 300 kilos. And the forms of pollution generated by these innovations differ from those of preceding generations of technologies. Although they emit zero CO₂ at the point of

use, they depend on a great many strategic metals, such as cobalt and lithium for vehicle batteries, rare-earth elements for wind turbine magnets, etc. Not only are the known reserves of these metals limited, but also, critically, they pose new geostrategic supply problems because their production is concentrated in a handful of at-risk countries such as Democratic Republic of Congo for cobalt and China for rare-earth elements. Technological innovation thus does not solve all the world’s ecological problems, it merely relocates them.

TEMPORAL AND SCALE EFFECTS

The second blind spot lies in scale effects. An incremental mindset when thinking about a product or infrastructure results in the scale and systemic effects being overlooked. In the early 20th century, the arrival of the first internal combustion vehicles was hailed by scientists of the day as a technology that would improve the quality and cleanliness of air in cities whose streets were strewn with strong-smelling horse manure that also kept streets very dirty. A hundred years later, we can measure how badly cities are being suffocated by pollutants from a global fleet of 1.4 billion vehicles. And while the arrival of the first electric vehicles was hailed as an innovation that would do away with these

atmospheric pollutants and cut CO₂ emissions, what will be the judgement of future generations when faced with the scarcity of rare-earth elements and the environmental and social consequences of their extraction? What will be their reaction if the global vehicle fleet continues to grow and wind and solar farms spread unstopably in all regions of the world, resulting in ever-growing land take and urban sprawl?

“All other things being equal” is no longer an acceptable attitude when confronted with the ecological crisis. Assessments of innovations must incorporate their temporal, scale and systemic effects as well as the irreversible nature of the social and environmental changes they may engender. The fact is that once they have been adopted, it is often very difficult to turn back the clock due to the considerable social and environmental costs of certain innovations.

THE FRUGALITY BLIND SPOT

Frugality is the third of the blind spots. According to the green growth myth, all these technological innovations will, taken together, allow people to maintain their lifestyles and indulge their endless thirst for the latest consumer goods. However, the green-growth myth fails to recognize that technological innovations have environmental impacts and that we must act on the demand side to reduce consumption of material goods. Ever since the pioneering work in the early 20th century by economist and sociologist Thorstein Veblen, we have known that conspicuous consumption is a social process driven by more than the requirement to meet essential needs. How can we move beyond this mindset of unfettered growth in consumption? This is the challenge





New technologies reach the countryside. Solar energy production on the roof of a home in Mungun Morit, Mongolia. Source: Dave Lawrence.

posed by frugality. Valérie Guillard defined it as an individual and collective attitude that seeks to moderate what is consumed.² In terms of individuals, she observed an uptick in public awareness of frugality.

Various studies all indicate that more and more consumers want to have their products repaired or to carry out repairs themselves, to buy pre-owned or reconditioned items, and to rent or share goods and equipment rather than buy a new product. Adoption of more frugal behaviors, she notes, requires changes to be made on three levels: personal norms (each individual's emotional and psychological reactions); social norms (social representations the individual has of themselves and the image that they seek to convey), and physical mechanisms (available public resources, such as bicycle routes and composting services that allow individuals to alter their behavior).

However, as long as managers in industry and manufacturing continue to be judged on the basis of unrealistic production and sales growth targets, there is little chance that frugal practices will develop spontaneously. For these to take root, proactive public policies are needed to spur fundamental changes in lifestyles and production practices by limiting advertising and all other techniques intended to artificially stimulate consumption. With the spate of recent crises (Covid, the invasion of Ukraine, repeated environmental crises), the idea of frugality as a way of avoiding shortages of energy or water is beginning to become more acceptable; frugality is now associated less systematically with degrowth. However, it remains a topic that is too often approached from an overly narrow perspective, relegated to simply a matter of energy frugality that can be summed up in a handful of "eco-gestures", such as turning down

the heating or investing in insulating buildings. But there is far more to frugality than this. It involves root-and-branch reviews of our lifestyles and production methods, seeking to systematically reduce unnecessary needs and the environmental impacts associated with our economic activities and shift our attitudes to time.

HOW CAN WE INNOVATE DIFFERENTLY?

Against this backdrop, how can we innovate differently? Two avenues can be explored: making innovators more responsible for the long-term consequences of their actions, a process we will call *responsible innovation*, and exploring *frugal innovations*, which are explicitly focused on changing lifestyles and consumption habits so they become more frugal.

PATHWAYS TO RESPONSIBLE INNOVATION

This first avenue of exploration is responsible innovation. The problem with the main environmental responsibility mechanisms used at present, whether judicial, financial or legal, is that most of them focus on retrospective responsibility. They are based on the problems of attribution, i.e. the search for a causal link between a type of pollution and actors that originally created the pollution, following the polluter pays principle. However, as we are reminded by philosopher Hans Jonas, the challenge underpinning the development of a technology is the implementation of future-facing projective responsibility.³ This involves anticipating possible negative medium- and long-term consequences associated with the introduction of new innovations, because the potential power associated with technologies has become so great that they may endanger the survival of the human race, if not the whole planet. Given this reality, a whole series of mechanisms must be updated or invented. Extended producer responsibility policies and processes could increase innovators' responsibility by focusing on targets for prevention, eco-design and extended product lifespans rather than on collecting and recycling waste, as is currently the case in most countries. Equally, we might imagine changes in accounting frameworks, the cognitive infrastructure of our economic activities, by adopting the idea of the triple bottom line, whereby economic organizations have debts to nature (natural capital) and employees (human capital) and must protect these in the same way as their financial capital. Governance of research and innovation is another avenue. This is where responsible and democratic innovations have a role to play: getting concerned parties (users, NGOs, public bodies, etc.) involved in discussions about the ultimate purpose of an innovation, its mechanisms, and the associated technological choices. The responsible innovation concept has gained traction in political, academic and economic circles. This is conceived as an approach that is anticipatory, reflective, inclusive and attentive to stakeholders' expectations (responsive in English), whose

² V. Guillard, *Du gaspillage à la sobriété. Avoir moins et vivre mieux? [From wastage to frugality. Living better with less?]*, Louvain-la-Neuve, De Boeck Supérieur, 2019.

³ H. Jonas, *Le principe responsabilité. Une éthique pour la civilisation technologique, [The Responsibility Principle. An Ethical Framework for a Technological Civilization]*, Paris, Champs essais (first published 1979).



missions are structured around the UN's sustainable development goals; an approach summarized by the acronym ARIR⁴. When considered from this angle, innovation is no longer synonymous with progress. It has to demonstrate its positive impact within a dialogical process that seeks to provide tangible proof rooted in assessment techniques such as LCA. However, these principles remain entirely voluntary; they must be rendered compulsory and subject to improved oversight to avoid the risks of greenwashing.

THE POTENTIAL OF FRUGAL INNOVATIONS

The second avenue of exploration involves looking at frugal innovation: innovations that are more able to produce wealth and create employment with a smaller environmental and material footprint. Frugal innovation centers on twin pillars: the eco-design of products and equipment to extend lifespans and increase use, and the development of service-based activities and new business models leveraging these sustainable products and equipment. Eco-design is critical because most current products and equipment are not designed to last, be repaired or recycled. They are primarily designed to be as cheap as possible to manufacture or install. Almost everywhere, it is the quest for the lowest cost that dominates, the ultimate expression of a short-term perspective that seeks immediate revenue with no thought to the medium- and long-term environmental and social impacts. Restoring durability to the heart of the design process could entail additional costs linked to the use of higher-quality materials and components. These extra costs could be absorbed by generating income streams linked to maintenance, repair, reconditioning, remanufacturing or recycling services. This does not necessarily imply that solutions will be more costly, it simply requires the adoption of simple principles: modularity, to facilitate the repair or replacement of defective components; the simplification of fixing systems and halting the use of unnecessary adhesive or solder; the selection of non-polluting and recyclable materials, and the adoption of robust technological systems that are not pointlessly sophisticated. This approach is not a rejection of high-tech. There is certainly a place for connected devices, provided they facilitate preventive and predictive maintenance and improve understanding of how product performance alters over time so that designs can then be improved.

Taking this strategy for built-in sustainability as the starting point, it then becomes possible to imagine strategies for new services. Such approaches are becoming more common, including among major corporations that are pivoting their business models to embrace a circular model. Michelin, for instance, has used this strategy for over 20 years in its relationship with business customers (fleet managers) on several continents, offering performance contracts

whereby it handles all aspects of tire maintenance, repair and retreading. Signify (formerly Philips Lighting) applies a similar approach to lighting, managing its clients' lighting energy use, quality and lightbulb recycling. In terms of repairs, retailer Fnac-Darty launched a subscription repair service for its products in 2019, leveraging its unrivalled aftersales service and repair network and its position as leader in the French market for electronic goods and household appliances. It also applies the reparability index introduced into French law in 2020 to five families of electrical and electronic products. The company hopes these services will account for a third of its turnover by 2025. It is also making efforts to guide consumer choice and supplier offerings by creating a ranking of the most sustainable products, based on a publicly available methodology. These examples show that other strategies for creating wealth exist that do not simply rely on the manufacture and sale of ever-greater quantities of new products. They are, however, very difficult and demanding to put in place because they require new skill sets such as repair specialization, maintenance, and financial and services engineering. Retraining may also be needed for people in roles associated with high-volume selling, adoption of new performance indicators, the establishment of new eco-design reflexes, and the restructuring of value chains and business models with the associated transformation of revenue and capital asset structures.

Technological innovation thus does not solve all the world's ecological problems, it merely relocates them

For the potential of frugal innovations such as these to be fulfilled in macro-economic terms, breaking the link between the production of wealth and the associated economic and social impacts, it is important to avoid rebound effects, meaning we need to move beyond the model of the consumer society. Buying a pre-owned or reconditioned product is only environmentally virtuous if the purchaser refrains from using the money saved to buy other items they have absolutely no need for. Limiting impulse buys is key to shifting to the more frugal lifestyles whose importance we have highlighted.

CONCLUSION

The transformation of production and consumption models will not happen spontaneously because both are deeply anchored in our cognitive and cultural frameworks. To change them first demands transformation of the cognitive infrastructure used to assess economic actors, such as national and international wealth indicators, business financial indicators, and production growth targets. Such a change will require support from policymakers at every level (local, national and supranational) and will need to make use of all available levers: education policies, systems to incentivize and inform consumers, tax regimes, and state investment. It is only under these conditions that this model of frugal and responsible innovation will have any chance of emerging.

⁴ J. Stilgoe, R. Owen and P. Macnaghten, *Developing a Framework for Responsible Innovation*; Research Policy, Vol. 42, no.9, 1565-1580, 2013.



IS TECHNOLOGICAL INNOVATION THE ONLY PATH TO THE FUTURE OF THE CIRCULAR ECONOMY?

Jean-Paul Raillard
Chairman of Fédération Envie



Jean-Paul Raillard taught economic management techniques before joining the Syndex consultancy in 1983, focusing on missions relating to social dialogue and serving as managing director from 2008 to 2014. Chair of the board of Envie 44 since February 2016, he was appointed chair of Fédération Envie in June 2019. He also chairs the supervisory boards of Envie Autonomie, a public interest cooperative, and Groupe Estille.

Fédération Envie is an umbrella group comprising 52 workforce reintegration businesses that employed 3,700 people in 2022, 2,800 of whom were on reintegration contracts. It is the first actor to cover the entire reuse chain, including logistics and the processing of electrical and electronic equipment waste and medical equipment waste. Envie has a threefold mission that is social (inclusiveness, reinsertion into the workforce for people struggling to find employment), environmental (development of repair and reuse), and economic (revitalizing local economic and industrial ecosystems).

The increasing scarcity of resources and the ever greater social and environmental cost of their extraction mean it has never been more vital for the circular economy to become the dominant economic model in our societies. Many solutions have arisen to meet this challenge, including eco-design for new products, extending the lifecycle of products already in the market, repairing products, and the functional economy. Technological, organizational, societal and social innovations are essential in each of these spheres.

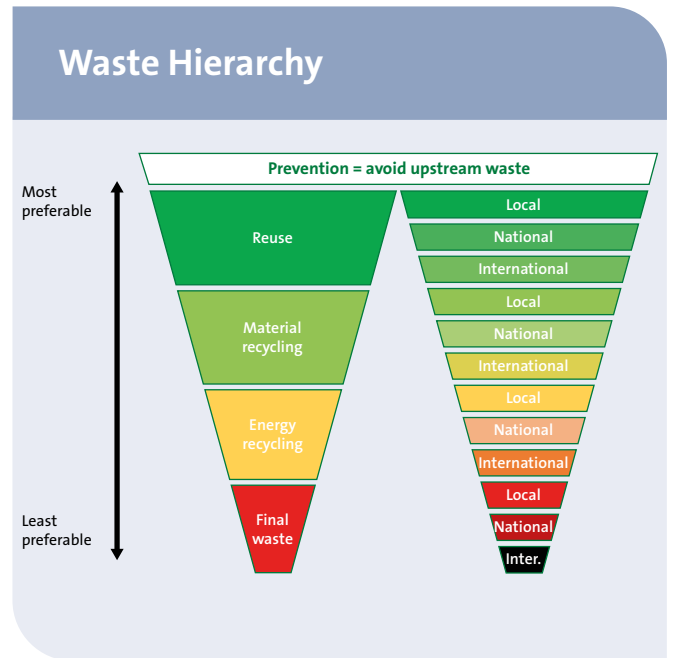
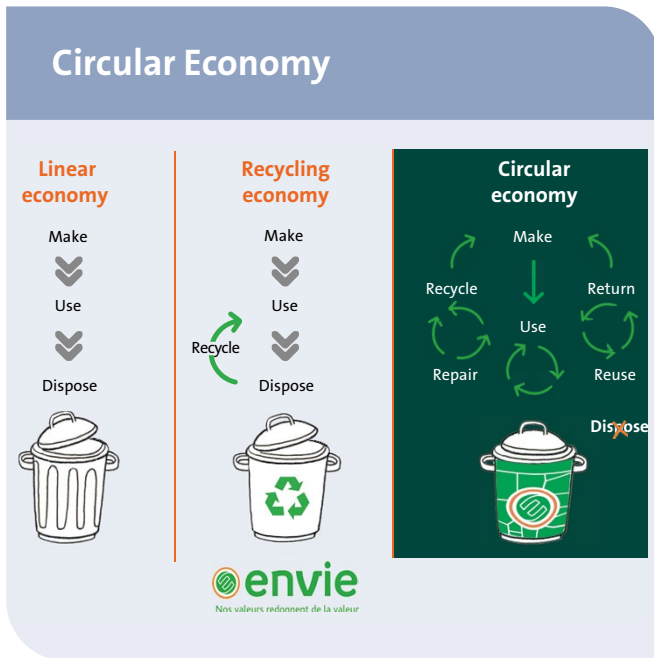
INTRODUCTION

The excellent recent book by Franck Aggeri¹ begins with these words: *“Innovation is the new modern religion. Everywhere we laud its virtues and its prophets who seek the construction of a better world.”* Against the background of the climate and environmental crisis facing humanity, countless politicians, academics and business leaders repeat the same message, leading to the belief that this is the only path to carbon neutrality by 2050. The watchword is that “only disruption brings success!”

Leaving aside the mantra-like aspects, the question is far from simple. On the one hand, innovation can only be judged through the prism of its results over the more or less long term and its impacts on ecological balances. On the other hand, it must be understood in a wider sense and not simply as something all too often centered only on technology.

¹ Franck Aggeri: *L'innovation, mais pour quoi faire?* [Innovation, for what purpose?], Seuil 2023.





INNOVATION AND THE CIRCULAR ECONOMY

The circular economy, the focus of the Envie networks actions, is one of the most promising avenues for combating reckless consumption of non-renewable natural resources. The linear economy is founded on per capita consumption growth. Its unlimited exploitation of resources not only often causes irreversible environmental damage but is also a source of waste, whose management poses on-going challenges.

The circular economy, according to the European parliament's definition is "a model of production and consumption, that involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible." The idea is to prevent the production of waste, or to reuse it to create new value.

In its most complete form, the circular economy promises "to break the link between economic growth and environmental impact, thanks to strategies to reduce impacts at source and the creation of material and energy loops."²

Infinite circularity does not exist in the waste management cycle, but the European Union's waste hierarchy (see above) makes it easy to identify the efficiency of the means employed.

Waste prevention is the number one solution to pursue. In the sectors where Envie operates, we focus on extending the working lives of electronic and electrical goods, centering initially on preventive maintenance, servicing and repairs. The next phase is reusing and preparations for

reuse, making it possible to return to service products that may or may not have been classified as waste.³ Dismantling waste appliances to recover spare parts falls within this category.

Recycling materials is a third method for extracting as much material as possible. The efficiency of recycling processes is an important area for innovation.

TECHNOLOGICAL INNOVATION IS VITAL, BUT ONLY PART OF THE SOLUTION

A simple example illustrates the complexity of the conditions facing technological innovations. Everybody knows about the problem of serious plastic pollution in rivers and oceans. According to a 2019 study by the International Union for Conservation of Nature, 35% of microplastics in water are released when washing synthetic fabrics. How can we tackle an issue that causes massive biodiversity destruction and whose impacts are felt in the food chain? A first step is to fit filters to washing-machine outlets. In the Envie network, we ran a trial in the town of La Rochelle that allowed us to demonstrate the efficiency of the two types of filter on the market, but also highlighted obstacles to their use: the cost of installing, emptying and cleaning the filters, while also avoiding tipping its contents down the sink!

2 F. Aggeri, R. Beulque, H. Micheaux, *L'économie circulaire [The Circular economy]*, La Découverte, 2023.

3 Reuse: any operation by which substances, materials, or products that are not waste are used for the same purpose for which they were conceived. Preparing for reuse: any operation to check, clean or repair for recovery, by which substances, materials or products that have become waste are prepared so that they can be reused without any further pre-processing.



Having these filters available to buy is a major technological innovation and they should be fitted to all new washing machines, but our study also showed that, above all, it is the type of fabric being washed that determines the amount of microplastics retained in the filter. Synthetic fabrics are the leading cause, but even clothing made from fabric with the very lowest ecological impact (linen and biosourced cotton) contains an increasing amount of synthetic fibers, elastane in particular, in response to consumer expectations (comfort, fashion, etc.).

It appears that this innovation – microplastic filters – offsets only the effects of excessive consumption of products that otherwise directly pollute the oceans. Is it not the case that true innovation would take the form of widespread actions to promote frugality and a responsible attitude to acquiring and discarding clothes? This is something that we encourage via the GreenFriday© movement that Envie started in 2017: consumption is not the goal, simply the means.

The response to every problem raised by the environmental crisis is not always rooted in technology, despite what others may claim. This means that embedding much-needed frugality into consumption habits could be thought of as an innovative mechanism, signaling a clear break with one of the tenets of our liberal economies. Similarly, returning to simpler, more robust and less energy-intensive designs for electrical and electronic equipment requires a mindset very different from the endless, and often highly illusory, race for ever more sophistication.

The circular economy [...] is one of the most promising avenues for combating reckless consumption of non-renewable natural resources

INNOVATING VIA PREVENTIVE MAINTENANCE, SERVICING AND REPAIRS

France's environment and energy management agency (ADEME) estimates that 50 to 70% of household appliance problems are caused by misuse, and that the instructions are read by only 46% of households polled.⁴

This is an area where we want to take things further than simply advice offering at the point of sale, or on the ADEME or envie.org websites. A washing machine or refrigerator, just like a heating boiler, is a complex device whose electronic components and mechanical parts are subject to wear in use. Why not offer a preventive maintenance contract to check that the device is operating correctly, while also offering advice on how to use, service and cleaning it with the aim of extending its working life?

A study allowed us to demonstrate that there is significant demand in towns and cities for regular (annual) visits by technicians who can inspect appliances and offer advice at a reasonable cost of a few dozen euros a year.

Social housing providers are also interested as these visits would improve users' practices, curb electricity use and reduce the risks of fire and water damage. These contracts would also enable us to create jobs to reintegrate people into the workforce. The overall benefits to society would be significant, although the figures have yet to be worked out (in terms of consequences for appliance lifetimes and validity of a business model for the project's partners).

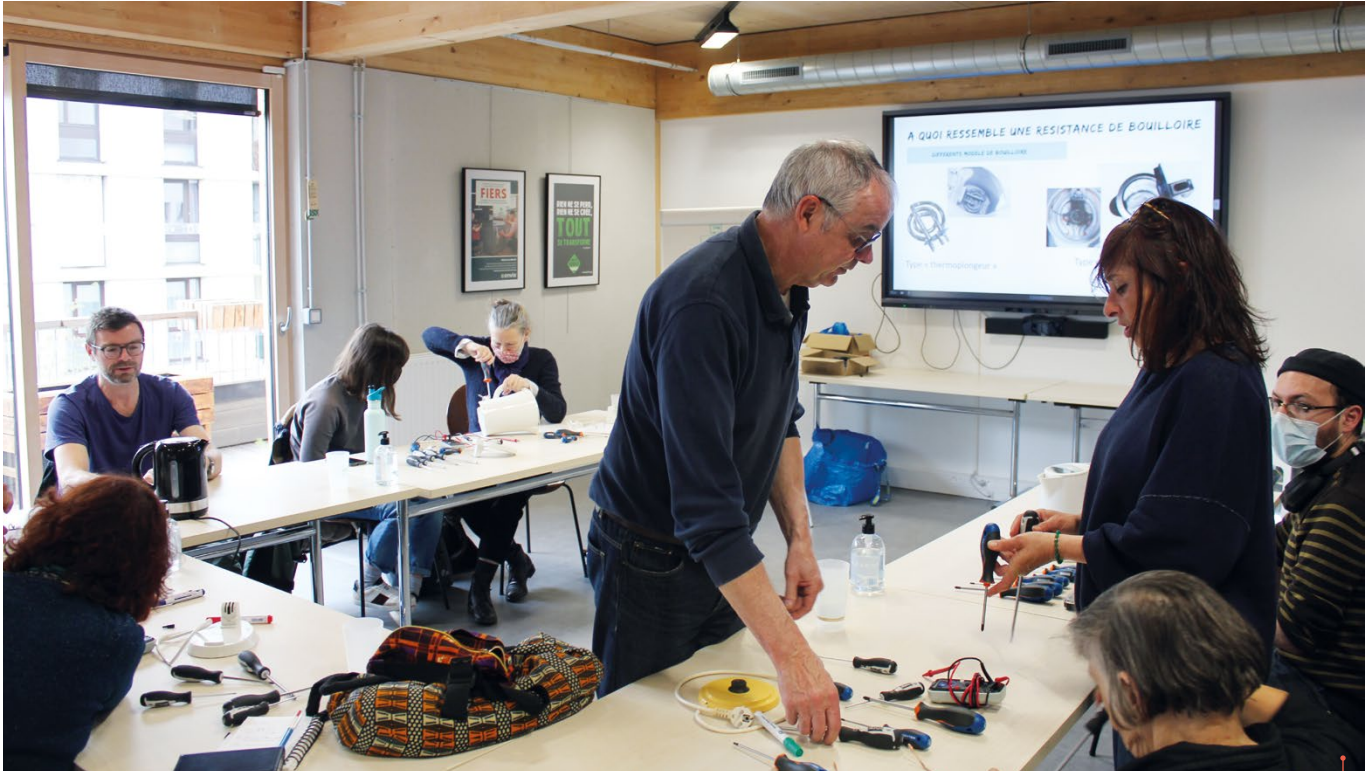
In terms of repairs, a major innovation following the 2020 french law on the circular economy and combating waste (AGEC) was the creation of Repair Funds. Managed by eco-bodies (Ecosystem and Ecologic for electrical and electronic waste), these funds are designed to incentivize consumers to repair rather than discard, and to establish a genuinely functional national repair ecosystem. The large majority of workshops operated by Envie are QualiRépar-certified, with certification in progress for the remainder, as this is needed for clients to take advantage of the repair bonus payment scheme.

Innovation, whether technological or not, can have very positive effects on device lifetimes and repair costs via a number of advances that herald a real step forward for the circular economy.

- Eco-designing products to make them more robust, easier to use, more reliable in use and with better physical access to parts requiring repair or replacement. Several projects exist currently, backed by innovative companies we are delighted to collaborate with by informing them of our observations, based on the 150,000 devices we renovate annually. For example, some refrigerator manufacturers restrict the physical capacities of components on power supply cards, leading to breakdowns that we see very regularly. This example calls to mind the issue of planned obsolescence, banned in France since 2015, which seeks to limit either the cost or lifetime of devices and appliances. The creation of a "reparability index" in 2021, with a "durability index" to follow in 2025 for certain classes of devices, is one the AGECE law's major innovations.
- Giving as many people as possible access to repair services is a major innovation in recent years thanks to the opening of countless repair cafés, as well as online tutorials and repair training sessions held at third places. At Envie Le Labo in eastern Paris, we hold monthly sessions to teach local people the basics to enable them to carry out simple repairs themselves, at no cost.
- Ensuring access to affordable new and second-hand spare parts will also be a major step forward in terms of extending appliance lifetimes. Envie launched a vast project in cooperation with AGORA that culminated in 2022, offering all professionals B2B access to our marketplace of over 100,000 items. This involved significant expenditure by our network in terms of storage space and creating jobs in testing, listing, storing and distribution. But the most productive innovation

⁴ <https://longuevieauxobjets.gouv.fr/comprendre-la-demarche>





Envie Le Labo.

would be if all professionals, and that includes us, always prioritized acquiring guaranteed used parts rather than new ones. We plan to launch a B2C marketplace for used parts soon.

SOURCES OF INNOVATION IN PREPARING USED EQUIPMENT FOR REUSE

Preparation for reuse is a very different type of operation than repair or reuse. It means taking a waste product and turning it into something that can be used again, backed by the two-year guarantee we offer across the Envie network. For a household appliance, this involves dismantling it completely to identify any faults and assess overall condition, a complete clean and then the replacement of all worn or defective mechanical, electronic or external parts, followed by a final quality inspection. This all takes around six hours to complete when conducted by an employee on a reintegration contract working under the supervision of a team leader who is an experienced professional.

It is not easy to find a business model that makes it possible to then sell this appliance at a price that is affordable to low-income households (no more than 50% of the price of the new product); this requires constant work to improve productivity and quality.

To help us achieve this, in 2020 we launched a project known as RR 3.0, which aims to introduce excellence

into every stage of our preparation for reuse operations. Run by an experienced engineer and a full-time workshop leader at a laboratory in Roanne, we are trialing processes for sorting collected products, organizing successive tasks, saving water and energy and inspecting products that are then distributed across our entire network. Our workshop processes are regularly updated to align with instructions from the project steering committee.



Envie workshop, Maine.





Panel workshop, Saint Loubès.

with recycling industry actors (Derichebourg, Suez, Veolia, etc.) and eco-bodies.

In a European first, we worked in cooperation with SOREN, the eco-body responsible for managing waste photovoltaic panels, and a Japanese manufacturer to install a line for reusing and processing photovoltaic panels at our site in Saint-Loubès, in western France in the fall of 2022. This initiative was supported by the government, ADEME and local authorities in the Nouvelle Aquitaine region.

This is a major innovation because the first line allows us to test the panels' reuse potential by testing every individual cell in each panel. This allows us to refurbish some of the panels, which are then re-sold with a power output rating of around 90% of their power output when new.

Panels judged unfit for reuse pass to a second line where a new technology is used to delaminate them, separating the glass panel from metallic components including silica, copper and silver.

Instead of crushing as would previously happen, this technique means rare-earth elements can be recovered efficiently for subsequent reuse in the manufacture of new panels in France or Europe. This is a critical challenge for the development of renewable energies in Europe. The Envie network's unit in Saint-Loubès leads the way as it is home to the only technology in Europe able to recycle silver, a critical metal that is essential to the energy transition.

With the inauguration of this first installation, the social and solidarity economy is showing it can compete with recycling industry heavyweights, forming a circular economy loop with impeccable environmental credentials.

Innovation can sometimes appear conventional, but if we apply the latest industrial standards in our workshops we must also, at the same time, think about how to improve conditions for upskilling our workforce, given that we only have a 12- to 14-month window, the average length of a reintegration contract in the Envie network (maximum two years). This means every investment decision is weighed in terms of this criterion, which is absolutely essential for us.

Is it not the case that a true innovation would take the form of widespread actions to promote frugality and a responsible attitude to acquiring and discarding [...]?

TECHNOLOGICAL INNOVATION AND RECYCLING PHOTOVOLTAIC PANELS

We are present across the entire value chain for electrical and electronic equipment waste, as well as dealing with the sorting and final treatment of certain types of waste: chiller units, small electrical appliances, televisions, etc. Our installations are often established in very close cooperation

SOCIAL INNOVATION HAS AN ESSENTIAL PLACE

As we have seen, the concept of innovation is generally associated with technological advances. But we have also stressed that searching for the best way to upskill employees on reintegration contracts, so that they can transition into long-term employment, also demands innovations in training approaches that create the same amount of value by investing in people. In 2023, we continued to explore this avenue with the creation of the Envie

college, which exists to train people to repair and recondition household appliances. This is our hands-on contribution to re-establishing a complete industry for repairing and reusing appliances, bearing in mind that there is currently a shortage of several thousand of these technicians.

A further example highlights the importance of innovation in terms of working conditions. In October 2022 we





Small electrical appliance processing line, Portet sur Garonne.

inaugurated Envie's new sorting and recycling unit for small electrical appliances in Portet-sur-Garonne, south-west France, designed and installed in partnership with Derichebourg Environnement.

As well as doubling the recycling capacity and benefiting from the latest sorting technologies for recovering waste and improving safety, particularly fire risks, another standout feature of this new industrial line is that it offers working conditions that are much better than at other recycling centers in Europe. The 50 or so employees work from booths that are insulated from the remainder of the line, providing them with ambient air of sufficient quality to make masks unnecessary. This is another European first.

50 to 70% of household appliance problems are caused by misuse

CONCLUSION

Innovation, be it technological, organizational, societal or social, is essential to making the circular economy the dominant model, and to avoid deviating from the pathways to carbon neutrality and biodiversity protection by 2050.

But all investments in innovation have to be judged in terms of their long-term effects, environmental and social externalities that absolutely must be planned for. The circular economy has the capacity to become a major source of value creation and job creation in the future,

providing that the innovations that allow us to proceed along this path are assessed and rolled out with these criteria in mind.

The experience gained in the Envie network over the past 40 years in reintegration into the workforce via repairing, reusing and recycling contributes to the creation of a new, greener economic model. We have never stopped innovating and proving that, leaving aside the rightful place of technology itself, the true challenge lies in investing in *“potential innovations that are more frugal, centering on transforming lifestyles and modes of production and consumption in ways that are compatible with planetary boundaries and the needs of future generations.”*⁵

Envie is determined to continue innovating in its field, seeking to forge lasting partnerships with players that share our goals for a world that is more sustainable, fairer and more caring. This is what it means to be an entrepreneur in the social and solidarity economy. We have a duty to be ambitious, for the good of our employees and for the planet as a whole!

⁵ F. Aggeri, *L'innovation, mais pour quoi faire? [Innovation, for what purpose?]*, op. cit.



THE OLYMPIC GAMES: SOCIAL AND ENVIRONMENTAL INNOVATION

Olivier Gilbert

Employment developer for the Paris 2024 Olympics and Paralympics



Olivier Gilbert has dedicated a large part of his career to promoting environmental and social innovations. At the Setude engineering consultancy, during a period in France when Brice Lalonde, the newly appointed minister for the environment, chose to highlight the importance of nature preservation, he helped local authorities set up their own environmental charters. After moving to Veolia, the world leader in environmental services, he took on a variety of roles, each with a major focus on environmental and social innovation: head of the sanitation division in Hauts de Seine; head of sanitation in Tangier and Tétouan, including running programs to ensure access to water for disadvantaged people; head of sustainable development for Veolia Water in Africa, Middle East and India; and, finally head of social innovation at Veolia. In 2014, he set up his own consultancy, *Réponse Sociétale*, specializing in societal innovation and inclusiveness. From 2018 to 2020, he was executive director of the Euro-African Sustainable Campus. In 2020, he joined the Labor Ministry as Employment Developer for the Paris 2024 Olympics and Paralympics, working across the Ile-de-France region from a base at the Seine-Saint-Denis prefecture.

In 2020, his track record as a social innovator led to Olivier Gilbert's appointment as Employment Developer for the Olympics and Paralympics, to be held in Paris from July to September 2024. Working mainly in the Seine-Saint-Denis department, near Paris, he identifies, coordinates and drives the rollout of various actions designed to deliver on commitments made by the French government to create and support local jobs during preparations for the Games. The government is determined that the Games will be green, inclusive and socially positive. A great many of the events will take place in Seine-Saint-Denis, a part of France scarred by poverty and high unemployment rates. This is an area where job creation is a priority, but it cannot happen in traditional ways: innovation is needed. The scale of the mobilization required to prepare for the Olympic Games, and the very tight deadlines they impose, make it possible to overcome some of the barriers that often hamper or block social and environmental innovation.

Can you tell us about your mission?

Olivier Gilbert: My mission involves tracking and coordinating commitments made in terms of job creation, integration into the workforce and training for people in areas affected by construction and events for the 2024 Paris Olympics and Paralympic Games, especially in disadvantaged neighborhoods. These commitments formed part of the bid the Paris 2024 organizers presented to the International Olympic Committee.

Most of the sports competitions will be held in Seine-Saint-Denis. Although only a few new facilities have to be built from scratch, such as the Olympic Aquatic Centre in the Plaine Saulnier development zone, many other training facilities that athletes will use during the games – that will then be handed over to local council ownership – require overhaul or modernization. Seine-Saint-Denis is also where the athletes' village and media village are currently under construction. Spread across three separate municipalities – Saint-Denis, Saint-Ouen-Sur-Seine and Île-Saint-Denis – the athletes' village will host 14,500 athletes and trainers during the Olympics, and 9,000 athletes and their assistants during the Paralympics. The media village, in the municipality of Dugny and next to the Paris-Le Bourget exhibition center, will be home to around 1,300 journalists and technicians communicating with the entire world.



The French government hopes that these games will generate major positive social benefits, particularly in terms of employment, and particularly for this part of France, which faces so many challenges. Creating employment, especially for people excluded from the labor market, is a major goal for authorities in Seine-Saint-Denis, for nonprofits working on integration into the workforce, and for local businesses, all of them faced with difficult social realities that nonetheless offer great potential. In 2019, the Seine-Saint-Denis prefect, in consultation with Jean Castex, then the interministerial delegate for the Paris 2024 Olympics and Paralympic Games, and with the agreement of then prime minister Edouard Philippe, decided they needed somebody experienced to work on this full-time. The individual in this role would help generate new ideas and approaches and coordinate initiatives proposed by a vast cohort of organizations to make sure that these initiatives were mutually beneficial and would generate as many jobs as possible. The bodies involved include central and local government, the state employment service (Pôle Emploi), regional government agencies (four in Seine-Saint-Denis), municipalities, nonprofits, local businesses and employers, all working closely with other departments in the Île-de-France region and with the region itself. The COVID pandemic and national lockdown meant my work effectively only started in September 2020.

Innovation is needed to make sure that you have the right mix of actors each time. Innovation is needed in working methods, in leadership, in experiments, in support

In what way did your career prepare you for this unusual mission?

O.G.: The authorities felt that innovation was the primary challenge if the French government's commitment was to be met. This is why my mission is as much about innovation as it is about coordination. At the time, I think that the pragmatic and original approaches Veolia developed in Seine-Saint-Denis to maintain access to essential services for the most vulnerable, as well as in Morocco in the outer suburbs of Rabat, in Tanger and Tétouan all played a part in the decision to appoint me rather than another candidate.

Among the qualities sought for this position were knowledge of local government, businesses and nonprofits, as well as agility and the ability to create and lead partnerships between public and private actors to create social added value, something that requires collective innovation. My experience gained in public-private-nonprofit partnerships to promote access to essential services in suburban France, Morocco, India and Niger, during my 12 years at Veolia, a group with a reputation for innovation, was very useful.

What innovations were adopted when preparing for the Olympic Games?

O.G.: This global event is a powerful catalyst for creativity. This means that all public services, national and local, as well as private actors have the opportunity, indeed the duty, to use the games to innovate. The most important innovation centers

on partnership. "Partnership, first, last and always," is how I describe it. It may sound simple, but it is anything but. Creating effective partnerships within very tight timeframes is far from simple, especially for something as important as the Olympic Games. The various actors each have their own agendas, and they may know each other but have possibly never worked together on a project. Innovation is needed to make sure that you have the right mix of actors each time. It is needed in working methods, in leadership, in experimentation, in support.

A Committee for Employment and Integration into the Workforce was set up, thanks to the prefect for Seine-Saint-Denis and the prefect for equal opportunities, now director of the National Urban Renewal Agency. The committee meets every three months and brings together all the public, private and nonprofit actors involved. It has created a strong dynamic that is extremely constructive. Everybody has ideas, but having a committee co-chaired by the prefecture and the departmental council allows everybody to talk to each other, to share ideas and create convergences between the different projects, picking the best solutions and designing action plans.

The second innovation focused on the concept of doing things together, jointly setting up and managing an action plan called the "emploi JOP de Seine-Saint-Denis" and processes for accessing training and employment through integration into the workforce and traditional channels.

These processes are faster and simpler, making them more efficient. They bring together people from different institutions, each also working in all topics and processes, no matter their specific job title or department. This organizational innovation has already been adopted in other locations and will certainly be part of the games' local legacy.

Let me give you a concrete example. We reached out to civil engineering companies to tell them about an organization we set up to help them recruit workers for Olympic preparations. This organization, "Emploi JOP 93", includes the prefecture, Pôle Emploi, the regional and interdepartmental office for the economy, employment, work and solidarity, local authorities, local integration taskforces, and neighborhood associations. The companies quickly understood that the state had set up a targeted structure specifically to meet their massive labor needs. In practical terms, for every work site we have a two-person team: a manager from Pôle Emploi, and a facilitator from the local authority who specializes in integration into the workforce, and whose role is to help companies integrate people in ways that make sense in terms of where they are based. Pôle Emploi agreed that cases would always be handled by the office nearest to the work site: an innovation that has proven highly efficient. When the Pôle Emploi manager has a suitable candidate, they collaborate with the work site facilitator for integration into the workforce. This two-person team is the sole point of contact for every company working on a site until 2024, the lead contractor and all sub-contractors, including all security and catering contractors. They will monitor work sites during preparations for the games, up to 2024 and in some cases into 2025, when some of the installations will have to be re-adapted.



Jobs created by Paris 2024 initially concern the preparations: mostly work to rehabilitate or construct installations, a task managed by Solideo, a company set up by the state to deliver Olympic facilities. Next are jobs involving management of the Olympic Games for which the Olympic and Paralympic Organizing Committee (COJOP) is responsible: these are service sector jobs in security, catering, hotels, cleaning and waste management, logistics and transportation. Figures are a very instructive way to describe the scale of services needed: the Olympic Games will be attended by 15,000 athletes from 200 countries and 20,000 accredited journalists, creating 150,000 jobs supported by 45,000 volunteers. During the games, a total of 13 million meals will be needed by athletes, helpers, spectators, etc., including 60,000 meals daily in the Olympic village. Over 13 million tickets will be sold. 100,000 hours of TV coverage will be produced, and the games will be watched by 3 to 4 billion people worldwide.

Since 2020 in Seine-Saint-Denis, thanks to Emploi JOP 93, every time a company with a Solideo or COJOP contract wants to recruit, they generally start by hiring locally in priority districts. But in the aftermath of the COVID lockdowns, certain skills are in such high demand that the search for candidates has widened to adjacent departments, the entire Ile-de-France region and, ultimately, the entire country. Security jobs are in high demand, as the games require 22,000 hires in Ile-de-France; catering, hotels, logistics and most other service industry roles are also in very high demand.

This environmentally led approach changed [employees'] working methods, but it also changed how they viewed their work and the dignity it offers. They took ownership of these new working procedures, improving their sense of the value of their work

used where possible in Olympic village buildings, lowering overall greenhouse gas emissions. The environmental quality of everything built is outstanding in every respect: energy management, waste recycling, carbon neutrality, economizing scarce resources, etc. In terms of catering, the goal is to halve the carbon footprint of a meal compared to the French average. Finally, there is a proposal to use certified offset projects, in France and internationally, to compensate for the million and a half metric tons of carbon that will be emitted.

There are further innovations that help make these the greenest games ever. The media village will be a hyper-modern garden city linking directly to Parc Georges Valbon, the third-largest park in the Île-de-France region. The athletes' village will become an eco-district once the games are over. Another innovation is that swimming once again possible in the Seine River after a 100-year ban! The prefecture first banned swimming in the river all the way back in 1923. The state, the Seine-Normandie water agency and various local authorities have invested €1.5 billion to restore water quality in the Seine to a level compatible with swimming.

This project involved analyzing wastewater and storm water connections at thousands of private houses, apartment blocks and industrial sites, then carrying out remedial work. It also entailed upgrading treatment systems at sewage plants to make them able to absorb and decontaminate rainwater runoff during storms and periods of heavy rain. This also meant hiring and training staff to carry out diagnoses and remedial works: just one illustration of how social and environmental concerns converge.

Pôle Emploi's facilitators for workforce integration, and other staff involved in Emploi JOP 93, needed to come up with responses to the very stringent environmental quality demands of Olympic work sites. They quickly gained considerable new expertise in environmental topics, arranging training sessions and working with nonprofits specializing in integration into the workforce through environmental services. Many specialist environmental consultancies were also involved. Thanks to the games, environmental considerations now play a larger role in job seeking and workplace integration.

What about environmental innovations?

O.G.: The Paris 2024 Games will be environmentally responsible games. This means that, in addition to social innovation, environmental innovation is also very important and is something the two Olympic leads, Solideo and the COJOP, are both determined to deliver. These aspects are also monitored very closely by the interministerial delegate for the Paris 2024 Olympics and Paralympic Games, who reports on them to the very highest levels of government. These games will be the first ever to respect the Paris Climate Agreement, signed here in Seine-Saint-Denis in 2015 during COP 21. The organizers' goal is to ensure that the Paris Olympics and Paralympics emit half the average greenhouse gas emissions of the 2012 Games in London and the 2016 Games in Rio. This equates to a carbon footprint of 1.6 million metric tons of CO₂ equivalent. Around a third of emissions will be generated by transporting athletes and spectators, construction accounts for another third, with the final third coming from energy production, catering, accommodation, digital services, etc.

Meeting this ambitious goal requires innovation. Construction phase emissions are limited because 95% of infrastructure needed for these games is temporary or already exists. High environmental quality is a feature of every new building and facility: choices of construction methods and materials deliver a 30% cut in carbon emissions. Wood is

What are your main takeaways for ramping up development of social and environmental innovation?

O.G.: First, and by far the most important, is leveraging major events to overcome barriers to innovation. One of the standout features of the Paris 2024 Games is the incredible spotlight it shines on the region where the games will be held. This is what made it possible to create a dynamic capable of experimenting, inventing and creating. Innovation generally needs lots of time, but the Olympic effect allowed us to try things that had never been done before, at least by many of the local actors, and to do them at speed. In terms of employment and integration into the workforce, every actor involved in Seine-Saint-Denis





Emmanuel Macron, President, and Elisabeth Borne, Prime Minister, visiting work sites for the 2024 Olympic Games - Seine St Denis (oct 2021).

recognizes the state's contribution in its role as coordinator for preparations for the Olympic Games. The Olympic effect raises the bar for actions taken by local authorities, public services, nonprofits and businesses, encouraging them to explore new avenues and invent new ways to deliver high social and environmental quality. In other words, the games gave us an actionable and genuinely effective right to innovate and experiment. This was decisive when it came to promoting the question of employment and the games, allowing us to operate collegially and to meet tight deadlines that became even tighter after COVID and lockdowns.

The second major takeaway is not to be frightened of cross-cutting working methods, of bringing together as many actors as possible and combining expertise from different areas: technical, legal, economic, communications, etc. To innovate is, first and foremost, to design and nurture partnerships, working with each other in third places that act as incubators, endlessly listening, talking and communicating. If preparations for these Olympics seem to have succeeded, it is because they were piloted collaboratively between different services, institutions and sectors (public, private and nonprofit). The innovations delivered are simultaneously social, technological, contractual, organizational, etc. In places like Seine-Saint-Denis, where large sections of the community are disadvantaged, you should not hesitate to look for help from sociologists to make it easier to reach out to local people, to understand them and improve how you work with them. It is also important to work closely with local politicians and grassroots actors, whether they are sports people, nonprofits, educators, etc., because concrete results can only be confirmed at the grassroots level.

Another takeaway is to design your project from a circular economy standpoint from the outset. These games were designed to be frugal, maximizing the use of existing installations, which had to be extensively renovated instead of built from scratch.

Lastly, and this is no surprise, it is vital to have powerful political backing, capable of organizing the collegial approach and making sure government administrations are on board and offering active support to the project, changing working methods, and shaking up actors so they step out of their comfort zones, silos and routines, and possessing the authority to settle any differences. You need a vision that is ambitious, attractive, and collective, and the rigor needed to make working in partnerships efficient.

What does ecological transformation mean to you?

O.G.: Ecological transformation is also social transformation. It restores prestige to specialties that are sometimes undervalued, such as collecting and sorting waste, and which are essential to decarbonization, saving scarce resources, protecting the natural world, etc.

Whilst preparing for the Olympic Games, workers employed on tasks associated with rehabilitating certain existing facilities in Seine-Saint-Denis received training in how to dismantle door and window units, glazing, plumbing, etc., so that these could be reused or recycled. This environmentally-led approach changed their working methods, but it also changed how they viewed their work and the dignity it offers. They took ownership of these new working procedures, improving their sense of the value of their work. This was particularly true at a work site where a former Ibis hotel was dismantled with assistance from a nonprofit called Réavie, which works on integration into the workforce and trains people in specialties relating to reusing, repurposing and recycling. These are all noble specialties whose ecological and societal benefits should be celebrated. The Paris Olympics and Paralympics are helping to demonstrate the benefits and added value that these jobs deliver.



FRUGAL INNOVATION FOR ECOLOGICAL TRANSFORMATION - A WAY FORWARD?

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Tilonia, Rajasthan, India, 6 September 2011: Women constructing solar cookers at the workshop of Barefoot College in Tilonia, Rajasthan, India.

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Frugal innovation is increasingly promoted as a solution to meet the needs of a growing human population while remaining within planetary boundaries. This article presents a nuanced understanding of what frugal innovation is and is not; highlighting that a wider understanding of frugality has the potential to promote the resilience, dignity and economic prosperity of people and communities that are not traditionally seen as part of innovation ecosystems. It highlights the necessity of overhauling the existing social and economic spaces of innovation, production, and consumption to envisage a just, inclusive way forward towards an effective ecological transformation.

INTRODUCTION

A successful ecological transformation holds the key for a sustained wellbeing of the planet we are living in. One of the most challenging tasks of the ecological transformation will be to balance the ever-increasing need of a growing population with the limited absorptive capacity of the Earth.

Frugal innovation, which can broadly be understood as a form of or approach to innovation that does more with less is one solution to this challenge. However, this definition of frugal innovation is overly simple, hiding both opportunities and challenges. Understanding not only the outcomes of frugal innovation and the principles and processes that underpin it unveils a more nuanced understanding of the ways that it can contribute to successful ecological transformation.



THE RISKS OF A NARROW UNDERSTANDING OF FRUGALITY

Frugal innovation emerged as a prominent topic in many businesses during the global recession of the 2008-09. In a time of economic downturn, large corporations sought to extend their reach by producing goods that were affordable and accessible in resource poor settings.

This called for a reorganisation of existing production, innovation, and distribution mechanisms of corporations, to make products which would be substantially less expensive and simpler, while retaining their core functionalities¹. For example, in 2009, Tata Motors, an Indian multinational automotive manufacturing company, introduced the Tata Nano, a compact, low-cost vehicle specifically designed for the Indian market. With a price tag of only \$2,000, it was branded as the world's cheapest car, providing an affordable transportation solution for millions of families. The cost reduction was achieved by minimizing the size and weight of the car, using lighter and less expensive materials, and new manufacturing processes.

Frugal innovation needn't apply only to the replication of existing products in less expensive ways, but to new invention with practicality and effectiveness as core principles

However this definition and example of simply doing the same with less misses much of the potential of frugal innovation. Increasingly, such definitions have received pushback from developmental scholars in particular. As businesses increasingly now look to frugal innovation as a means to accelerate ecological transformation, a broader and more nuanced definition is needed.

Without altering the core of the existing production, innovation, and distribution we would achieve very little in environmental sustainability terms. Consider a clothing manufacturer that adopts a cheaper, faster chemical dyeing process as a frugal innovation; while this increases profitability and product accessibility, it could inadvertently exacerbate water pollution and textile waste, thereby escalating environmental harm.

What's more, frugal innovation activities, while ostensibly providing more affordable solutions, can, allegedly, cannibalise "informal", social spaces of innovation, production, and distribution, by usurping localised mechanisms of innovation and production². This can have a negative effect on the diversity of organisational spaces and associated knowledge and practice of communities, harming the cause of social sustainability and livelihoods.

A NUANCED DEFINITION OF FRUGAL INNOVATION

A deeper understanding of frugal innovation grounded not only in its outputs but in its processes and social value helps to demonstrate the true value of frugality to ecological transformation.

Recent scholarship has examined the historical legacies of the term, delving deeper into the meaning and nuances of "frugality"³. As early as Adam Smith, frugality is associated with "judiciousness," and "industriousness" in organising economic activities. It emphasises the ability to learn from one's experience with the environment and to implement decisions which are practical⁴. In this sense, frugal innovation needn't only apply to the replication of existing products in less expensive ways, but to new invention with practicality and effectiveness as core principles.

A frugality-embedded innovation, however, also needn't be a radical technological breakthrough. In fact, scholarship concerning innovation have long demonstrated how economic benefits of innovations have often been associated not with radical technological breakthroughs, but with minor innovations and invention around a given technology that extend its life or uses. For instance, the introduction of smartphone protective cases, a relatively minor invention, extended the lifespan and functionality of existing smartphone technology, leading to significant economic and environmental benefits without necessitating a radical technological breakthrough.

Many countries in Asia and Latin America brought about significant economic prosperity through such iterative approach⁵. In these contexts, what was required was a change in the mindset which welcomed and legitimised local approaches to innovations to bring economic prosperity. Critical to a wider understanding of frugal innovation is to pay attention to the processes it involves. Scholarship concerning decision theories show how "frugal" ways of decision-making based on heuristics, rules of thumbs and improvisations, can lead to more efficient and faster solutions in conditions of uncertainty compared to decisions predominantly based on protocols, which are often determined at a global or otherwise nonlocal scale.

These innovation processes are guided by the knowledge of the relevant challenges and local environment, leading to better outcomes for that context. For example, in emergency disaster management, a local team using frugal innovation strategies, such as relying on practical experience and improvised solutions, may achieve more effective and swift outcomes than a team adhering strictly to comprehensive, but non-local, protocols.

In the global South, the value of frugality is seen in the vast innovative activities taking place in informal economy spaces. In India, the term "Jugaad" can be loosely translated as a "hack" or an innovative fix. It refers to the practice of finding low-cost solutions to problems by thinking out-of-the-box and using available resources in an unconventional way. In Kenya, "Jua Kali" refers to the creativity and resourcefulness informal workers use to find effective solutions in resource-constrained environments. In Brazil, the "solidarity economy" is also underpinned by processes and practices that embody frugality.

3 Jain, S. and Bhaduri, S., 2021. The many facets of frugality: Insights from a quasi-comprehensive literature survey. *Journal of Scientometric Research*, 10(2), pp.265-278.

4 Bhaduri, S., 2016. *Frugal Innovation by 'the Small and the Marginal': An Alternative Discourse on Innovation and Development*. Erasmus University Rotterdam.

5 Rosenberg, N. and Steinmueller, W.E., 1988. Why are Americans such poor imitators?. *The American Economic Review*, 78(2), pp.229-234.

1 Radjou, N. and Prabhu, J., 2015. *Frugal Innovation: How to do more with less*, The Economist.

2 Meagher, K., 2018. Cannibalizing the informal economy: Frugal innovation and economic inclusion in Africa. *The European Journal of Development Research*, 30, pp.17-33.



This understanding of frugality as a process as much as an outcome demonstrate the possibilities of frugal innovations by recognising the power and value of various alternative forms of knowledge creation and innovation activities undertaken at the grassroots level by communities, social enterprises, and civil societies⁶. These innovations originate either from individuals or socially connected actors, outside the controlled environment of a laboratory or a factory, to resolve localised problems in the actual environment of use and application⁷. They are driven by the experiential local knowledge, and an awareness about the local environment of opportunities and resources. The values they create are diverse⁸.

FRUGAL INNOVATION'S ROLE IN ECOLOGICAL TRANSFORMATION

Ecological transformation calls for radical changes in existing production and consumption mechanisms. At the same time, these changes must enable greater societal inclusion and justice. A frugality driven narrative of innovation-production and consumption has the potential to be a driver of both.

One major challenge that frugal innovation can play in driving positive environmental impacts is in the reduction of resource consumption and waste. Social movements like "right to repair" and "do-it-yourself" that seek to undo environmentally devastating consequences of existing dominant approaches to innovation like "planned obsolescence" and "disposable economy" inherently apply frugal approaches. In many, though not all, contexts, the innovations these groups promote use local knowledge, supply chains and locally available, often discarded, materials to extend the lives of many items.

In support of greater societal outcomes, frugal innovation helps make innovation processes more inclusive by opening up the possibility of innovation to the diverse traditions of knowledge creation and invention. It gives legitimacy to the activities and experiences of "fringe" people, not only "experts"⁹. By addressing barriers to frugal innovation and creating supportive mechanisms like financing and opportunities for knowledge sharing, more communities can develop solutions that help them to adapt to and mitigate the environmental ills facing our planet.

Its production can also be localised, and contextual. This implies lesser dependence on transportation and scale, particularly when facilitated by new decentralised processes and technologies such as 3D printing, for example. Such solutions not only promote positive environmental outcomes such as reductions in waste and pollution related to transportation, they also address local

Localisation of innovation and production through frugality can be particularly of value in promoting resilience to shocks



Smartphone protectors help extend their lifespan.

needs, while leveraging local skills and experience, signifying greater fairness and justice¹⁰.

This localisation of innovation and production through frugality can be particularly of value in promoting resilience to shocks. For example, during the pandemic, the various efforts to intervene in the disease management process through open-source manufacturing of ventilators, experimental therapies and validation of medical kits based on their performance in real-world settings symbolised a shift towards frugality, even in the countries of the global North. They symbolised a shift away from the conventional innovation-production-consumption mechanisms too, where the usefulness in the actual context of consumption validated the methods of production and innovation, more than "what ought to be" produced/innovated¹¹.

Though there is no systematic body of research as yet, many of these efforts, in popular perception at least, have importantly contributed to building a resilient response to the pandemic. Given the warnings of the WHO about possible recurrences of such events, we need to take proper lessons from these experiences, including in how we allow innovation to happen. Often, these innovation-production-distribution activities could be successfully organised at places local levels through platforms and the use of 4th Industrial Revolution technologies.

SCALING FRUGAL INNOVATION

Today, the commercial prospects and scalability of localised frugal innovations remains inadequate. Solutions that promote community participation and the nurturing of "innovation democracy" are proactive solutions that can be pursued. However, to allow frugal innovation to flourish and play its role in ecological transformation, existing levers and boundaries that are set around innovation will also need to change, particularly regulatory and financing models.

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11 <https://www.iss.nl/en/news/covid-19-should-europe-embrace-frugality>. Accessed on 17 July 2023.





Urban Horticulture - Community garden in central square of the city, Turin, Italy - September 29, 2016.

Most regulations related to physical products today are built on the idea of separation between producers and innovators. Innovators design products and associated processes; once these are set, that product moves to production in a highly standardised way. These two spheres are controlled by their specific protocols and regulations. However, many kinds of frugal innovations combine production with innovation. Innovation here happens at the site of the production. When regulations dictate this separation of spheres there is hardly any scope to indulge in trial-and-error in the production stage.

To enable frugal innovation, we need to create regulations that would indulge and allow for trial-and-error in the spheres of production. Scholarship concerning this idea is at a very nascent stage and requires further development¹². There are major tensions that will need to be resolved and that are even more challenging when also seeking to specifically promote innovation in service of ecological transformation. For example, how to ensure adherence to various safety and environmental standards in more varied products.

Financing of frugal innovators, and particularly of smaller-scale, localised frugal innovation is another significant challenge. A wide range of funding sources can support frugal innovation at local scale. Private sources of funding might both grow as the potential of frugal innovation as a tool for ecological transformation, resilience and adaptation becomes clearer. Governments, too, may recognise the role that innovation can play in building localised resilience and economic prosperity. However, today, very few such examples of large and widely accessible sources of funding exist.

In the meantime, other sources of financing such as individual crowd funding and other localised, participatory methods will also be important. The examples of Grameen Bank and other

microfinance organisations are notable examples that can be learned from. These sources also mitigate the potential negative consequences of imbalances in power between funders and innovators that can result in local gains from innovation to be lost. At the same time, there is a limit to the scale or spread of frugal innovation that can be expected to flourish when financing in support of it remains small and disconnected.

CONCLUSION

Properly defined frugality-based approaches to innovation can contribute significantly to ecological transformation while democratizing the innovation space by giving legitimacy to fringe actors and bringing them into innovation process. It ensures diversity of knowledge traditions and social practices can thrive, while achieving greater environmental sustainability.

While scale remains important, one should also be mindful of the various trade-offs scale brings with respect to the control innovators enjoy over their creations, the limits that it imposes on the needs of specific contexts, and the ability of local actors to use their knowledge of the local environment and experiences to adapt their innovations in response to changing environment of demand, costs and social values.

A reorientation of our mindsets and enabling systems for innovation is also needed. Innovation - production - consumption systems which thrive on rapid product obsolescence and the idea of a "disposable economy" need to be done away with, to create space for frugality driven innovations. To allow frugal innovation to flourish in the service of social and environmental goods, our current "over-engineered" system of regulation that treats the spheres of innovation and production as non-overlapping spheres of activity must also be revisited.

¹² See Chowdhury. Last accessed on 28 July 2023.



2. IMPLEMENTING INNOVATION FOR ECOLOGICAL TRANSFORMATION



Many examples illustrate the potential of human ingenuity to address the challenges we face, and the progress being made across all sectors. At the same time, there are also significant challenges to be overcome, not least how to rapidly scale and spread these innovations to meet the scale of the challenges we face.

Today, a wide range of stakeholders – from governments, to NGOs, to financial institutions, to large businesses and small enterprises – are deploying innovations in service of the ecological transformation. Many examples illustrate the potential of human ingenuity to address the challenges we face, and the progress being made across all sectors. At the same time, there are also significant challenges to be overcome, not least how to rapidly scale and spread these innovations to meet the scale of the challenges we face.

This section illustrates a range of examples of innovation for ecological transformation in different sectors. **Mahima Sukhdev, Senhal Bhosale and Anupam Ravi from GIST Impact** speak to innovative models of measurement that are helping businesses and other institutions to understand their impact on the natural world and to take action.

Certain spaces and contexts require specific approaches to innovation. With more than 56% of humanity now living in cities,¹ transforming these spaces into ones that support thriving lives and a healthy environment is a particularly important pursuit. **Dayna Baumeister and Nicole Miller of Biomimicry 3.8** share a framework for integrating biomimicry – adopting and adapting nature’s designs – into the built environment. Practitioners and academics who are part of the UN-sponsored **Net Zero Cities Initiative** highlight the diversity of technology, low-tech, social, and other innovation strategies being employed in cities across the world to promote ecological transformation. The case study of **Urban Rigger** in Copenhagen illustrates the role of innovative start-ups in creating new solutions that promote both positive environmental and social outcomes.

Of course cities are only one area where innovation is taking place today. **Catherine Ricou, Head of Innovation at Veolia**, shares examples of how the company is developing new approaches and technologies to reduce the environmental impacts of a range of industries and essential social goods – from water, to air, to soil. Experienced practitioner **Henri Boyé** shares an example of how governments are creating an enabling environment to scale promising innovations in the marine renewables sector. And to round off this section, **Ellen Martin and Amandine Joly of Circulate Capital** outline the role that investors and finance can play in scaling innovation for circularity.

Tejas Bachiraju
India Boschet
Grace Chua
Julian Lambin
Kite Insights,
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¹ The World Bank. Urban Development Overview.



UNPACKING NATURE'S VALUE - taking biodiversity impact measurement from science to action

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Maroondah reservoir, Yarra Valley (Victoria, Australia).

GIST Impact is a leading impact data and analytics provider that has been measuring and quantifying corporate impacts for more than 16 years, with a team of 100+ scientists, engineers, data scientists, and environmental economists. GIST Impact works with pioneering companies across all sectors and investors representing over \$8 trillion in assets under management, and partners with the world's largest ESG data providers, business networks, and fintech platforms.

Protecting and restoring biodiversity is an essential component of the ecological transformation we need to support a thriving society. The healthy functioning of natural systems provides the foundation upon which human society, and within it, business, can progress. This article discusses innovative approaches being deployed by GIST Impact with companies and other partners to measure and value biodiversity and ecosystem services. By incorporating this data into their decision-making and monitoring, companies can better align their practices and processes with positive outcomes for nature and generate value for people and planet.

INTRODUCTION

Biodiversity is the living fabric of this planet – its ecosystems, species, and genes¹. In recent years, we've seen growing awareness of biodiversity's central importance for viable economies, human health and wellbeing, and maintaining the balance of our planetary systems. This is evidenced by recent commitments to the 2030 nature restoration targets of the Convention on Biological Diversity (CBD), established at the 15th COP of the Global Biodiversity Framework².

Companies rely on nature to access valuable resources and are exposed to significant risks from biodiversity decline. More than 50% of global GDP – or \$44 trillion USD – is estimated to be moderately or highly dependent on nature and the services it provides³. These ecosystem services include carbon storage and water regulation by forest ecosystems; pollination by insects; food, fuel, and fibre supplies from various species. In the absence of these provisioning and regulating services, recent studies have shown that none of the world's top industries would be profitable⁴.

Most understandings of the change required of economies and societies to bring humanity back within planetary boundaries include the integration of non-financial risks and measures of value into economic and private sector thinking. In this future, companies, and investors need to have a clear and objective set of metrics to help them make informed decisions about nature and biodiversity, as with carbon emissions and other negative externalities. Companies are often predominantly concerned with their carbon emissions, but there are many other significant impacts (and opportunities) that must be measured to ensure a holistic ecological transformation.

1 TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.
2 UNEP. (2022) "COP15 ends with landmark biodiversity agreement."
3 WEF. (2020) "Nature Risk Rising report."
4 TruCost & TEEB. 2013. Natural Capital at Risk: The top 100 externalities of business.



Once these metrics are integrated into decision-making, the resulting investments and changes in business models can stem the rising tide of financial, physical, and systemic risks biodiversity loss presents. Even further, as these innovative ways of measuring and valuing nature mature, businesses will increasingly see reward from the positive contributions they make to the protection and regeneration of ecosystems.

ADOPTING A SCIENCE-BASED APPROACH TO MEASURING AND VALUING BIODIVERSITY

Quantifying how a company affects the natural world, and the ways in which a company relies on nature for its success, poses some significant challenges:

- **More complex than CO2e:** Biodiversity encompasses life at every stratum and operates at various spatial and temporal scales. From genetic variations within species to entire ecosystems, capturing this complexity demands robust methodologies.
- **Scarcity of on-the-ground data and expertise:** Comprehensive in-situ biodiversity data is often unavailable, particularly in remote regions and for lesser-known species. Accurate identification and classification of species also require taxonomic expertise, which is scarce in some regions.
- **Tight coupling of dependencies and risks:** Biodiversity impacts need to be evaluated both inside-out (i.e. impacts on the public due to the activities of a company and its value chain) and outside-in (i.e. threats to a company's performance due to its dependency on the services of nature and the decreasing ability of damaged ecosystems to provide these services).

More than 50% of global GDP – or \$44 trillion USD – is estimated to be moderately or highly dependent on nature and its services

Tackling these challenges requires investment in data collection using a wide range of approaches informed by an emerging set of frameworks. It also requires an understanding of both direct and indirect biodiversity impacts. With these underpinnings, sound science and robust economics are required to provide meaningful and actionable insights to decision-makers on how a company and its value chain are impacting biodiversity.

KEY FRAMEWORKS ELEVATING BIODIVERSITY MEASUREMENT AND REPORTING

In recent years, key frameworks, grounded in science-based approaches, have emerged to drive transparency in reporting biodiversity-related risks and opportunities. The most notable is the Task Force on Nature-related

Financial Disclosures (TNFD)⁵. Along with others, this framework is creating increased pressure, but also increased structure for companies to engage with their biodiversity impacts.

In the EU, the Corporate Sustainability Reporting Directive (CSRD) requires large companies to disclose information on material biodiversity and ecosystem-related topics as detailed in its new sustainability reporting standards (ESRS)⁶. France also requires financial institutions to publish the main biodiversity-related risks arising from their investments as part of Article 29 of its Energy-Climate Law passed in 2021⁷.

The Partnership for Biodiversity Accounting Financials (PBAF) has also published its Standard for Financial Institutions, with guidance on how to measure impacts and dependencies on nature and biodiversity⁸.

There is heartening congruence in these frameworks, as PBAF is aligned to the “Evaluate” stage of the TNFD’s “LEAP” framework (Locate, Evaluate, Assess, Prepare), for example. Together, these increasingly aligned frameworks are providing the foundations of a robust and science-based system of measurement and reporting.

Understanding these frameworks is the first step for companies and investors who wish to contribute to safeguarding ecosystems, preserving endangered species, and promoting sustainable practices through their activities. And by adopting such frameworks, biodiversity measurement and reporting can become more transparent, comparable, and credible.

MEASURING DIRECT AND INDIRECT BIODIVERSITY IMPACTS

Businesses and investors have significant impacts – both direct and indirect – on biodiversity and ecosystems through their operations, products, and investments.

Direct impacts are what most people consider when they think of biodiversity loss e.g. clearing forested land for business purposes. These impacts can be significant for companies in primary sectors such as agriculture, forestry, water, hydropower, and mining.

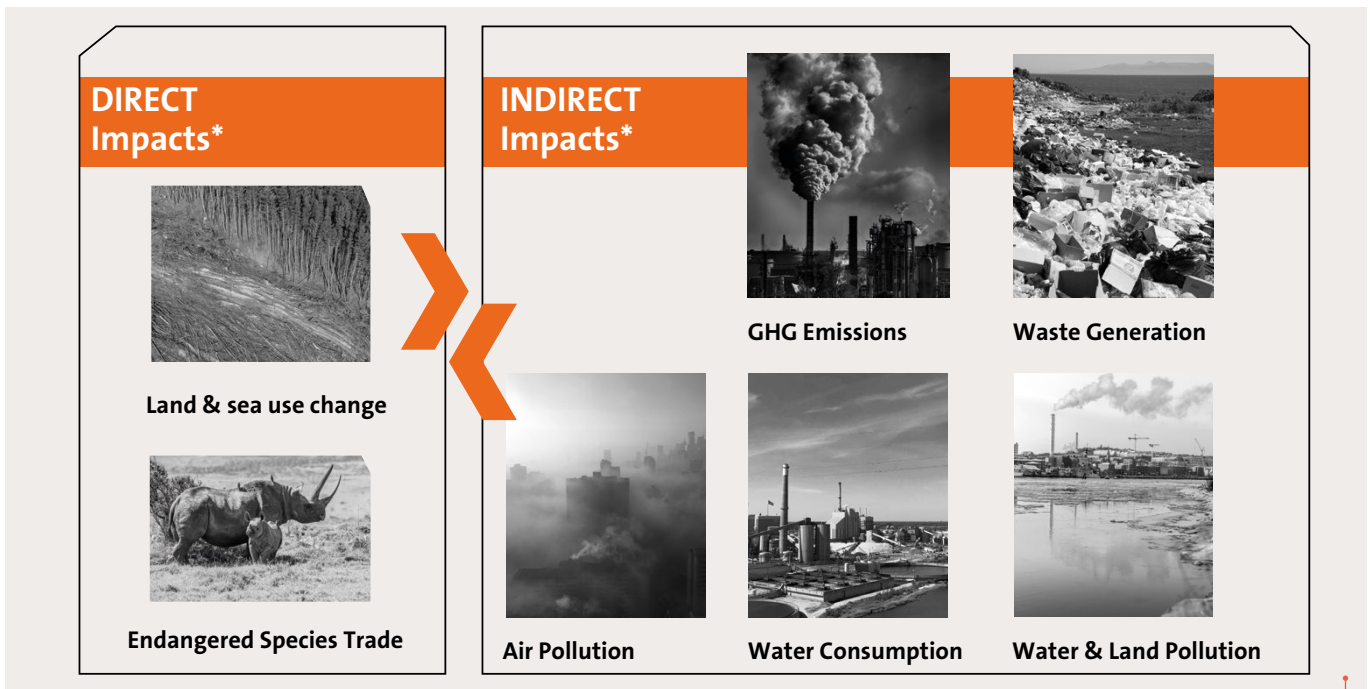
5 TNFD. (2023) “TNFD Nature-Related Risk & Opportunity Management and Disclosure Framework, v0.4 Beta Release.”

6 European Commission (2023) “Corporate Sustainability Reporting.”

7 Ministry of Economics, Finance and Industrial and Digital Sovereignty (2021) “Publication of the implementing decree of Article 29 of the Energy-Climate Law on non-financial reporting by market players.”

8 PBAF (2022) A Biodiversity Accounting Standard for the Financial Industry.





Impact on biodiversity can occur via direct and indirect drivers. Source: GIST Impact (2023).

Indirect impacts can be greater, taking many forms – a company in Europe releasing carbon emissions from its factory, for example, which leads to Amazon rainforest dieback and impacts Amazonian biodiversity.

We cannot effectively address biodiversity loss without understanding, measuring, and valuing **both types** of impacts.

While the impacts of direct drivers of biodiversity loss are significant and should be investigated, the majority of the biggest companies by market capitalisation are in sectors that typically have mainly indirect impacts on biodiversity.

These indirect drivers include greenhouse gas emissions (GHGs), water extraction, water & land pollution (Nitrogen and Phosphorus), air emissions (such as oxides of Nitrogen and Sulphur) and impacts from end treatment/disposal of waste. While the indirect impact drivers might not have an immediate impact on biodiversity, the eventual scale of these impacts can be significant.

In a world increasingly stressed by natural capital scarcities and risks, a company can only be said to be “future-ready” if it has a good understanding of, and viable management plans for, its most material natural capital impacts and dependencies

VISUALISING BUSINESS RISKS WITH PROXIMITY ANALYSIS

By using **proximity analysis**, companies with land use footprints can visualise direct risks better. The Integrated Biodiversity Assessment Tool (IBAT) is a powerful tool helping facilitate this process. The tool aggregates detailed global datasets on protected areas, species distribution, and key biodiversity areas, providing a comprehensive view of the potential impacts of corporate activities.

With this spatial data, IBAT allows businesses to understand biodiversity significance around where they have or might plan to have operations. For example, a mining company may use the IBAT tool to assess the biodiversity sensitivity of a proposed expansion site. By overlaying their proposed project areas with IBAT data, they can identify the presence of critical habitats and protected species nearby, enabling them to modify their project design to minimise negative impacts on biodiversity.

BEST PRACTICES AND INNOVATIONS IN MEASURING BIODIVERSITY IMPACTS

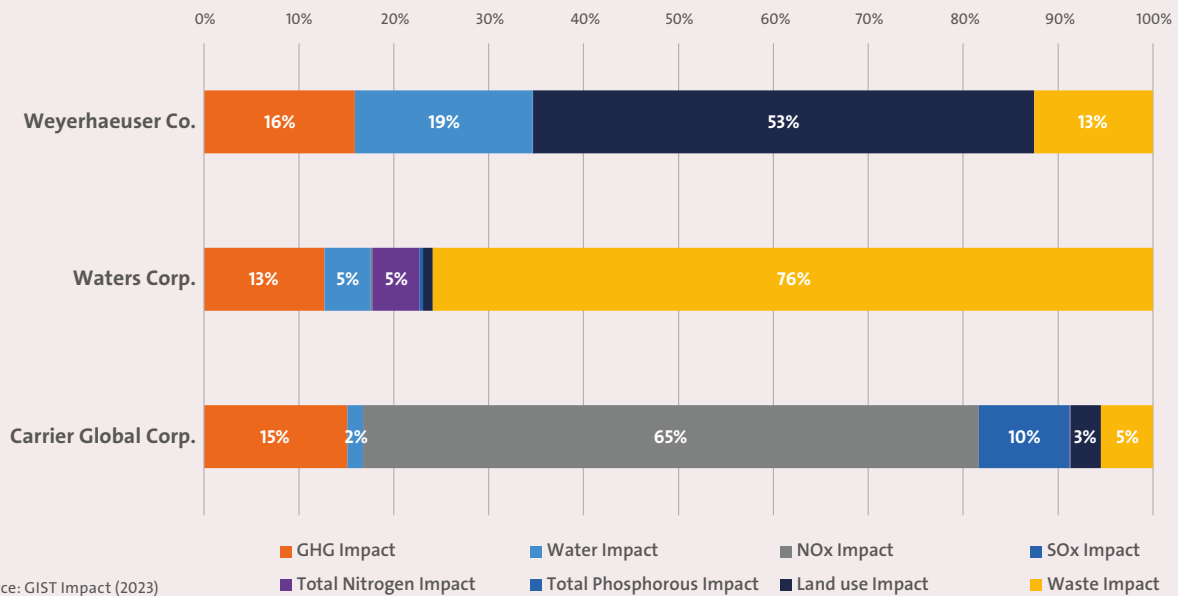
Businesses are deploying a range of approaches to capture and harness data on their biodiversity impacts and dependencies, enabling them to make informed decisions and prioritise nature-positive investments.

MEASURING BIODIVERSITY FOOTPRINTS WITH PDF AND MSA

For companies and investors looking to assess species-level biodiversity impacts, the TNFD framework offers a comprehensive set of recommended metrics. These include assessments of species richness through indicators of *destructive pressure* such as Potentially Disappeared Fraction of species (PDF), and indicators of *state of intactness* such as Mean Species Abundance (MSA).



Comparative biodiversity impacts: contribution of drivers to PDF (2021).



PDF provides a helpful indicator of how specific business activities can increase the risk of driving species to extinction both directly (e.g. via land use change) and indirectly (e.g. via GHG emissions causing habitat loss). Using driver-specific PDF impact assessment data helps companies and investors analyse and manage their biodiversity impacts.

When comparing biodiversity impacts of three North America-based companies from different sectors (see above), the most prominent drivers emerge — for Weyerhaeuser, a timber company, 53% of impact came from land use (a direct driver) in 2021. In contrast, Waste and Air Pollutants (NOx and SOx) were respectively the primary drivers of biodiversity impact for Waters Corp (an analytical instruments and software manufacturer) and Carrier Global (an industrial machinery manufacturer).

Mean Species Abundance (MSA) is another helpful indicator to understand how primary sector businesses (e.g. mining, forestry) affect the abundance of species in an area. Using geographic information system (GIS) maps overlaid with business asset locations, MSA helps visualise and identify biodiversity hotspots or areas of concern, showing the state of biodiversity at different points in time.

In the example on the following page, the mining areas in China, India, and the USA were assessed using the MSA indicator. The difference between the mean MSA for country and mining areas shows the decline in MSA due to mining activity-led habitat loss and fragmentation. Showing this picture can help businesses

to identify the scale of the challenge they need to address to minimise their negative impacts.

EVALUATING IMPACTS AND DEPENDENCIES ON NATURAL CAPITAL

Natural capital is defined as “the limited stocks of physical and biological resources found on earth and the limited capacity of ecosystems to provide ecosystem services”⁹.

Biodiversity encompasses life at every stratum and operates at various spatial and temporal scales... capturing this complexity demands robust and scientific methodologies

These ecosystem services provide substantial economic value and other benefits to society, and are pivotal for businesses and communities alike. By quantifying the value of ecosystem services companies can gain insights into their dependence on natural capital and the potential risks associated with its further degradation. Simultaneously, models of how materially a company and its value chain impact these ecosystems

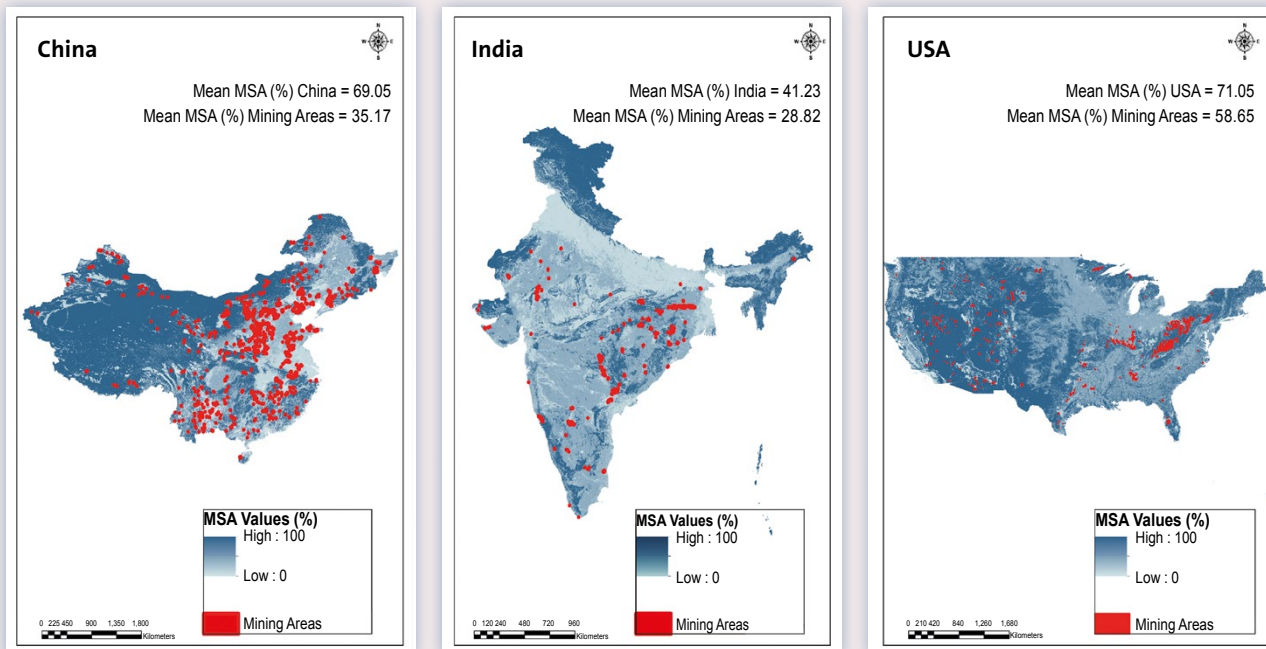
through destruction of natural capital can size their damages: a social cost or externality which can be internalised by institutional changes, laws, and reputational or physical disasters.

In a world increasingly stressed by natural capital scarcities and risks, a company can only be said to be ‘future-ready’ if it has a good understanding of, and viable management plans for, its most material natural capital impacts and dependencies.

⁹ TEEB (2010) The Economics of Ecosystems and Biodiversity. Mainstreaming the Economics of Nature.



Mining areas using MSA indicators



Based on GLOBIO 4 Methodology (Alkemade et al., 2009), Source: GIST Impact (2023).

It should also be considered that some of the most material environmental drivers (such as air pollutants) have *human capital* impacts (such as the health costs of air pollution). The below coal-fired electric utility is a case in point:

The social costs of this utility are derived primarily from estimates of damages to human health. This company operates in population-dense areas in South-East Asia, and the health costs of the air pollution it releases are sizeable (\$2.76 billion) compared to the company’s annual turnover of \$6.6 billion. By quantifying the size of these impacts

in monetary terms, companies and investors can integrate these considerations into their decision-making processes and adjust its practices as needed.

A future ecological transformation that includes these more holistic measures of value could therefore fundamentally reshape how we think about the ways in which companies create or destroy value. Today, using these measures can help companies ensure they create not just financial value, but also human and natural value.

Yarra Valley Water (Australia)’s Biodiversity Journey

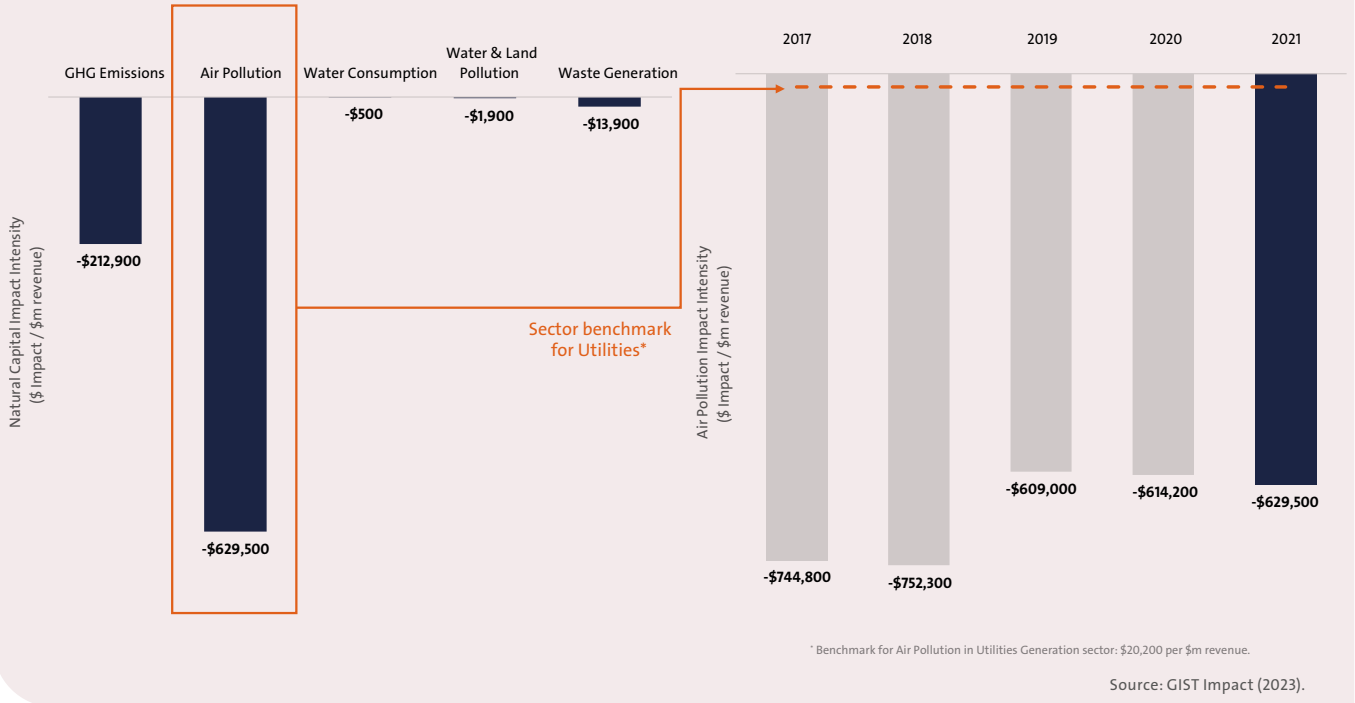
As Melbourne’s largest water utility, Yarra Valley Water (YVW) recognised its responsibility towards sustainability and wanted to demonstrate its commitment and progress to restorative practices. In 2016, the company sought GIST Impact’s help to develop its first Integrated Profit & Loss Report and benchmark its environmental and social impacts.

During this process, the team unearthed a key insight – the company’s biodiversity impact from land clearing was greater (in terms of materiality) than its greenhouse gas impact. This finding prompted the YVW team to revise their corporate strategy. As a next step, YVW carried out a PDF biodiversity assessment of the approximate 1500 hectares of land it owned, spread across 190 sites. They identified 12 sites with high-value remnant biodiversity requiring enhanced protection and identified the top 10 restoration opportunities.

With data that quantified the value of these opportunities - and associated risks from inaction - the company was able to gain backing from its board to embed biodiversity into its corporate strategy, establish a business case for a biodiversity-focused programme, and start to implement via a series of strategic investments. The company also pledged to refund around \$1.5 million annually to customers if they failed to meet their biodiversity targets. This is a commitment to taking biodiversity protection seriously, and to embracing science-based approaches to measuring and valuing nature.



Natural capital impacts of an Asian electric utility: across drivers, and over time



UTILISING BIODIVERSITY DATA FOR CONTINUOUS IMPROVEMENT

Once biodiversity impacts and dependencies are measured, companies can use this data to drive improvement and conservation efforts, and support the ecological transformation. The potential benefits of measuring and valuing nature are substantial:

- Regularly tracking biodiversity metrics allows businesses to **monitor changes**, identify emerging risks, and assess the effectiveness of conservation initiatives.
- Transparently **communicating biodiversity performance** to stakeholders builds trust and accountability. Adopting global reporting **standards**, such as the TNFD, enhances credibility, comparability and, increasingly, access to favourable finance.
- Integrating biodiversity considerations into **corporate strategies** aligns business objectives with nature conservation goals, unlocking opportunities for innovation and sustainable growth.

CONCLUSION

The power of data-driven approaches to measuring biodiversity impacts cannot be underestimated. Companies have a very significant opportunity to leverage innovative and advanced tools and assessment frameworks to understand, protect and enhance the value of biodiversity and ecosystem services; for their own businesses, and for the planet at large.

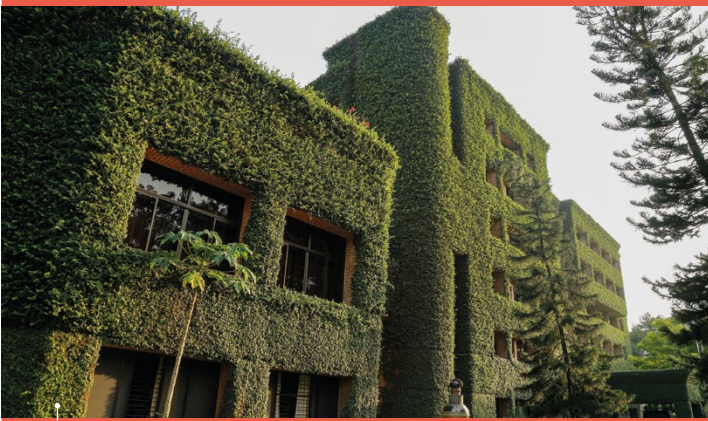
Armed with this knowledge, businesses can continuously monitor, report, and improve their biodiversity performance, and incorporate biodiversity considerations into corporate strategies. Real-world examples like Yarra Valley Water show the transformative potential of these practices, inspiring a path toward a sustainable future where corporate growth and biodiversity conservation can coexist. By embracing a truly innovative and scientifically robust approach to valuing nature, companies can become champions for ecological transformation, and play a key role as protectors and restorers of nature.



CAN THE BUILT ENVIRONMENT FUNCTION LIKE NATURE?

Dr. Dayna Baumeister
Co-Founder, Biomimicry 3.8

Nicole Miller
Managing Director, Biomimicry 3.8



Building of RDRS (Rangpur Dinajpur Rural Service) is covered with green plants in Rangpur - a NGO working to empower the rural poor in northern Bangladesh 02 May 2017.
Source: Abir Abdullah / Climate Visuals Countdown.

Since 1998, Dayna’s foundational work has been critical to establishing biomimicry as a fresh and innovative practice, as well as a philosophy to meet the world’s sustainability challenges. With a devotion to applied natural history and a passion for sharing the genius of nature, Dayna is the senior editor of *Biomimicry Resource Handbook: A Seed Bank of Knowledge and Best Practices (2014)*, co-founder of Biomimicry 3.8, co-Director of the Biomimicry Center at Arizona State University, and creator of the world’s first Master of Science in Biomimicry at Arizona State University. Dayna has helped dozens of Fortune 500 companies and hundreds of practitioners consult the natural world for elegant and sustainable design solutions.

Nicole Miller serves as the managing director of Biomimicry 3.8, a certified BCorp and social enterprise dedicated to helping change-makers create a more sustainable world by emulating nature’s designs and core principles. Since joining B3.8 in 2012, she has overseen the development of key strategic partnerships to increase access to biomimicry and worked with clients such as Google, Interface, Jacobs, Microsoft, and others to drive innovation and sustainability outcomes. Nicole has a unique grasp of how to position great science to drive commercial practice--and, ultimately, market transformation.

The Positive Performance Methodology (PPM), developed by Biomimicry 3.8, draws key principles from nature and how healthy ecosystems function. Its framework consists of four steps:

1. IDENTIFY a reference ecosystem in the local context and the conditions of the place and/or site.
2. QUANTIFY baseline performance and targets based on the local reference ecosystems.
3. CREATE design guidelines and strategies to emulate ecosystem performance metrics.
4. IMPLEMENT the strategies to move towards positive and regenerative performance and assess their effectiveness.

The PPM can be applied to the built environment at different scales – building, development, or city – and to various sectors as wide-ranging as agriculture, forestry, transportation, housing, and education. Applied appropriately, it can help projects meet specific ecological performance goals that contribute to a regenerative, harmonious urban future.

INTRODUCTION

A thriving city life heavily relies on the benefits provided by nature, such as climate control, air cleaning, water storage and purification, pollination, and soil health. Although these ecosystem services are typically provided by areas outside of cities, there’s a growing awareness that cities themselves need to contribute to these services to ensure access to clean water, air, and stable ecosystems. The Sustainable Development Goals set by the United Nations stress the importance of local ecosystems and suggest that all aspects of a city - its buildings, infrastructure, and natural surroundings - should actively contribute to environmental health. This includes maintaining clean air and water, healthy soil, sequestered carbon, cycled nutrients, reduced erosion, reduced heat, and supporting biodiversity.

Regenerative design, a proactive approach aimed at developing urban infrastructure that delivers positive environmental benefits, is an essential part of this process. Current green building standards, like LEED and Net-Zero, do a good job of limiting negative environmental impacts but don’t necessarily encourage or incentivize positive contributions. If we’re looking to not just reduce harm but actively improve local ecosystems, we need new standards.

One promising approach is the idea of ecological performance standards. Biomimicry 3.8, a nature inspired consultancy, has developed the Positive Performance Methodology (PPM), which takes inspiration from how a healthy, native ecosystem would function in a given area and sets these conditions as the performance goals. This involves translating the services generated by local ecosystems into tangible design targets for the building sector. By setting goals based on the capabilities of the local ecosystems where our cities exist, we’re working towards a more regenerative and harmonious urban development that benefits all life.



When combined with the PPM approach, technologies like green roofs, pollinator corridors and water purification systems create multifunctional benefits that enable urban areas to provide many of the same services as a healthy ecosystem, directly contributing to the overall health and well-being of the community.

Implementing ecological performance standards through the Positive Performance Methodology requires a team effort involving urban planners, ecologists, architects, engineers, and designers, as well as operations and maintenance teams, all working together to incorporate ecosystem services into urban designs. Over more than 15 years of applying this work, we have honed a four-step framework for applying PPM:

1. IDENTIFY a reference ecosystem in the local context and the conditions of the place and/or site.
2. QUANTIFY baseline performance and targets based on the local reference ecosystems.
3. CREATE design guidelines and strategies to emulate ecosystem performance metrics.
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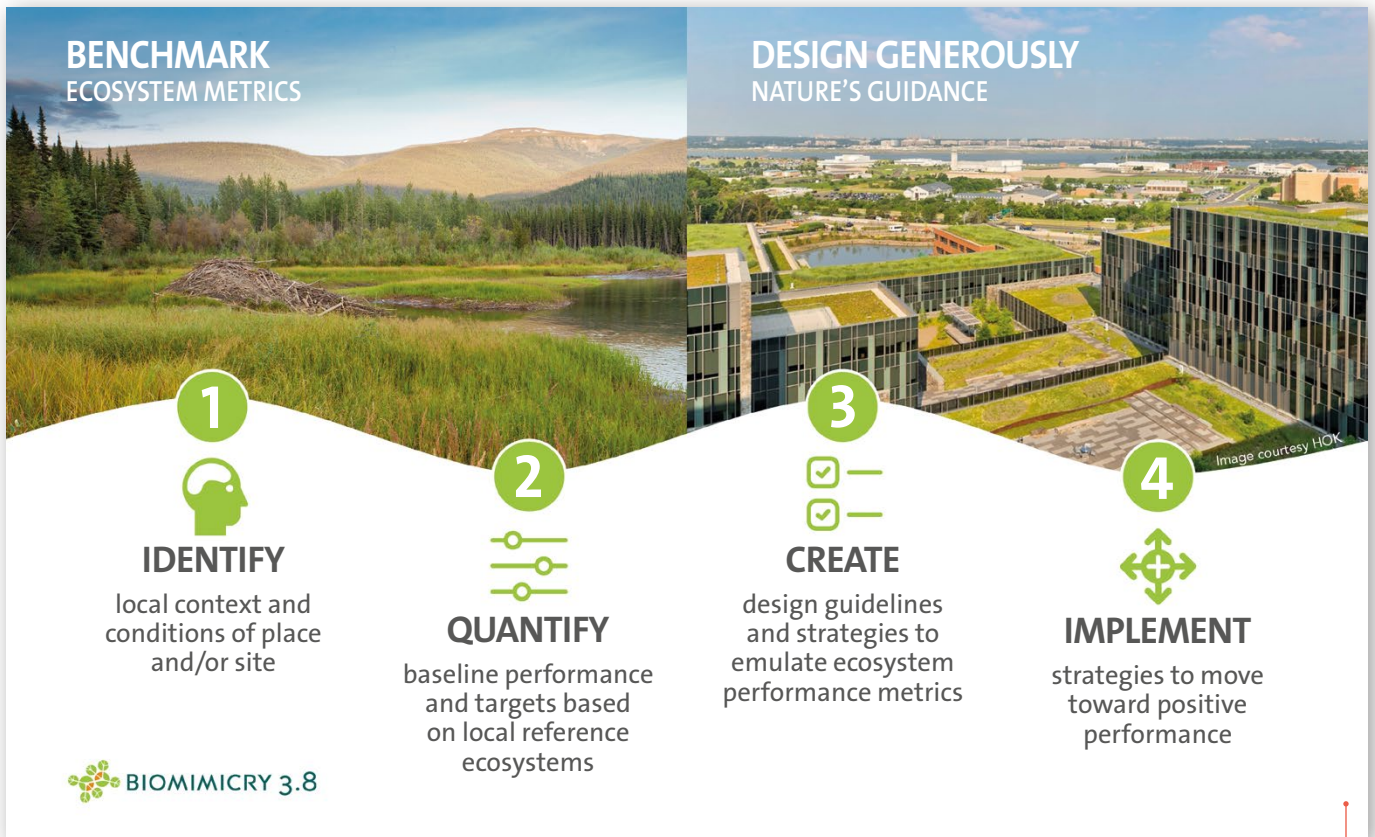
This process encourages collaboration between those who gather information about ecosystems and those who create designs that incorporate this knowledge, working towards creating urban spaces that perform as well as, or better than, their natural counterparts.

IDENTIFYING A LOCAL REFERENCE ECOSYSTEM

Implementing the Positive Performance Methodology (PPM) starts with choosing a local reference ecosystem and its habitats. This means figuring out what type of native ecosystem would exist at the building site if left undisturbed. Often, this involves looking at protected conservation areas or wildlife preserves in the same region. Sometimes, the building site itself, if it's still in a relatively

natural state, can serve as a reference. It's important to remember that a site can host a mix of ecosystems and habitats, like forests, grasslands, and wetlands, and each should be evaluated independently.

In cities like New York and San Francisco, experts have used digital recreations of historical ecosystems to help set goals. However, while historical data is informative,



it can't replace a current, living reference ecosystem. Conditions have changed since those historical ecosystems existed, which can result in a mismatch in the PPM goals. Furthermore, actually visiting an existing ecosystem allows design teams to set clear, tangible targets and draw inspiration for their designs.

Current climate conditions and challenges, like climate change and the urban heat island effect, should also be considered when choosing a reference ecosystem. If the present context isn't considered, solutions based on the reference ecosystem may not work in reality. For instance, native plants that were once common may no longer be suitable due to changes in climate or soil chemistry.

In recent years, there has been an increasing appreciation for so-called novel ecosystems, which have been directly or indirectly shaped by human activity. These could include lands impacted by past farming or areas with introduced species. Some of these novel ecosystems may hold significant cultural value and could be chosen for restoration. Ultimately, it's up to the research team to decide which aspects of an ecosystem to emulate, and in certain cases, novel ecosystems might serve as valuable reference points.

QUANTIFYING ECOSYSTEM SERVICES TO DEVELOP PERFORMANCE METRICS

Once a reference ecosystem and habitats are chosen, the next step is to measure the ecosystem services it provides. These are commonly split into four categories: provisioning (like food or fuel), regulation (like pollination), supporting (like soil formation), and cultural (like recreation). Project teams should decide which metrics to focus on for a specific project or site based on what is most important for that place. For example, water quality might be emphasized in an area that has experienced polluted groundwater due to environmental degradation.

The aim of PPM is to create metrics for infrastructure projects that equal or surpass the services provided by the reference ecosystem. However, it's unlikely that a single project can deliver all ecosystem services. Therefore, the team needs to work with project partners to choose which services to prioritize, considering factors like local environmental conditions, stakeholder needs, urgency, and budget. Both quantitative and qualitative metrics can be useful for this process, and there are many tools available to help gather this data on-site.

One such tool is the Ecological Intelligence (EI) tool (an evolution of the ESII tool) by EcoMetrix Solutions Group,

which allows for easy on-site or off-site data collection and provides estimates for a variety of ecosystem services to support early planning, decision making throughout the design process and long-term monitoring of impacts. Another tool is InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) by the Natural Capital Project, which uses GIS technology to map and value a site's goods and services.

However, certain ecosystem services, like aesthetic and cultural services, are harder to quantify. In these cases, qualitative metrics can be useful. Measuring biodiversity support is also challenging, but a literature review can provide useful information about native species and biodiversity threats. Moreover, digital tools like EI, mentioned above, and iNaturalist, can assist in conducting biodiversity surveys.

Site visits to reference ecosystems offer the design team a first-hand experience of a functioning ecosystem, which can provide valuable design insights and allow for local community

needs and cultural aspects to be incorporated into the design process. To assess the performance gap, the same measurement process should be conducted at the development site to determine its current ecosystem services. While the choice of metrics might vary across projects, the comparison between the reference and development site should remain consistent. Even if detailed measurements can't be taken, qualitative metrics can still be informative when applied consistently across sites.

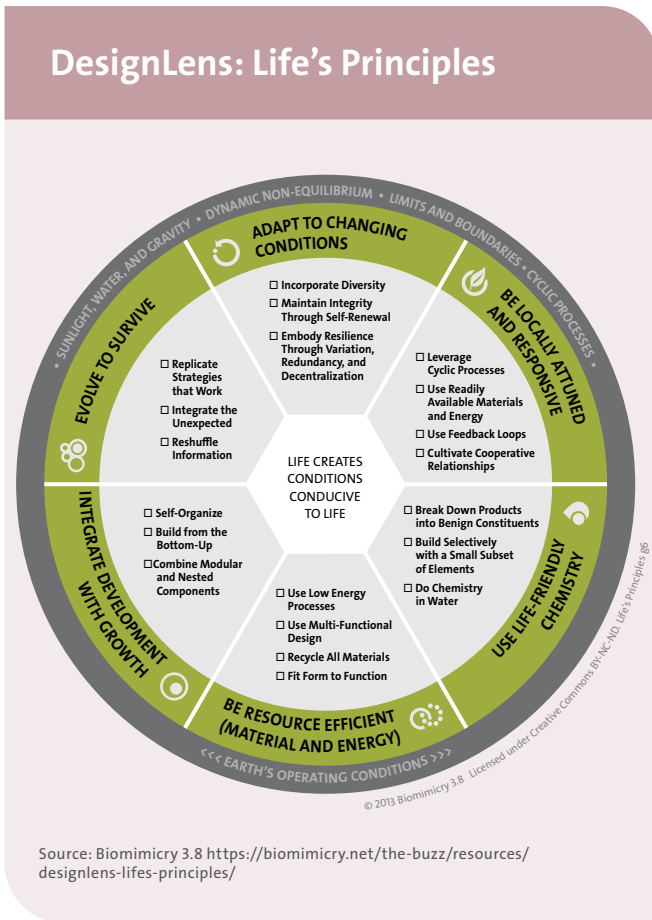
DESIGNING TO MEET OR EXCEED POSITIVE PERFORMANCE METRICS

Once PPM metrics are defined and the performance gap measured, the third step involves creating design guidelines and strategies to meet or advance toward the PPM goals. The early design stage, where site selection occurs, is the ideal time to develop project design guidelines for maximum impact. To ultimately achieve regenerative outcomes the design guidelines should be informed by Life's Principles, design lessons from nature.

Using the established design guidelines and performance metrics informed by nature, teams might identify areas for preservation or decide to consider alternative sites. Though the PPM is different from ecological restoration aimed at restoring native ecosystems, they can work together to maximize on-site ecosystem services. However, since it's unlikely to restore all services even with the most innovative design, restoration of functional ecosystems should be prioritized.

Site visits to reference ecosystems offer the design team a first-hand experience of a functioning ecosystem, which can provide valuable design insights and allow for local community needs and cultural aspects to be incorporated into the design process





Source: Biomimicry 3.8 <https://biomimicry.net/the-buzz/resources/designlens-lifes-principles/>

Several questions must be addressed at the start of the design phase: What's the scale of implementation? What are the budget limits? What are the project's social needs, and can it create local green jobs or start-ups? Recent restoration ecology projects have used decision science tools to create formal consensus procedures among stakeholders, which could be useful in the PP framework.

To assist decision-making, the EI tool is used to build alternate scenarios, enabling design teams to compare how different approaches impact ecosystem services. This allows clients and stakeholders to prioritize design interventions best aligned with the PPM goals, considering any budgetary or other constraints. Although it's theoretically possible for design interventions to exceed PPM goals, this hasn't been seen in practice yet. Performance metrics shouldn't be restrictive; advancements in technology may allow for exceeding performance goals in certain areas. Furthermore, projects applying PPM should take future environmental challenges into account, such as climate change.

There are already several design interventions to support advancing PPM goals. For example, bioswales, permeable pavement, and rainwater capture systems manage

stormwater runoff and erosion. Composting toilets, green roofs, and carbon-sequestering cement are other common practices. The design team's task is to decide which technologies and design approaches to integrate, and where best to develop innovative, nature-inspired design interventions. The Biomimicry 3.8 team has collected a series of over 100 intervention types based on site conditions and functional needs, stakeholder priorities and community needs, and application considerations.

PPM projects also offer significant opportunities to support and improve biodiversity by emulating the functions of a reference ecosystem. Landscaping with native plants is common in regenerative design, and efforts to incorporate animal habitats into urban design plans are gaining momentum. For instance, design teams might consider how the site connects to other potential habitats through natural and constructed corridors that allow plant and animal dispersal. Other principles include minimizing threats and disturbances, facilitating natural ecological processes, and improving the potential for positive human-nature interactions. Incorporating these into design proposals can benefit a wide range of native species.

IMPLEMENTATION, ASSESSMENT, AND MONITORING

The final phase of a PPM project involves execution and evaluation. This entails implementing the proposed design strategies and intervention, which can occur as short-, medium-, or long-term actions, depending on timeline, budget, and project scale. Thus, performance metrics and biomimetic design guidelines can act as enduring targets for planners as they carry out new construction or upgrade existing structures. A well-defined evaluation strategy

allows operation teams to track their progress in bridging the performance gap and achieving PPM goals. In our pilots, the opportunity to engage employees and communities also resulted in a more engaged workforce and social license to operate.

For businesses and communities, assessing the positive ecosystem services produced by a site presents

a chance to appreciate how closely they are emulating a healthy native ecosystem. B3.8 puts it as "being functionally indistinguishable from the wildland next door." Realizing these goals requires a mix of habitat restoration, biomimetics design interventions, and a mindset shift that buildings can have a positive impact on the place in which they operate.

To learn more about this work and examples provided, please visit <https://biomimicry.net/project-positive/>

A project site emulates a healthy ecosystem when it is "functionally indistinguishable from the wildland next door"



LAVASA, INDIA: DEVELOPMENT MASTER PLAN (2008–2009)



B3.8’s Positive Performance Methodology has evolved through numerous pilot projects, with public and private clients, and at different scales: building, development, and city. We present three significant case studies from more than a dozen projects in which B3.8 has been involved. These case studies represent our journey from our initial application of PPM, Lavasa, located in Pune, India, to our latest projects completed with Interface and Microsoft. Each case study illuminates our evolving methodology and the challenges and opportunities we faced with each pilot, showcasing the continuous evolution and improvement of the PPM to meet the growing environmental and social needs faced by corporations and communities.

Our first PPM pilot took place in Lavasa, India, in collaboration with the architecture firm HOK. The goal was to create a sustainable master plan for Lavasa, a private development on the shores of Dasve Lake outside of Pune, intended to house up to 200,000 residents. We focused on using biomimetic design and PPM to restore ecosystem services disrupted by the construction of Lavasa, which required clearing some forest areas. The surrounding subtropical, moist, broadleaf forest served as our reference ecosystem.

Creating accurate performance metrics that emulated the local ecosystem for this project presented a significant challenge due to the extreme monsoon season. To improve communication with the clients and builders, we grouped these complex metrics into simple categories, such as “water”, “light”, “earth”, and “biodiversity”. While we lacked the tools for direct on-site measurements, we estimated baseline values using ecological literature and qualitatively assessed proposed design interventions against these baselines.

Despite the challenges, this initial project garnered three awards from the American Society of Landscape Architects for HOK’s development master plan. Key interventions included roof designs for enhanced evaporation that mimicked the leaf tips of local species (to help manage for rainfall), road modifications for erosion management that were inspired by a local mound-building ant species, and increased buffer zones along intermittent waterfalls by measuring the deep pattern of “riparian” zone dimensions.

DURBAN, SOUTH AFRICA: RESILIENT DEVELOPMENT PLAN (2014)



B3.8 joined a consortium to create an eco-friendly development plan for a project in Durban, South Africa. In this project, we utilized the InVEST tool to quantitatively model and compare the ecological performance of different design interventions. The development site in Durban was primarily under sugarcane cultivation, leading us to identify two reference ecosystems: Southern Africa mangroves and KwaZulu Natal-Cape coastal forest. With a major concern over the loss of natural mangrove habitat, we prioritized water yield and flood attenuation in the performance metrics.

Using InVEST, we provided data-driven metrics to inform a resilience framework focusing on carbon storage, water yield, flood index, sediment yield, and nitrogen and phosphorus export. Among our proposed design solutions were rehabilitating wetlands and estuaries and using infrastructure inspired by mangrove trees for storm surge protection. Ultimately, we were able to demonstrate that a development aiming for Positive Performance performed better than the sugarcane fields it was designed to replace.

MICROSOFT (2020-PRESENT)

Over the past several years B3.8 has been working with teams at Microsoft to help identify what it means to be a good steward of the lands they use, specifically the primary objective was to apply regenerative practices at various datacenter sites, with North Holland serving as the initial testing area. After researching adjacent ecosystems, we identified a series of landscape solutions that could be incorporated into the existing datacenter campus to address water issues, aesthetics and phosphorous concerns in the community. The first phase included the planting of 150 native trees and 2,300 square meters of shrubs, grasses, and groundcovers around the campus. Additional phases of this project will measure the impact on air quality, soil health, and biodiversity both on the direct campus and for the surrounding area.

As Microsoft look to incorporate these strategies across its footprint, ecosystem performance benchmarks based on local biome metrics and biomimetic design guidelines are helping to integrate and standardize a process that can scale across the company.



INTERFACE, INC.: FACTORY AS A FOREST (2015–2020)



Factory as a Forest Initiative.
Source: Interface Inc.

In 2015, in partnership with Interface, Inc., a global manufacturer of commercial flooring, B3.8 launched the “Factory as a Forest” initiative. This project involved deploying PPM at multiple locations in Australia and the U.S. With this project, B3.8 collaborated with Terrapin Bright Green and EcoMetrix Solutions Group to develop performance goals on-site using the ESII tool (the predecessor to the current EI tool). The primary focus was on water and carbon storage, reflecting Interface’s Climate Take Back strategy, with design solutions including carbon sequestration in mass timbers and a focus on water harvesting and storage interventions.

This project demonstrated the potential for deeper integration of PPM into design plans, as well as the valuable role of tools like ESII in collecting ecosystem performance metrics. Moreover, it highlighted the positive impact of PPM application on employee engagement, with staff showing great enthusiasm for learning about their local ecosystems and the company’s effort to improve their working environment. Interface noted a marked increase in employee retention and national recognition for the application of PPM to its Global Headquarters in downtown Atlanta process that can scale across the company.

CONCLUSION

These projects have shown that it is not only possible but also appealing to integrate biomimetic design and ecosystem service performance metrics into regenerative design. To expand the potential for positive impact in the built environment, we need engagement across industries, and policies to promote learning from nature as the optimal pathway to regenerative design.

It’s also crucial to incorporate PPM into wider conservation strategies to enhance ecosystems on a larger scale. Beyond just buildings and sites, PPM can be applied to fields such as agriculture, forestry, transportation, housing, and education. We have extended the concept of “Factories as Forests” to “Backyards as Forests,” “Campuses as Forests,” and so on, enabling companies and communities to explore design for positive impact – for both people and the planet.

From our past projects, we’ve gleaned two key lessons for future PPM implementation. Firstly, it’s vital to involve all major stakeholders from the onset to establish metrics that align with the primary developer, community and/or company’s goals. These metrics, which may be quantitative, qualitative, or related to social goals, should be aligned with overall project objectives as early as possible. For instance, identifying the ideal site for development to maximize ecosystem performance should be done before finalizing site selection. Secondly, tools like EI are invaluable. These allow practitioners to easily collect ecosystem metrics and quantify performance in ways that would be nearly impossible to obtain from literature reviews or without extensive field research. The models produced by such tools enable the project team to see potential impact and support key decision making milestones, along with community engagement. Continued refinement of such tools, along with features for alternative scenario planning, will further streamline the PPM process, and potential for impact.

Looking ahead, we see several opportunities to further expedite PPM implementation. Collaborations between ecologists and built environment professionals can devise and assess methods for delivering ecosystem services through design and help designers evaluate how well their designs meet PPM goals. In addition to the scientific challenges of developing reliable ecosystem services models, we also need to understand how various design interventions will synergistically contribute to positive ecosystem services over time. Long-term case studies with proper measurement protocols will be crucial for this.

Policy will also play a key role in a more rapid integration of holistic design frameworks like PPM that deliver multifunctional design and co-benefits to meet adopted laws, regulations and guidelines – such as the Biden-Harris Administration Roadmap for Nature Based Solutions, the European Unions Nature Restoration Law, and Task Force for Nature Related Financial Disclosures.

Lastly, documenting PPM projects and case studies helps create a set of best practices for ecosystem services design. Although it can be challenging when project details are confidential, we need to push for more transparency about project successes, lessons learned, and to share best practices. If we share project outcomes, we could potentially create a global ‘atlas’ of ecosystem services metrics, performance targets, and biomimetic design interventions, which would make it easier to adopt Positive Performance goals, integrate solutions and apply at scale, to truly have a positive impact on “all the lands we touch”.



CITIES AS CATALYSTS AND LABORATORIES FOR ECOLOGICAL TRANSFORMATION

Luise Fischer, Francesca Rizzo, Adriana O'Phelan, Anthony Zacharzewski, Andrea Gabaldon Moreno, and Carla Rodríguez Alonso on behalf of the NetZero Cities Initiative



Modern sustainable neighbourhood in Almere, The Netherlands. The city heating (stadswarmte) in the district is partially powered by a solar panel island (Zoneiland). Aerial view.

Coordinated by Europe's largest public-private partnership, EIT Climate-KIC, the NetZero Cities initiative supports European cities to reduce their greenhouse gas emissions. The four-year long initiative was launched in 2021 to support cities to overcome the existing structural, institutional and cultural barriers they face to achieving climate neutrality by 2030. This article is authored by Andrea Gabaldon Moreno, R&D Engineer and Climate-Neutral Cities Expert, Carla Rodríguez Alonso, Research Architect and Climate-neutrality Urban Planner, Anthony Zacharzewski, President at Democratic Society, Adriana O'Phelan: NetZeroCities Project Lead, Democratic Society, Luise Fischer: Systems Innovation Co-Lead, NetZeroCities, EIT Climate KIC, and Francesca Rizzo Ph.D, Full professor at Politecnico di Milano – Rector's Delegate for European Projects. The authors have all been commissioned by the NetZero Cities Initiative.

Cities comprise complex networks and systems that have long provided opportunities for innovation and human flourishing. However, the same systems contribute to today's major environmental challenges. Cities thus find themselves at the heart of driving innovation for a just ecological transformation. Not only do cities foster, pilot and scale high-tech solutions, but they can also enable low-tech and social innovation. This article explores the conditions that allow cities to foster various forms of innovation, and do so collectively, for an inclusive and just ecological transformation.

INTRODUCTION

Cities are uniquely enriched by diverse uses of their space and diverse kinds of innovation, wrote the urban thinker and journalist Jane Jacobs in her book *The Death and Life of Great American Cities*: "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody."

Today, cities are also uniquely placed to address ecological transformation and to develop, pilot and scale the variety of innovation that ecological transformation demands. Again, these innovations must be designed and created 'by everybody', for everybody. Social innovation and democratic, participatory processes matter as much as investable, scalable technologies. Cities have a leading role to play, not just in meeting the climate goals and targets set out by international frameworks such as the COP21 Paris Agreement, but also in ensuring that decarbonisation efforts are just and equitable.

How can the public and private sector work together, in and across cities, to foster technological, economic, and social innovation for ecological transformation? How can cities pilot these innovations and scale them citywide and beyond?

NetZeroCities offers a model for transforming and decarbonising cities at scale. As the platform supporting the EU Mission: Climate-Neutral and Smart Cities, NetZeroCities supports cities as they work with their stakeholders to get to climate neutrality by 2030. As part of the Horizon 2020 Research and Innovation Programme in support of the EU Green Deal, NetZeroCities consortium organisations provide dedicated services to cities, with the objective of helping 100 European cities become climate-neutral by 2030 in equitable and inclusive ways. Cities from Barcelona to Budapest have become Mission Cities, which engages them with the process of writing a Climate City Contract – a new way of governing the climate transition through a combination of action planning, commitments, and ideas for investing in climate neutrality. Many have gone even further as Pilot Cities implementing and testing out on-the-ground activities from which others can learn.

Based on NetZeroCities's experience, we outline key opportunities for urban innovation to drive systems change; how cities can foster urban innovation at different scales, and how private-sector and other stakeholders can understand and play a role in city ecosystems to initiate and advance innovation for ecological transformation.



WHY CITIES?

Human civilisations have long organised themselves into cities. Cities are politically, socially and economically vibrant, drawing citizens to a host of opportunities. Today, cities make up just 4% of the EU's land area but are home to 75% of EU citizens¹. Thanks to this attractiveness and density, cities are hotbeds of culture and innovation of all kinds, from technological invention to art and design.

The size, resources and diversity of a city also force it to continually manage public opinion, coordinate and negotiate public-private partnerships, and build regulatory frameworks that both protect citizens and enable private sector innovation to flourish – all vital skills and practices for fostering innovation. Indeed, cities have supported business to become more energy-efficient and sustainable, while urban density can also facilitate reverse-logistics or sharing business models for the circular economy.

At the same time, cities need energy to keep their buildings, transport systems, manufacturing, food production, and countless other activities running. They consume and emit disproportionately to their population: globally, cities consume over 75% of the world's primary energy and account for at least 50-60% of global CO₂ emissions². Cities face other environmental challenges besides CO₂ emissions. Burning fossil fuels for transport and heating leads to urban air pollution, and if waste is not well managed in a high-density city, it contributes to land and water pollution.

Between their carbon footprint and their key role in catalysing innovation³, it is imperative that cities drive innovation for ecological transformation.

THE VISION

So what do climate-neutral cities look like compared to today's cities, and how should we get there? By the principles of ecological transformation, cities' net-zero or even zero-carbon-emissions plans should be inclusive, just, and well-integrated with other interrelated aspects of ecological transformation such as pollution, circular economy principles, and biodiversity.

Net-zero cities may arrive at their goals through high-tech or low-tech means or both. Technological pathways for emissions reduction include:

- Electrification
- Reducing energy demand, as well as smart energy technologies for managing energy demand
- Carbon capture
- Sector-coupling, which refers to a more integrated approach to electricity generation, heating, cooling, transport and other industrial processes that consume energy, with the

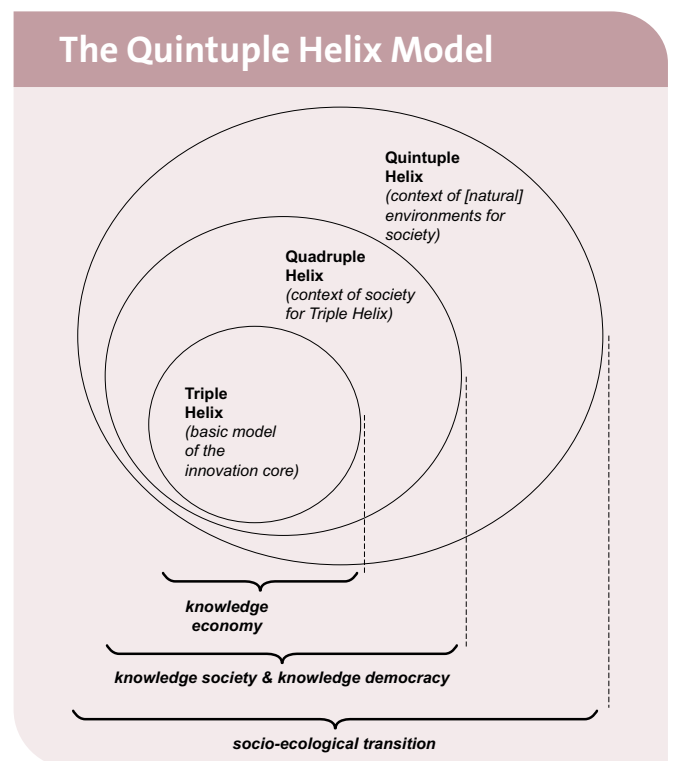
increasing electrification of more of the economy⁴. Today, increasingly it also includes supply - side sector-coupling, such as the production of green hydrogen.

These pathways can be pursued concurrently.

Urban planning and design also help manage cities' energy demand and emissions. For instance, cities of the future could be '15-minute cities' in which amenities are within a nearby, easily accessible travel radius; communities could be planned to integrate public transit, bicycling and other low- or no-emissions transport; and green cover can reduce energy demand for cooling.

PILOTING AND SCALING HIGH-TECH INNOVATION

When a city adopts an innovative technology, that adoption must be implemented in consultation and synchronisation with the 'quintuple helix' of stakeholders: government, the private sector, science and technology, the public, and the natural environment. (The terms 'quadruple helix' and 'quintuple helix' are more typically used to describe innovation models that encompass these various stakeholders' knowledge and interactions⁵.) For example, NetZeroCities helps cities as they change how they govern their climate transition, ensuring that a wide swath of stakeholders have the chance to give input on their plans.



¹ EU Mission: Climate-Neutral and Smart Cities.

² Urban Energy, UN Habitat.

³ Concilio, G., Li, C., Rausell, P., Tosoni, I. (2019). "Cities as Enablers of Innovation". In: Concilio, G., Tosoni, I. (eds) *Innovation Capacity and the City*. SpringerBriefs in Applied Sciences and Technology. Springer, Cham.

⁴ Towards a greener economy in Europe through "sector coupling". UNEP, 17 April 2020.

⁵ Carayannis, E.G., Barth, T.D. & Campbell, D.F. "The Quintuple Helix innovation model: global warming as a challenge and driver for innovation". *J Innov Entrep* 1, 2 (2012).



For example, the Greek city of Kozani has an old and poorly insulated building stock that is subject to cold winter weather. It struggles with uncertain generation of renewable energy locally, as well as fluctuating energy prices and supply due to the Ukraine conflict.

Kozani, a city of about 67,000 people in northern Greece, now seeks to develop and pilot the use of existing innovative technologies such as green heat modules, which convert green electricity into storable high-temperature heat for industrial processes. It plans to complement this with other technologies such as digital twins and Building Information Modelling for a just transformation. Adopting green heat modules could serve many district heating networks in Kozani and elsewhere, and the stored heat could be used for industrial, residential and commercial applications.

To most effectively implement this pilot activity, the city will need to work with stakeholders from across sectors, from citizens and academia to private-sector companies and NGOs.

Besides high-tech and social innovation, ecological transformation also demands low-tech or appropriate innovation, typically on the demand-side. Making public transport more accessible and convenient, increasing pedestrians' safety, or retrofitting buildings to be more energy-efficient can go a long way towards driving cities' net-zero transformation, for example.

A FRAMEWORK FOR FOSTERING SOCIAL INNOVATION

Bringing about ecological transformation for cities is not just about implementing cutting-edge technological change or top-down urban planning, however. Climate change and

other sustainability challenges are a democratic problem, not just a technological one. Thus, for cities to engage in ecological transformation, they must also adopt and scale *social innovation* – as Jane Jacobs foreshadows when she writes 'cities...created by everybody'.

What is social innovation? It is not separate or distinct from other kinds of innovation. Rather, it is developed through a co-creative approach in a local context, addressing people's needs which are otherwise not solved by the state or private offerings. Social innovation for ecological transformation might look like community composting, co-housing, bike-sharing and car-sharing, or community solar programmes (versus solar panels installed by individual residents). Usually, social innovation has environmental and social co-benefits beyond the initial objective, such as better health outcomes, reduced waste, and improved engagement with residents.

Social innovation doesn't have to be free of charge for residents to access; these solutions can involve private sector actors and be part of a market economy. A community might charge a nominal fee to develop and host an app that residents can use; or make a

collective decision about where its electricity (a paid service) comes from. What matters is that social innovation meaningfully includes the people who are meant to benefit.

Social innovation can take place at various scales. It may be bottom-up, led by neighbourhood-level activities; top-down, with city governments initiating and incorporating social innovation into their programming; or a mix of the two, with approaches such as participatory budgeting that co-create policies with residents. It can even be digital: integrating users into the design of digital services makes for a much smoother user experience on government platforms.

Cities have a leading role to play, not just in meeting the climate goals and targets set out by international frameworks such as the COP21 Paris Agreement, but also in ensuring that decarbonisation efforts are just and equitable



What factors, then, contribute to an enabling environment for social innovation? Research by Universidad Politécnica de Madrid and Politecnico di Milano uncovers the following key enablers:

- Education and capacity-building strengthens the skills and processes that organisations need to engage in practices such as Tu Decides youth participatory budgeting, which expanded people’s capacity to act and interact with public administration
- Information and awareness-raising engage audiences through communications campaigns such as Climate Meal labelling, which highlighted climate-friendly dining choices
- Financial enablers provide strategic and long-term funding, such as the national-level Viable Cities initiative in Sweden
- Public policy: For example, as Paris’ ‘15-minute city’ concept was infused into public policy, it has been translated into bike lane expansion, pedestrianised streets for safe trips to school, and the placement of amenities near where people live⁶.
- Regulatory frameworks such as Bologna’s Citizen Collaboration Pacts empower citizens to participate in climate and other decision-making, and are replicable elsewhere
- Technological innovation: many social innovation initiatives draw on clean energy and other technologies, and can themselves be the source of tech innovation.

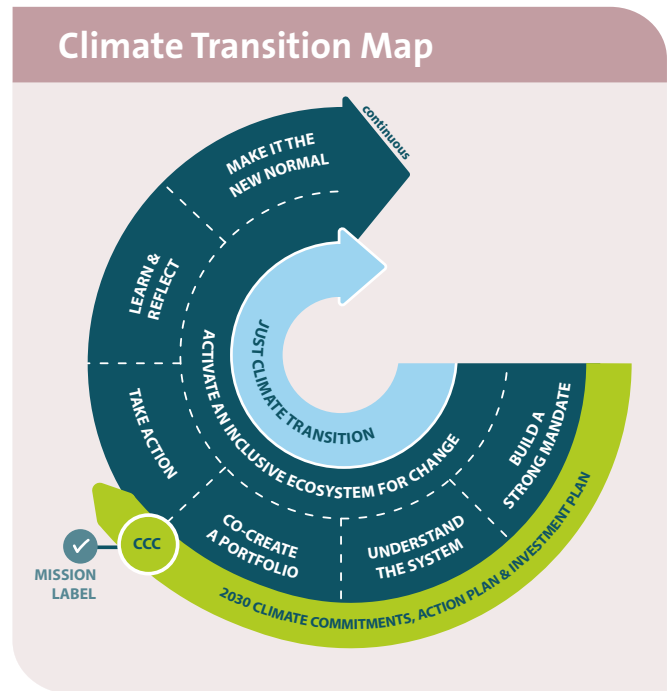
Finally, this framework must be underpinned by ways of measuring, monitoring and learning from ecological transformation initiatives and practices.

CITIES, COLLECTIVELY

To accelerate innovation, cities might participate on national platforms, which together with other intermediaries can bridge the gaps between cities and across many levels of government, from cities to national governments to the European Commission.

For example, besides straightforward peer-to-peer knowledge-sharing, NetZeroCities facilitates cities’ collective innovation. NetZeroCities partner EIT Climate-KIC (Knowledge and Innovation Community) has facilitated exchanges between Spanish cities, which have built a platform for learning, communicating targets and coordinating action for sustainable innovation. Seven Spanish cities – Barcelona, Madrid, Seville, Valencia, Valladolid, Vitoria-Gasteiz, and Zaragoza – have teamed up on collective innovation like finding new financing models for ecological transformation. Meanwhile, seven Dutch cities together are exploring ways to leverage private and government finance for ecological transformation⁷.

The size, resources and diversity of a city force it to continually manage public opinion, coordinate and negotiate public-private partnerships, and build regulatory frameworks that both protect citizens and enable private sector innovation to flourish – all vital skills and practices for fostering innovation



CONCLUSION: MISSION-DRIVEN SYSTEMS INNOVATION

Finally, to make technological innovation, social innovation, or cities’ collective innovation truly transformative, systems approaches are needed.

“A systems approach is not a thing you do, it’s how you do things,” says Climate-KIC’s Luise Fischer, a consortium partner on NetZeroCities. What’s more, action for systems change is not linear: it is an ongoing, iterative process of analysing and understanding the system; designing solutions; acting; learning; building coalitions; and making improvements. Investment and participation in that iterative process stems from a long-term mission, in this case ecological transformation.

To meet the challenge of ecological transformation at scale, we need to rapidly multiply the number of agents of change taking part in transformation – and accomplishing that will require radical collaboration, from redefining who is a citizen or urban stakeholder, to significantly deeper engagement and participation⁸. We need distributed agency and collective action across public, private and civic sectors of the city – to create not just a city but also a future that is by everybody, for humanity.

⁶ Salome Gongadze & Anne Maassen (2023). Paris’ Vision for a ‘15-Minute City’ Sparks a Global Movement. *World Resources Institute*, January 25, 2023.

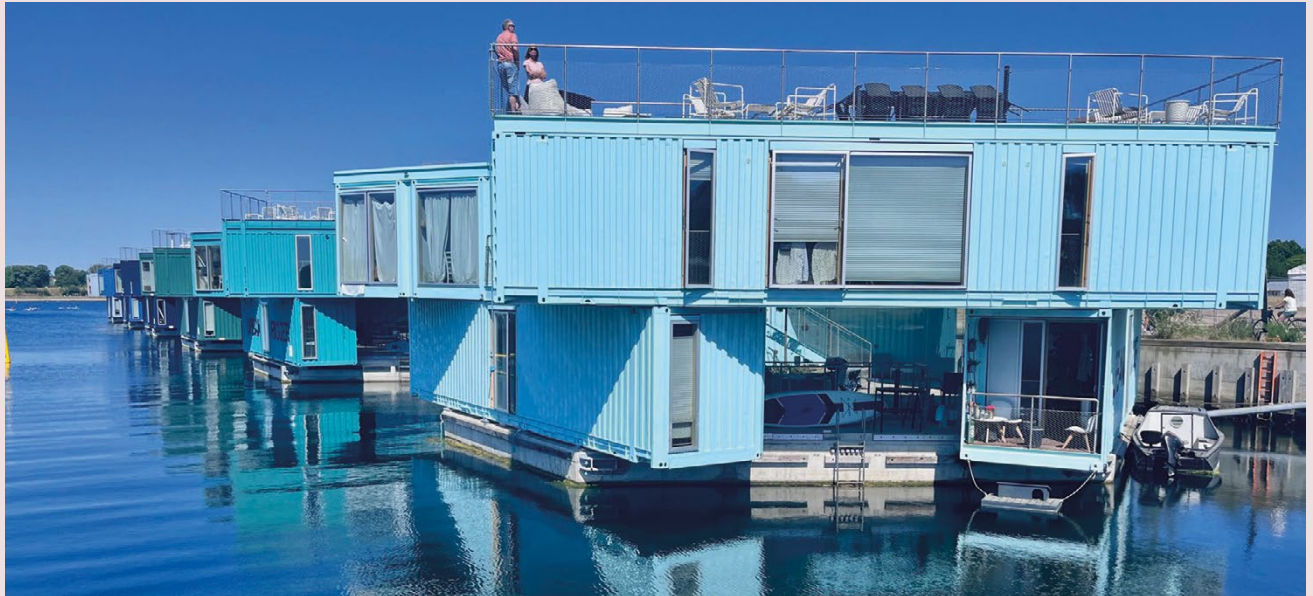
⁷ Katherine Peinhardt, ‘Stronger Together: Multi-City Pilot Cities Teaming Up’.

⁸ NetZeroCities, (2022). Deliverable 8.1: Desktop report on engagement. A NetZeroCities call to action for a participative transition to carbon neutrality and beyond. Available at.



URBAN RIGGER AND FLOATING CITY SOLUTIONS FOR ECOLOGICAL TRANSFORMATION

Anna Rosa Rylander and Signe Ryborg, Urban Rigger



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Signe Ryborg is the Head of Communications at Urban Rigger. She has over 20 years of experience in the fields of policy, consulting and communications.

The Danish capital of Copenhagen, a port city built on two islands, has piloted an affordable and sustainable housing solution that floats on its unused inner harbour. Completed in 2019, the Urban Rigger student housing complex is designed to be energy-efficient and built from upcycled shipping containers. The floating construction offers cities a way to extend their liveable area and address housing shortages while potentially increasing resilience to sea-level rise.

For centuries, people who live near and on water have constructed floating communities and infrastructure. These include the floating islands of Lake Titicaca on the border of Bolivia and Peru, built by the Uros people out of bundles of reeds; *kelongs*, the stilted fishing platforms of Malaysia and Indonesia; and floating agriculture in Bangladesh, where people raise vegetables on water-hyacinth beds in the flood-prone monsoon season.

Floating infrastructure can be adapted, too, to the needs of densely populated cities. It can serve as an innovative

and equitable housing solution. It can be a means of climate resilience, given that more than a billion people in low-lying cities and settlements are at risk from coastal-specific climate hazards by 2050.¹ Designed well, it can also help to create a sense of community among residents.

The Urban Rigger housing complex was built with these objectives in mind. The first prototype 'Rigger' was developed in 2016 by Danish entrepreneur Kim Loudrup in close collaboration with the Bjarke Ingels Group, a Danish architecture firm, to address a dearth of student housing.

DESIGN AND COMMUNITY

Each Rigger consists of nine upcycled shipping containers stacked atop a floating concrete platform to create 12 apartments plus communal living spaces. The platform also has a basement which houses amenities such as storage rooms and laundry. The structure is prefabricated and towed to its site.

¹ Dodman, D., B. Hayward, M. Pelling, V. Castan Broto, W. Chow, E. Chu, R. Dawson, L. Khirfan, T. McPhearson, A. Prakash, Y. Zheng, and G. Ziervogel, 2022: Cities, Settlements and Key Infrastructure. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 907–1040, doi:10.1017/9781009325844.008.



Urban Riggers are energy-efficient and use current energy technology. Each Urban Rigger gets about 75% of its heat from the surrounding seawater through pumps. It also generates electricity from rooftop solar panels, while its ventilation system recovers roughly 95% of heat.

The complex is designed to be a living community: communal spaces, a central open courtyard, annual investments to improve community welfare, and residents' meetings and a residents' app all help foster interaction. Altogether, some 100 residents live in its 72 apartments.

The complex is built at the disused industrial site of Refshaleøen, a former shipyard. Along with other public uses, such as events and festivals, art galleries and a street food market, it helps revitalise the space and brings conscious lifestyles to cities.

PUBLIC ENGAGEMENT AND SCALING UP

In theory, replicating the Urban Rigger design requires only a sheltered harbour with sufficient depth and open space. In practice, developing urban floating housing can mean navigating a maze of regulations about what is allowed to be built where, as well as technical requirements and safety standards for connecting to the electrical grid and sewer system. Making floating infrastructure equitable also means ensuring access to city amenities and ensuring

that a diverse swathe of city residents has access to the infrastructure rather than creating wealthy enclaves.

While these regulatory and access requirements vary by location, in Copenhagen, the Urban Rigger complex rents harbour space from the municipality. The Urban Rigger team has engaged and continues to engage with city administrators, politicians, harbour-users and other citizens, and keeps abreast of current regulations.

Next, Urban Rigger plans to expand to other sites in Denmark and begin to build with wood as a more sustainable, renewable material. It has been cleared to rent apartments to seniors as well as students, to diversify its residential community. And in future, the Urban Rigger team also aims to design floating structures for other housing typologies.

FUTURE PLANS

Today, as the crises of sea-level rise and housing affordability become more urgent, there is growing global appetite for floating infrastructure as an adaptation to these twin challenges. Floating infrastructure can also offer a sustainable alternative to land reclamation and provide space for agriculture or solar energy.

In the Netherlands, cities such as Rotterdam are already home to floating homes, office buildings and even a floating farm as part of its adaptation and resilience measures against flooding. Other floating cities and developments are being planned in Busan, South Korea, and in the Maldives.

In its Sixth Assessment Report, the Intergovernmental Panel on Climate Change notes that Rotterdam's municipal government and private sector work directly together to create "an institutional environment that favours eco-innovation", and that the city and its construction sector are building a body of knowledge, experience, and expertise around the technologies, design and engagement for floating cities. With its existing complex as proof-of-concept, Copenhagen's Urban Rigger project joins this body of knowledge and expertise. Replicating and scaling floating infrastructure is a vital opportunity for cities and the private sector alike.

Floating housing such as Urban Rigger's is not a silver bullet against coastal climate hazards. But driven by the urgent need for climate adaptation and resilience, with some 0.7m of sea-level rise already locked in by the end of the century, it can be one of the innovative solutions that humanity needs for ecological transformation.



HOW INNOVATIVE SOLUTIONS HELP VEOLIA TO DRIVE ECOLOGICAL TRANSFORMATION WITH ITS STAKEHOLDERS

Catherine Ricou
Head of Innovation of Veolia



Vig'ileo, Veolia's latest hypervision center for managing the water service of the future - launched by the Métropole Européenne de Lille.

As the Head of Innovation at Veolia, Catherine Ricou is supporting the company to cultivate a culture of innovation in pursuit of ecological transformation. Because of the company's work in strategic domains including water management and technology, waste recycling and local and decarbonised energy management, Veolia is in a privileged position to drive the ecological transformation of its customers and partners, as well as its own. In this article, Catherine Ricou shares real world examples of the innovation solutions that the company is deploying in pursuit of these goals, blending new technologies with innovative business models and processes. These examples, alongside the investments the company is making in fostering innovation internally and externally, can serve as inspiration for many other companies.

Catherine Ricou became Head of Innovation of Veolia in 2022. A graduate from AgroParisTech, Catherine has more than 25 years of experience in the field of environmental management, water, waste and energy recovery, with roles in engineering and operations, and finally strategy and innovation. Since the merger with Suez by Veolia, Catherine has taken responsibility for innovation for the new scope of Veolia to develop solutions tackling challenges including: climate, energy, pollution management and circular economy. Previously, she managed capital planning for water, engineering services and related innovation in the United States for Suez.

INTRODUCTION

As they increasingly recognise the urgency of addressing climate change, scarcity of resources, pollution and loss of biodiversity, companies become strongly motivated by the imperative to address their environmental impacts, including reducing carbon emissions and meeting net zero targets, reducing pollution and building circular loops to reduce resource wastage.

Veolia is in a somewhat unique position. Of course, the company has set its own target to achieve net-zero emissions by 2050, as well as additional targets concerning other major environmental issues. But, thanks to its capabilities with 165 million euros invested in 2022 and 14 R&D centers across the globe, experience and portfolio of innovation – nearly 5,000 patents – we provide in strategic domains including water management and technology, waste recycling and local and decarbonised energy management, Veolia is also set to play a major role in supporting other companies' and jurisdictions' sustainability journeys.



In 2022, the company published its new statement of purpose; declaring that *"We develop and implement locally solutions to depollute our vital resources and preserve them from depletion, solutions to decarbonize our ways of living and producing and adapt them to the consequences of climate change."* The same year, Veolia's actions helped decarbonize their client's activities, and contributed to avoiding 14 MtCO₂ being released in the atmosphere and saving 320 million m³ of water compared to 2019 thanks to reducing network leakages.

In support of our purpose, Veolia has made innovation one of its key assets to achieve ecological transformation. Using a range of innovation approaches combining technologies with new business models, and in collaboration with a wide range of partners and experts, we are pursuing the development of practices that can drive significant carbon reductions and other reductions in environmental harms.

As Head of Innovation at Veolia, I have the honor and responsibility of leading the company's work across major strategic innovation pillars of ecological transformation: decarbonisation, depollution and resources' saving and regeneration.

Innovation is not the work of one siloed team, but the day to day contribution of all employees including in market, operations, sales and support functions. A crucial part of my team and I's role then, is to create the conditions of ideation, incubation and collaboration for the definition of new projects and the deployment of innovation across our teams. In this article, by sharing examples of projects and approaches that we are pursuing, the mindsets and skill sets we are cultivating in doing so, I hope to illustrate the pace and scale of change that large businesses are pursuing in support of ecological transformation, and the crucial role that innovative companies like Veolia can play in driving wider change through innovation.

THE ECOLOGICAL TRANSFORMATION IS FACING SEVERAL CHALLENGES WHERE INNOVATION CAN PROVIDE SOLUTIONS

While some may argue that new technologies could lead, at the end, to increasing unexpected negative impacts on the environment, it is of the utmost importance to conciliate innovation with clear benefits in terms of energy consumption, raw materials and resources utilization, and waste generation. At Veolia, any new innovation solution and technology is weighted and rated regarding its net

contribution to the ecological transformation. This way, we aim at developing meaningful innovation that contributes to regenerate ecosystems that have been damaged and polluted by the extractive and throw-away model of previous decades.

But innovation in the context of ecological transformation is not only a question of technological advancement.

Alongside this comes innovations in business models, in notions of value and social equity and accessibility. Water reuse either for municipal markets, agriculture or industrial needs is a clear example. The technologies exist to produce reused water of very high quality. However, the challenge of implementing the innovation relates to social acceptance of reusing water for agriculture, or even more for potable drinking water, on top of defining the overall governance for water usage and competition between uses in the context of water scarcity.

In our work with other companies and public entities, Veolia is deploying a wide range of projects that illustrate and promote these wider forms of change. Next, I will share some of those examples.

Veolia is in a somewhat unique position [...]. Thanks to the capabilities [...], experience and portfolio of innovation we provide in strategic domains including water management and technology, waste recycling and local and decarbonised energy management, Veolia is also set to play a major role in supporting other companies' and jurisdictions' sustainability journeys

DELIVERING A MORE RESPONSIVE APPROACH TO CIRCULAR MATERIALS

The world's current linear economic model, which centers on the unsustainable cycle of "extract, produce, consume, throw away", poses a grave threat to our planet's limited resources and the well-being of its 8 billion inhabitants. While several planetary limits have already been exceeded, addressing this challenge is crucial, especially with the growing adoption of new green technologies, like electric vehicle batteries, wind turbines, and photovoltaic panels, which require substantial amounts of critical materials such as copper, cobalt, nickel, lithium, and rare earths.

Veolia is spearheading efforts to address this challenge. For example, in circularizing the production of electric vehicles batteries; from mechanical recycling to refining lithium and other strategic metals, which has been strongly encouraged in Europe via regulations that promote the re-incorporation of strategic metals in new electric vehicle batteries.

Another example is the company's Plastilooop, the first global integrated platform for circular polymers, that relies on an extensive network of experts and 37 plastic recycling plants around the world. The new offer combines the technological ability to produce high-quality recycled products with a circularized and demand-based business model. This combination of innovations is helping to create purer recycled outputs that not only curb the need for new materials but also reduces pollution sources.





As Samra wastewater treatment plant, Jordan. This plant treats and redistributes wastewater from the capital and the surrounding area. 25% of the country's agricultural water requirements and 12% of global water needs (for domestic use in particular) come from this site.

While the technologies involved are impressive, the most notable innovation is the approach taken. With Plastilooop, Veolia starts with the end product and works with our customers to define the exact qualities and standards their products require, and produce those materials from recycled products. Whereas most recycling processes begin with “let’s recycle the waste and find uses for it”, here, we ask “let’s establish what our clients need, and recycle for that outcome.” By taking a similar approach, other businesses can embrace a core principle of circularity; pursuing the highest value re-use of any material in sequence and ensuring it is used, not wasted.

REMOVING POLLUTANTS MORE EFFECTIVELY AND EFFICIENTLY

Across the globe, the urgency of removing pollutants from the environment is becoming increasingly evident. The Food and Agriculture Organization of the UN paints a concerning picture: roughly 33% of the world's soil is currently degraded, a condition largely attributed to the excessive use of chemical fertilizers. This signifies that the earth's natural capacity to filter out and neutralize pollutants is waning,

Innovation in the context of ecological transformation is not only a question of technological advancement. Alongside this comes innovations in business models, in notions of value and in social equity and accessibility

illustrating the importance of innovative de-pollution initiatives to extract contaminants from the environment.

Water is central to the fight against pollutants in the environment. Where water flows, pollutants go. Hence the importance of detecting pollutants which result from industries, agriculture and our own consumption (pharmaceutical residues, residues of pesticides, microplastics...). Legislators across the globe, and in particular in the EU and US, are taking action to tighten regulation on effluents as well as water quality.

Veolia has placed depollution and addressing new pollutants as a cornerstone of its innovation strategy. Veolia's approach encompasses various pollution types across multiple environments, including soil, air, and water. The company has developed a range of technological solutions; from zero-liquid discharge solutions, reverse osmosis processes and flue gas treatment; for private and public water utilities in addition to strategic industrial markets, across all our geographies, with a large footprint in North America, Australia, Asia, Europe and Middle East.



The challenge that Veolia faces isn't only about developing advanced treatment technologies. These solutions could often come with an increased energy footprint and the need for supplemental chemicals. Recognising the importance of considering these multiple environmental trade-offs and challenges together, we are also turning our innovation towards enhancing the efficacy and efficiency of these processes to minimize secondary environmental impacts.

FROM GRAY TO GREEN INFRASTRUCTURES

Cities around the world are grappling with the dual challenges of increasing urbanization and climate change. With city jurisdictions, Veolia is navigating this challenge by shifting from a gray to a green&gray approach to infrastructure, described by the European Commission as a planned network that blends both natural and semi-natural areas with other environmental elements. Nature Based Solutions have been identified by the IPCC as key green infrastructure solutions for Climate adaptation and

From ideation, to incubation and then industrialization, innovation is about people, talent, discipline, market knowledge, processes, understanding of business models, perseverance, and entrepreneurial spirit

Water resilience. Its purpose is twofold: to provide human well being and to give essential ecosystem services to cities thanks to biodiversity. Instead of viewing nature as a challenge, green infrastructure innovations see it as an ally in building resilient, efficient and biodiverse infrastructures and urban ecosystems.

An example of this transformative approach can be seen in Alicante, Spain. The Urban Flood Park La Marjal, a collaboration between Aguas de Alicante and the Alicante City Council, spans 3.6 hectares. This initiative stemmed from a genuine need : protecting Alicante from severe flooding, while reviving biodiversity and improving health and well being.

The park's design, with green spaces with four Mediterranean native vegetation types and two purpose-built ponds, designed to mimic Mediterranean wetlands, revolves around water retention. Two strategically placed collectors in flood-prone areas harness rainwater, guiding it safely into the ponds. This not only helps combat flooding but provides a sustainable approach to managing water.



Urban Flood Park La Marjal in Alicante, Spain.



And this infrastructure's design logic extends beyond mere water collection. The harvested rainwater isn't left stagnant – using the principle of a circular water management system with a cascade for water oxygenation, and aerators to avoid algae blooms. Excess water is also rerouted to wastewater treatment facilities to be reused for irrigation and city needs.

The park has been proposed and designed by Aguas de Alicante, a 50-50 joint venture between Veolia's Spanish subsidiary and the Alicante Municipality. And operation and maintenance responsibilities are shared between the Alicante City Council (gardening, irrigation systems, landscape design, park cleaning, security, and social activities) and Aguas de Alicante (water quality, algae control, pumps, rainwater inlet control from the lagoons, and ornithological center management).

FROM VOLUME TO VALUE

Veolia is also adapting its business approach to better align with climate change objectives by moving from a "volume to value" model. One of the earth limit boundaries is the Freshwater Use: This boundary concerns the unsustainable use of freshwater resources, particularly in terms of excessive water consumption from rivers and aquifers. Facing the climate adaptation challenge, Veolia is providing Water conservation solutions to ensure the reduction of "volume" of water being used in all the ecosystems, to reduce the risk of Water scarcity.

For example, on May 11, 2023, Veolia renewed a contract to supply water to the Lille metropolitan area for the next ten years. Unique to this contract is a stipulation that the company aims to reduce water consumption by 10% throughout the contract's duration, a first in France. If not met, financial penalties have been agreed upon. As Estelle Brachlianoff, the CEO of the group, pointed out, this contract represents a change in the company's traditional business model, where the focus is now on conservation and value.

To achieve this, Veolia plans to leverage advancements in water management technology. The company will work on limiting water leakage by introducing 5,000 sensors and probes to their network and by renewing close to 12,000 drinking water connections. Another integral feature is the "leak alert" system, which provides remote meter reading capabilities piloted by Vig'iléo, an extension of Veolia's Hubgrade hypervision centers. This system is designed to identify unusual increases in consumption, potentially pointing to leaks, and can provide alerts in as little as 48 hours.

Furthermore, Veolia understands the importance of engaging its consumer base, which numbers 1.2 million in the area. To this end, the company will be providing "consumption coaches" to assist users and developing apps

that offer insights into individual water usage alongside an innovative approach for a balanced tariffication. Collaborative efforts are also planned with large-scale water consumers such as businesses, local authorities, and housing managers. Veolia aims to finalize 1,200 water-saving contracts, with the goal of each achieving a 15% reduction in water consumption.

Veolia is particularly proud of this innovative approach, which aligns commercial success with positive outcomes for the environment and communities, and which illustrates the opportunity that many other companies have to adjust their business models to serve people, planet and profit at once.

CULTIVATING AN INNOVATION SPIRIT

INSIDE OUR WALLS

From ideation, to incubation and then industrialization, innovation is about people, talent, discipline, market knowledge, processes, understanding of business models, perseverance, and entrepreneurial spirit. As an organization of more than 220,000 people Veolia needs to create an enabling environment and invest in fostering these features to create an innovation spirit at the company.

Because innovation is part of their daily missions, it is our duty to train our employees to provide them with all the skills and tools necessary for innovation, alongside an enabling environment in which it can take place

Because innovation is part of their daily missions, it is our duty to train our employees to provide them with all the skills and tools necessary for innovation, alongside an enabling environment in which it can take place. This is the mission statement of the Innovation Academy that Veolia launched in 2022 to boost the innovative mindset and unlock the innovation potential across the group.

In its first year, the Academy has focused in particular on working with business units to develop innovation programs in their territories. Based on these programs, the Academy is working with managers to spread innovation amongst the culture of Veolia and developing supporting tools and training – both for innovation focused staff and to help all employees to identify the role they can play, even when innovation is not formally part of their job description.

Already, innovation is permeating the culture of the company, and gives us confidence in our ability to drive our own transformation and those of our clients in the coming decades.

OUTSIDE OUR WALLS

To give ourselves the means to respond to the urgent need to find new solutions to the ecological crisis, Veolia is developing Open Innovation ecosystems. These Open Innovation programs





Electric car battery recycling.

and initiatives enrich or accelerate projects for which in-house knowledge is less or to discover and support new solutions that complement or enrich our own. First and foremost, this means investing in start-up incubators, with which we have forged numerous partnerships around the world.

For these start-ups, like PureControl with which Veolia optimizes energy consumption in Wastewater treatment plants for example, the support of a Group like Veolia often makes it possible to access resources, visibility and credibility. For Veolia, this often means agility and reactivity to address activities that are still considered "niche" but with great potential. Open innovation at Veolia also translates into partnerships with scientific and academic institutions, to help bring to light biological, physical or chemical issues that are still not fully understood, and to accelerate fundamental knowledge.

CONCLUSION

Working with leading thinkers and institutions, including many that have contributed to this FACTS report, I and all of Veolia are motivated by the responsibility and opportunity of putting innovation to work for people and the planet.

Pursuing ambitious targets to reduce our own emissions is of course essential. What is most exciting, though, is the potential to be a driving force of the transformation journey of so many other organizations and places, and to do so using what has made this business a success; our capacity to innovate. The examples shared in this article illustrate the combination of technological and business model innovations that are helping us to succeed by supporting our clients' transformations in support of a better planet.

While the nature of our business perhaps places Veolia in a privileged position in terms of the scale of potential impact, the principle of seeing an organization's purpose as being to support others to drive the ecological transformation is one that many businesses can adopt. Achieving this purpose requires a deep investment in the people and practices of the organization to foster an innovation mindset, and it means looking around the corner and outside of your walls to work with others for speed and scale. It means adopting business models that mean your company does well when the planet benefits.



THE ROLE OF THE STATE IN ENVIRONMENTAL SERVICES INNOVATIONS

Henri Boyé
Energy and water consultant



Henri Boyé is a graduate of the Ecole Polytechnique and Ecole Nationale des Ponts et Chaussées (X-Ponts) and Honorary General Engineer of the Corps of Bridges, Waters and Forests. He began his career as a technical officer at the French Ministry for Industry before joining EDF as Director for Africa, then becoming Executive Director for Morocco. He next took a post at the Environment Ministry as Energy and Climate Coordinator and specialist in renewable energy for the CGEDD (higher council for the environment and sustainable development). Then President of a cooperative project called EMACOP (coastal marine and port energies), he is currently an energy and water consultant, working particularly with countries in Africa.

The public sector's power to encourage innovation is significant and frequently underestimated. Its support, which takes a variety of forms, is always useful. This article presents the testimony of a retired senior technical officer, Henri Boyé, Honorary General Engineer of the Corps of Bridges, Waters and Forests, formerly Director for Africa at EDF and Energy and Climate Coordinator for the CGEDD, today an international water and energy consultant who is very involved in state support for innovation in France as well as in Europe and Africa. He describes an example of state-supported innovation in renewable marine energy: the oscillating membrane tidal power generator from EEL Energy.

INTRODUCTION

The public sector's power to encourage innovation is frequently underestimated. The state plays an active role in stimulating growth based on innovation. Some countries do, however, produce more innovations than others. This article concentrates on the role the state can play to support innovation that is mission-focused and directed toward a specific goal, as well as the ways in which governance and policies can improve a country's capacity for innovation.

I have been interested in innovations throughout my career, and spent a considerable time supporting them, including during the time I worked as part of the French state system. I no longer work for the state, which allows me to express my more personal views, as requested by the Veolia Institute, on the role of the state in implementing innovations in environmental services.

In 1988, as a young engineer working for EDF, I was one of the founders of an association called TRANSINNOVA, which focused on transferring skills, technologies and innovations, and was lucky enough to take part in a mission to the USA, a country that was the world leader in innovation at the time. A standout example of that innovation is 3M, inventor of Post-its, small removable self-adhesive paper sheets that use a non-drying glue. This was not the product originally being researched, but is an example of serendipity, the result of a chance encounter between a commonplace situation and a seemingly unconnected concern that ultimately produced a useful creative combination that found a market all over the world.

In reality, the innovation process is far longer and far more difficult, and a lot more innovation projects fail than succeed. It takes time, money and resources as well as an entire ecosystem and the involvement of countless actors from the value chain – inventors, laboratories and universities, patent holders, startups, application developers, investors and financiers, manufacturers, services companies and subcontractors – to journey through the "valley of death" that is the development phase before finally arriving at the industrial phase.

Innovation corresponds to the introduction of new technologies, new uses or new methods, and modernization processes within a competitive system, and it often faces difficulties that center on resistance to change.



THE ROLE OF THE FRENCH STATE AND EUROPEAN UNION IN SUPPORTING INNOVATION

At the French and European levels, there is considerable aid for innovation as well as bodies that support it. There are generous incentives and financial assistance, with potential projects selected from a wide pool of candidates.

In France, sources of state innovation support include the ANR (national research agency), ADEME (the environment and energy management agency), IEED (institutes for excellence in decarbonized energy), state innovation challenges, FASEP (private sector assistance funds), BPI France (the public sector investment bank), SGPI (the general secretariat for future investment), CEA (alternative energies and atomic energy commission), IFP Énergies Nouvelles (French petroleum institute for new energies), CNRS (national center for scientific research), BRGM (geological and mineral research bureau), the major energy and environmental services groups (EDF, Engie, Total, Suez and Veolia) that all have their own in-house missions but also respond to calls for projects from the state, the European Union, SER (renewable energies syndicate), Coopération Européenne, OME (Mediterranean energy observatory), Plan Bleu Méditerranée, and so on...

For example, ANR, which administers the France 2030 program on behalf of the state, works on implementing the commitments of the future investment programs (PIA) created in 2010 to stimulate job creation, boost productivity, and ramp up the competitiveness of French businesses by channeling investment and innovation into priority growth-creating sectors.

Seed funds specialize in providing innovative businesses with capital and participate in the initial fund-raising process designed to finance the first costs involved in setting up a company, paying for research and development, feasibility studies and market research, or the cost of expert financial and legal advice. There are a great many seed funds, including the 600-million-euro national seed fund (FNA) created as part of the future investment program and managed by BPI France Investissement. **Regionally**, there are also semi-public seed funds, since regional authorities prefer to work with companies from their regions to support their local economies.

I should also mention the **role the state plays in setting standards and regulations**, which has a major impact in the development of innovative environmental solutions.

Afnor (the French standards agency) publishes guidelines on the management of innovation. This non-binding document describes the ideal trajectory for innovative businesses to follow.

There is an extensive **process of selection and support** to help innovations get off the ground and then over the long term, tailored to match their degree of maturity. Selection is an important and difficult process: where should help be targeted? Using which criteria? This is the difficulty of having

to make choices. At the European level, on seven separate occasions I myself was part of assessment, grading and selection groups looking at research projects submitted in response to an EU call for research and innovation solutions in the Mediterranean. The assessments were made by a team of experts from various countries and backgrounds and without any conflicts of interest.

A FRENCH INNOVATION INITIATIVE: IEEDS (DECARBONIZED-ENERGY EXCELLENCE INSTITUTES)

The goal of the IEED future investments program is to nurture the emergence in France of five to ten IEEDs within technology innovation campuses that have a global reach. After several rounds of calls for projects, each of the selected IEEDs receives funding to allow it to make investments and support its activities over the medium term. These institutes are structured as innovation hubs and include educational establishments, public and private applied research laboratories, prototyping, and at-scale demonstration capabilities via strategic public-private partnerships for research, training and innovation. They run research programs that leverage technology platforms for experimental developments focused on market-led needs, ensuring knowledge transfer to businesses via pre-established partnerships as well as positive socio-economic spin-offs of the results obtained.

Examples of IEEDs for high potential future-facing energy and climate sectors include geothermal, energy efficiency in buildings, tools for controlling and attenuating energy use, observation methods, adaptation strategies, marine energies, hydrogen

and fuel cells, solar energy, green chemistry and industrial biotechnologies, energy storage and smart networks, and CO₂ storage and capture:

- **FEM (France Energies Marines)**, in the field of renewable marine energy (offshore wind, wave energy and oceanic thermal energy); based in Brest.
- **Supergrid**, in the field of electricity transmission networks (development of systems for transmission of large quantities of electricity over long distances); based in Villeurbanne.
- **IFMAS** (French agro-sourced materials institute) in the field of green chemistry (such as biomass recovery, starch macromolecules in particular); based in Villeneuve d'Ascq.
- **Green Stars**, in the field of biofuels and CO₂ recovery (innovative processes for harvesting and biorefining microalgae); main site in Mèze.
- **IPVF** (Ile-de-France photovoltaic institute), in the field of new-generation solar photovoltaics (thin-layer technologies); based on the Paris Saclay campus.
- **VeDeCom** (low-carbon intelligent transportation systems) in the field of ground transportation and eco-mobility; based at Satory.
- **Geodenergies** (geotechnologies for decarbonizing energies)

At the French and European levels, there is considerable aid for innovation as well as bodies that support it, incentives and financial assistance, with potential projects selected from a wide pool of candidates



in the field of underground technologies (geothermal, CO₂ and energy storage); main site in Orléans.

- Other projects are also funded in the fields of energy efficiency and solar energy.

The state provides more than just funding, it also helps **support the projects**. From 2007 to 2015, I worked at CGEDD (now IGEDD – general inspectorate for sustainability and the environment) in the Sciences and Techniques department (now TECI - energy, construction and innovation transition), where I was Energy and Climate Coordinator specializing in renewable energies, photovoltaic and wind power, energy storage, energy efficiency, smart grids, waste and the circular economy, with particular expertise in renewable marine energy.

My role gave me a ring-side seat since many innovative project owners were sent to see me, sometimes the inventors of a one-in-a-million concept. This was how in 2011 I came to meet the people behind **EEL Energy**, a highly original and innovative project for an oscillating flexible membrane harnessing tidal energy without a turbine or fan.

INTERNATIONAL INNOVATION IN AFRICA AND ELSEWHERE

I have described the landscape of French state support for innovation. But what of innovation elsewhere in the world, especially in regions such as Africa where it is badly needed for ecological transformation? In these regions, Europe may bring technical and financial support as well as expertise in innovation selection and administration processes. Together with locally-relevant knowledge and expertise, such support can help African countries fulfill their ecological transformation and sustainable development potential through accelerating innovation. According to an analysis of the number of worldwide patents that is regularly updated by the **World Intellectual Property Organization (WIPO)**, innovation is primarily centered on the most developed countries and those from the global north, with the exception of China, which has overtaken the USA. Many actors, particularly the countries of Asia, are home to growing numbers of activities centered on scientific research and invention, a field previously monopolized almost completely by a handful of rich countries. In 2021,

EEL ENERGY, A 100% BIOMIMETIC OSCILLATING ELECTRIC EEL MEMBRANE, HARVESTS ENERGY FROM TIDAL CURRENTS BY MIMICKING HOW FISH MOVE

EEL Energy provides a disruptive tidal power technology that instead of employing a turbine, uses the current to move a flexible membrane that undulates underwater in a manner similar to a whale tail – an undulation that can propel certain species of fish to speeds up to 110 kph!

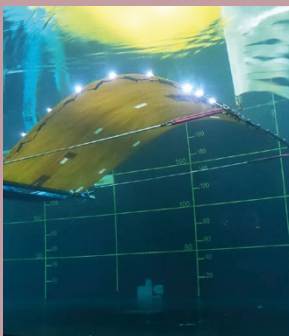
EEL Energy was set up in 2011 and the first small-scale tests were conducted in a tub on Rue des Ecoles in Paris, then in Boulogne at a tank belonging to IFREMER (French institute for exploitation of the seas). EEL Energy was presented at COP21 and received backing from BPI (French public investment bank). The project is financed by the European Union with the European Fund for Regional Development (ERDF). Then followed testing in the bay at Brest, a lengthy process that managed to overcome a number of obstacles. In 2022, the startup scaled up successfully with a 30-kW generator delivering 50% greater efficiency than conventional tidal power turbines. As I write, in 2023, EEL Energy has installed its first pre-commercial unit, a 30-50 kW machine,

on a section of the Rhône between the Cité Internationale district of Lyon and the town of Caluire, as part of a partnership with Voies Navigables de France (the inland waterway authority) for what will be the country's first tidal power farm. The teams are now working on a 250-kW river generator and a 750-kW tidal marine unit.

Demand for green electricity is exploding and marine energies, which are far more predictable than other intermittent renewables, will make a significant contribution to tomorrow's energy mix.

The company has already been approached by countries in Africa and the Americas for rural electrification projects, and from major European power companies for the development of offshore tidal power farms.

There is a critical need for constant and increased state support so that EEL Energy can become a world leader in its field.



In the IFREMER tank, and the bay at Brest.

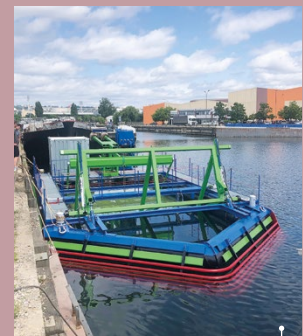


Photo of the barge on the Rhône in Lyon.



China lodged 1.59 million patent applications, more than twice as many as the USA (WIPO, 2022). This geographical breakdown of innovations may seem paradoxical: production of scientific knowledge and innovations is increasingly globalized and interconnected on the planetary scale, yet intensively concentrated in a handful of hubs.

As a specialized agency of the United Nations, WIPO contributes to meeting the UN's Sustainable Development Goals by supplying tangible services to member states, enabling them to use the intellectual property system to stimulate the innovations, competitiveness and creativity they need to meet these goals. It is only thanks to human ingenuity that it will be possible to design new solutions to eradicate poverty, boost agricultural productivity and ensure food security, combat diseases, improve education, protect the environment, accelerate the transition to a low carbon-emission economy, increase productivity, and stimulate business competitiveness.

The role the state plays in setting standards and regulations has a major impact in the development of innovative environmental solutions

RESEARCH, INNOVATION AND SUSTAINABILITY IN AFRICA

Sub-Saharan Africa is very badly under-represented in this worldwide race for patents. Africa will be home to a quarter of the world's population by 2050, but currently boasts only 2.4% of the world's scientists, fewer than 1% of all patent applications and fewer than 4% of all scientific publications (CNRS, 2021).

The fast-growing population of Sub-Saharan Africa is very young. Deforestation and the climate emergency represent a threat to the region, despite considerable potential for renewable, hydroelectric and solar energies, which remains underexploited. The ongoing slow pace of electrification is one of the causes limiting development and innovation.

For countries in the Organisation of African, Caribbean and Pacific States (OACPS), the **ACP Innovation Fund**, financed by the EU, is a key component in their research and innovation (R&I) programs. Following a European call for proposals published in October 2019, the ACP fund is financing 12 consortiums to provide support to R&I actors in OACP states. The support provided is both technical and financial, via capacity-building, assistance from peers, mentoring, networking, swapping experiences, and lobbying policymakers. The 12 projects are all located in a different geographical region and cover different fields – green agriculture, access to digital culture, climate challenges, health – while also reflecting local conditions and synergies and promoting local and indigenous wisdom and its use in furthering knowledge within inclusive innovation ecosystems. They are also linked to efforts designed to create a critical mass of qualified people with skillsets suited to the needs of the labor market.

One of the 12 projects is **PDTIE (project to roll out environmental technologies and innovations for sustainable development and reducing poverty)** that runs in DR Congo and Cameroon. It aims to lay the groundwork for the future by working to support the strengthening and improvement of applied R&I capacities by training targeted scientists, technicians and

engineers, providing these actors with the necessary material and financial resources, and supporting scientific and technical innovations that favor sustainable development and are suited to local contexts, needs and knowledge.

The outstanding natural wealth of this region of central Africa, thanks mainly to the network of waterways within the Congo River basin, offers considerable possibilities for environmental innovations in the field of renewable energies. This great untapped potential must also be seen in the context of extremely low electrification rates in both countries. According to 2019 data from the International Energy Agency, the electrification rate in Cameroon was 69%, compared to just 19% in DR Congo, making this one of the least

electrified countries anywhere in the world. The delay in delivering electrification is one of the factors limiting research and innovation.

In terms of emerging digital technologies for energy and the environment, Africa is developing very rapidly, using ICT for telephones and mobile payment apps, and for small decentralized solar-powered electricity networks including storage, with connected metering and remote pay-as-you-go systems for users to ensure the projects' financial viability.

CONCLUSION

Appropriate initial and ongoing support from public authorities and the state for energy and environmental innovations is indispensable to the achievement of progress and sustainable development. This support is available in France in many forms and is relatively well resourced.

There is a special focus on green technologies, technological incubators, collaborations with international partners, and non-profits that are active in researching and innovating to protect the environment.

Several important questions must be considered. Why do certain innovations succeed? Conversely, why in many cases do they fail, missing their window of opportunity?

If an innovation project is to succeed in tackling the challenges of today and tomorrow, it requires perseverance on the part of the actors involved, significant long-term financial backing (over 10 years in the case of EEL Energy's tidal generators), immersion in a stimulating ecosystem, connections to the market, properly taken opportunities, and maintaining a long-term competitive edge over rivals.

Specifically, it has to pass through the so-called valley of death, a critical moment in any business' innovation strategy, a phase that sees many startups fail as they scale up, a moment when investment is harder to attract, the risks are higher, and investors can lose faith that the project will succeed or become sufficiently profitable. It is during this critical moment that support from the state and the public authorities is absolutely critical if worthwhile projects are to succeed.



MOBILISING LARGE-SCALE CAPITAL EQUITABLY ACROSS BORDERS TO ACCELERATE IMPACT

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Plastic waste remains a global environmental challenge for oceans and waterways.
Source: Circulate Capital.

Ellen Martin is Circulate Capital's Chief Impact Officer. In her role, Ellen is responsible for driving impact and insights for Circulate Capital and managing ESG through the investment process. As a member of Circulate's leadership and investment teams, Ellen is focused on ensuring the firm's collective strategies, assets, and relationships deliver impact as it grows.

As External Affairs and Investor Relations Director, Amandine leads Circulate Capital's communications strategy and implementation. Amandine brings with her ten years of strategic communications expertise in stakeholder engagement, reputation management and public affairs. Amandine has been working for a wide range of actors, supporting each of them to define and implement impactful engagement strategies to address social and environmental challenges.

Circular economy solutions have the potential to address pollution, the climate crisis, health and livelihoods, and inequality. Circulate Capital was launched in 2018 to invest in solutions for the ocean plastic crisis in South and Southeast Asia, and has since broadened its investment focus to plastics circularity, including disruptive innovations across value chains, throughout high-growth markets globally. It partners with global brands and institutional investors and leverages development finance to transform circular plastic supply chains at scale. This article outlines the steps that Circulate Capital takes and which investors might consider to effectively mobilise capital at scale for ecological transformation and positive impact.

If there is a hallmark of the Anthropocene, the epoch in which everything on earth is shaped by human activity, it might be plastic. Today, the oceans are choked with plastic pollution, which can entangle or suffocate marine species, and which releases microplastics and endocrine-disrupting chemicals into the food chain.

Physical and chemical pollution is not the only problem that today's plastics create. In 2022, global greenhouse gas emissions from plastic were an estimated 1.8Bt, contributing to climate change.¹

So, can plastic pollution be halted at its source and prevented from reaching the ocean – or better yet, can demand for plastics be addressed so pollution need never arise? Addressing this systemic challenge requires capital to be mobilised at scale, and applied across the value chain.

Impact investment firm Circulate Capital was started in 2018 to tackle the issue by investing in solutions that prevent plastic pollution from entering the ocean. Since then, it has broadened its investment focus to plastics circularity, including disruptive innovations across value chains, throughout high-growth markets globally. To date, Circulate Capital has invested some \$80M and avoided 200,000T of CO₂ emissions, and aims to unlock \$1B to prevent 150 million tonnes of plastic pollution. Here are three steps that it takes to effectively mobilise capital at scale for ecological transformation.

ONE, UNDERSTAND THE SYSTEM AND ITS LEVERAGE POINTS

When Circulate Capital was started in 2018, its primary impact focus was to address the ocean plastics challenge and 'turn off the tap'. Its key metric was the amount of plastic pollution prevented from entering the ocean.

¹ OECD. Plastic leakage and greenhouse gas emissions are increasing. Accessed July 8 2023.





Arzeda's circular technology facility. Source: Arzeda via Circulate Capital.

Quickly, conversations around managing plastic pollution grew to encompass social and environmental factors: *how* to build inclusive, circular supply chains that also curb climate change. “At the beginning, we had separate conversations about how to fight the plastics crisis on one hand and the climate crisis on the other. Now, the circular economy is seen as a pathway to accelerate the transition to a net-zero economy,” says Circulate Capital external affairs and investor relations director Amandine Joly.

Today, while ocean plastic pollution continues to be a primary focus and it still aims to avert 150 million tonnes of plastic pollution by 2030, Circulate Capital invests end-to-end along the full value chain. That means thinking holistically to tackle pollution, facilitate the shift to circularity, mitigate climate change and boost climate resilience, and improve livelihoods.

Circulate Capital invests through two complementary strategies. *Recycling Supply Chains* invests in high-potential solutions along the recycling and waste management supply chains, while *Circulate Capital Disrupt* targets disruptive innovations such as novel re-usable materials, alternative delivery models, with great potential for technology transfer. The *Circulate Capital Disrupt* portfolio includes Circ., an advanced recycling technology innovator with patented technology that returns clothes to the raw materials from which they were made, and Arzeda, an industry-leading protein design company.

As part of its *Recycling Supply Chains* strategy, Circulate Capital is expanding the supply of recycled materials to cater to growing demand. A key goal is to support portfolio companies to produce high-quality recycled materials in quantities that enable them to supply global brands. For example, its investment supported plastic recycler Srichakra Polyplast to build India's first food grade polyethylene terephthalate

(PET) bottle-to-bottle recycling facility. It recently entered into agreements with Coca-Cola India and PepsiCo India to supply high-quality plastic resin for the companies' 100% rPET bottles. This growing demand and commitment from global brands, alongside Circulate Capital's investment, has supported Srichakra to successfully scale its recycling capacity sixfold since 2020.

Similarly, investment into Dalmia Polypro supported its growth as one of the largest PET flake and polyolefin granules recycler in India. The company is advancing developments in food-grade applications, building the country's most advanced and largest single-location recycling facility to supply food-grade recycled plastics to global companies for use in packaging.

Besides plastic recovery and recycling solutions, Circulate Capital invests in companies like waste-commerce company Recykal, which connects waste generators, processors, recyclers and brand owners to facilitate material flows and transparency across the recycling value chain. In addition, Circulate Capital's investments are also directed toward processing methods and technologies, like flexible-plastic recycler Lucro, to help recovered materials find their way into circular supply chains.

“We have the opportunity to solve the problem not just for plastic but for other materials as well,” says Circulate Capital chief impact officer Ellen Martin. That boosts capacity to address not just single-use plastic packaging challenges, but other waste streams and material types too.

Circulate Capital's corporate partners engage actively with portfolio companies to help them scale. One corporate partner, material science company Dow, has partnered with Lucro to develop recycled flexible films and scale their use across various sectors.

Investors often need to build trust and educate SMEs and family businesses as part of the investment process before a deal that will help them scale can be negotiated



A woman working at a waste treatment facility. Source: Circulate Capital.

By offering technical help, redesigning their packaging to make it more sustainable and recyclable, and implementing recycled material requirements for procurement, partner corporations create demand for the materials that portfolio companies provide. “All of that support builds a more holistic system,” Ellen Martin says. “If we were just building one end or the other of the value chain, it wouldn’t scale.”

The other part of Circulate Capital’s strategy is longer-term, disruptive innovation at the intersection of climate tech and circular solutions. Some of its portfolio companies, like Arzeda, are creating novel, bio-based materials to become scalable alternatives to plastic, while others like recycling-technology company Circ develop new methods for separating and recovering mixed polyester-cotton textiles.

Philanthropic and patient capital from family offices, high-net-worth individuals and development finance institutions can help de-risk investments for more mainstream investors and catalyse further investment at scale

TWO, UNDERSTAND AND EMBRACE THE CONTEXT

Roughly half the world’s ocean plastic pollution comes from emerging markets where the development of waste management infrastructure has lagged behind economic growth and plastic use.^{2,3} In striving to maximise its impact, Circulate Capital initially focused on high-growth markets like Indonesia, where a population dispersed across a vast archipelago makes waste management a challenge.

In such emerging markets, recycling activities are typically carried out by waste pickers and other informal entrepreneurs, who can help avert a significant proportion of ocean plastic pollution. For example, a study in India estimated that 50 to 80% of generated plastic waste is recovered by garbage collectors, waste pickers, and waste dealers in the informal sector, and is thus kept out of the environment.⁴ The sorting and processing of waste is then done by small and medium enterprises (SMEs) including small family businesses.

The informal workforce needs enabling infrastructure and other support, says Ellen Martin. “When we invest, we’re not thinking about disrupting those workers’ livelihoods, but creating models that will be beneficial to those at the very first point of collection.” Meanwhile, SMEs and family businesses often require extensive engagement, trust-building and investor education before agreeing to a deal that will help them scale. Circulate Capital connects SMEs with large corporations for commercial agreements and technical partnerships, helping connect organisations across what is otherwise a very fragmented waste-and-recycling value chain.

Embracing the existing context also means paying attention to intersectional areas such as gender. For example, women make up a high proportion of waste collectors and processors in some markets, as informal work can provide the flexibility and income they need. Around the world, women are also major consumers of products that are made from recycled

2 Jambeck, J.R. et al. (2015). “Plastic waste inputs from land into the ocean”, *Science* 347, p. 768-771. DOI: 10.1126/science.126035.

3 Borrelle, S.B. et al. (2020) “Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution”, *Science* 369, p1515-1518. DOI:10.1126/science.aba3656.

4 B. Nandy et. Al. (2015). “Recovery of consumer waste in India – A mass flow analysis for paper, plastic and glass and the contribution of households and the informal sector”, *Resources, Conservation and Recycling* 101:167-181.



plastics or plastic alternatives, or plastic products that can end up as waste. As consumers, they make important decisions about where these materials go at the end of their lifespan.

Investing in women, therefore, is key to accelerating circularity in the plastics value chain. As of 2022, the Circulate Capital Ocean Fund is 2X qualified, meaning it is part of the 2X Challenge and its organisation and portfolio investments meet specific gender criteria.⁵ Portfolio companies are often at stages of their growth where they are thinking about how to attract and retain talent and better manage their workforce, says Martin, and this is a good starting-point for companies to think about gender diversity and inclusion in hiring, retention and other organisational policies.

THREE, IDENTIFY ENABLERS OF SCALE

Even as efforts continue apace to address plastic pollution, global plastic production is still on track to increase, driven by growing populations and rising incomes. Without radical action to curb demand, increase product lifespans and improve waste management and recyclability, the OECD estimates plastic production will triple by 2060.⁶

The Circulate Initiative, which monitors investment in plastics circularity, estimates that some US\$1.2 trillion is needed globally to fully transition and scale the plastics circular economy to the level of infrastructure required for sustainable development.⁷

How might investors like Circulate Capital contribute to helping circular-economy services and infrastructure reach the scale needed to tackle the volume of plastic waste and the emissions from plastic? Data and a visible pipeline of investable opportunities are key. “At the beginning we had to do our own landscape analysis because the pipeline was not clear. But we’re starting to see a track record of exits,” Ellen Martin says. Circulate Capital also worked with the world’s leading environmental NGOs and researchers to develop its own set of environmental, operational and social impact metrics relevant to the places where it invests.

Another aspect is addressing risk: Helping other investors understand how to manage and mitigate the risks of investing in circular economy solutions. Philanthropic and patient capital from family offices, high-net-worth individuals or development finance institutions can help de-risk investments for others and catalyse further investment at scale. The Circulate Capital Ocean Fund was backed by corporate partners and development finance agencies, such as the United States Agency for International Development (USAID) and the U.S. International Development Finance Corporation (DFC).

Fortunately, since Circulate Capital’s inception, the risk landscape has shifted thanks to global and national policy signals. In 2022, at the United Nations Environment Assembly in Nairobi, countries agreed to negotiate a legally binding agreement on plastic pollution by 2024. At the regional and national levels, the European Union has extended producer responsibility (EPR) rules for single-use plastic, while India, the Philippines and Vietnam have implemented or are adopting EPR requirements for plastic packaging. These policies increase demand for circular solutions and send a signal to innovators to meet the challenge.

“This space has been evolving so quickly over the last few years,” says Ellen Martin. “We’re pretty optimistic that we’ll continue to see many actors respond to the challenge.”

USAID AND PREVENTED OCEAN PLASTIC SOUTHEAST ASIA: HARNESSING THE POWER OF BLENDED FINANCE AND TECHNICAL ASSISTANCE

Addressing ocean plastic pollution has long been a high-priority development outcome for the United States Agency for International Development, or USAID. In 2019, in a blended finance partnership with Circulate Capital, USAID provided a partial loan guarantee to de-risk up to \$35 million worth of investments and encourage private capital and new business development to scale the recycling value chain in South and Southeast Asia. By the end of that year, that guarantee helped Circulate Capital raise some \$106 million from private-sector companies for the Circulate Capital Ocean Fund.

Following the success of the partnership, USAID joined Circulate Capital and portfolio company Prevented Ocean Plastic Southeast Asia (POPSEA) in a 2022 partnership to expand waste collection and recycling infrastructure in the coastal Indonesian city of Semarang. The partnership benefits from USAID’s technical assistance and experience with the Clean Cities, Blue Ocean initiative; Circulate Capital’s expertise in scaling innovation and driving growth; and Prevented Ocean Plastic’s sector experience, access to global markets, and proven traceability model.

In June 2023, POPSEA opened a new waste collection centre that can process 500 tonnes of plastic a month. Its output is high-quality, traceable plastic bound for global markets. The centre creates some 40 direct jobs, supports the livelihoods of about 100 employees and waste collectors in all, and helps grow a profitable, self-sustaining market for plastic recycling in Indonesia.

5 Circulate Capital Commits to the 2X Challenge, Setting a New Standard for Gender Smart Investment in the Circular Economy for Plastics. (2022). 2X Challenge. March 3, 2022.

6 OECD (2022), *Global Plastics Outlook: Policy Scenarios to 2060*, OECD Publishing, Paris.

7 The Circulate Initiative. Plastics Circularity Investment Tracker. Accessed July 31, 2023.



3. INNOVATION LEVERS FOR ECOLOGICAL TRANSFORMATION



***Innovation relies on new ideas and innovators.
But the success of innovation also depends
on wider levers of change including economic, legal, and social factors.***

Innovation relies on new ideas and innovators. But the success of innovation also depends on wider levers of change including economic, legal, and social factors. This section explores the levers and other factors that help innovation for ecological transformation to succeed.

Arnoud de Meyer shares insights from his research on the role of “business ecosystems” in facilitating innovation for ecological transformation. **Scott Bryan** provides lessons from **ImagineH2O’s** support of entrepreneurs working to safeguard and expand access to fresh water around the world. And **Andrea Bina and Simon Cooper of the UNDP** discuss the importance of understanding and measuring systemic change to support ecological transformation, drawing from tools they have developed to support the prevention of deforestation.

A growing group of scientists, experts and organisations is also drawing attention to the role of mindsets and skillsets in directing innovation activities towards supporting prosperity for people and planet. These new notions of leadership are innovations in themselves, as well as important preconditions to wider change.

In this collection of related articles, **Andreas Schleicher of the OECD** shares lessons for our education systems so that children have the skills needed to drive ecological transformation and thrive in new economies. **Jan Artem Henrikssen, Doreen Ankrah, Daniel Hires and Jamie Bristow** present the **Inner Development Goals**, an accompaniment to the UN Sustainable Development Goals that describe the inner qualities needed to realise the SDGs. Environmental psychologist **Renee Lertzman** illustrates the value of climate psychology principles in helping to accelerate action for ecological transformation. **Seedlings founder Emmanuelle Aoustin** outlines the mindsets that business leaders in particular will need to adopt to make their companies supporters of transformation. And philosopher **Cécile Renouard** shares her “Six Gates” framework that can support leaders across society to understand and address the systemic nature of the challenges we face.

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DEPLOYING BUSINESS ECOSYSTEMS TO COPE WITH ECOLOGICAL TRANSFORMATION

Arnoud De Meyer

Professor Emeritus, Singapore Management University



A hydrogen bus in use in Central London, England.
Source: Sludge G.

Arnoud De Meyer is Professor Emeritus and former President of Singapore Management University. He is an alumnus of the Vlerick Business School, taught and had several leadership roles at INSEAD, and was the dean of the Cambridge Judge Business School. He is an internationally recognised and widely published scholar in R&D and Innovation Management, Manufacturing Strategy, and International Management. Currently he is the Chair of the Temasek sponsored Stewardship Asia Center (Singapore), member of Hong Kong's University Grants Committee, Chair of EQUIS Accreditation Board and independent director of Viva Energy Australia (Melbourne), Banyan Tree Resorts and Hotels (Singapore), and upGrad (Mumbai, India). He recently published "Ecosystem Edge: Sustaining Competitiveness in the Face of Disruption" and "Building Excellence in Higher Education: Singapore's Experience"

At a time when businesses must innovate quickly and in support of sustainability, "going it alone" is no longer the most effective or efficient model. Business ecosystems – networks of companies, researchers and other stakeholders each involved in a given value chain – offer an effective route to companies seeking not only to find new advantages, but to drive wider systemic change. When innovation takes place through ecosystems, often, the results are faster to diffuse through an industry or value chain. To address needs of the ecological transformation like the transition to clean fuels, this is exactly what is needed; it is no use having commercially viable and scalable sources of green hydrogen if there are no trucks ready to use the fuel, for example. This article outlines the characteristics of successful innovation ecosystems, and the practices and mindsets that business leaders must adopt to become "ecosystem leaders."

Nearly 15 years ago, when I was still working for the University of Cambridge, I observed that entrepreneurs building businesses around the university were acting quite differently from what I had learned about entrepreneurship in the United States and in particular on the West Coast. I noticed that these UK based entrepreneurs preferred to work in loosely coupled networks, in contrast to the USA where companies strive for dominance and individual entrepreneurs are strong public figures. Faced with uncertainties in technology and markets, UK entrepreneurs around the University relied on these networks to reduce the impact of such uncertainties. Later my co-author Peter Williamson and I described in our book on the Ecosystem Edge¹ how loosely coupled networks or what we later called business ecosystems, were often deployed by companies to innovate in the face of uncertainty, share risks, scale up faster, react flexibly, and build shared intellectual property.

¹ De Meyer A and P.J Williamson. 2020. *Ecosystem Edge: Sustaining Competitiveness in the Face of Uncertainty*. Stanford Business Books.



BUSINESS ECOSYSTEMS AT THE SERVICE OF ECOLOGICAL TRANSFORMATION

This is precisely what is needed to deal with the challenge of ecological transformation. Take for example the deployment of green hydrogen as a carrier of energy or a way of storing energy. We know that using hydrogen is less efficient than relying solely on electricity, as there are significant losses in the transformation of electrons into molecules. But in some applications, such as heavy trucking or shipping, or storing solar based energy over a long time, and where batteries are less effective, converting electricity into hydrogen may well be a good solution. Yet, the uncertainties and the required investments are very high. Therefore, it's logical that the producers of green hydrogen, manufacturers of powered trucks, potential hydrogen retailers and transport firms that would be prepared to use hydrogen powered trucks, have to come together in a consortium to share the risks in the face of uncertainty. They need a business ecosystem to address the hydrogen challenge.

Collaborating in loosely coupled networks is not a new form of organization. In fact, it is probably older than the multi-divisional firm that has become dominant today. But we have seen over the last 15 years a revival of the concept. Companies like Alibaba Taobao, the dominant Chinese online shopping mall, have been able to scale up very fast by collaborating in an ecosystem with firms that could provide financial services, last mile delivery, etc. The French software company Dassault Systemes, has been able to apply its algorithms for product lifecycle management (PLM) systems, originally developed for aviation or automotive applications, in many other sectors, such as fast-moving consumer goods, electronics, pharmaceuticals, mining, fashion, etc. They did so by collaborating closely with leading companies in each of these sectors, to understand how design was performed.

They also built an ecosystem of smaller specialized suppliers who could help them understand some of the specific challenges related to design and development in each of these sectors. Haier, the world's biggest producer of white goods, is another example. They built a platform on which thousands of micro-enterprises collaborate together to develop new products. Platforms for supply chain functions are common in industry, but Haier's platform is quite different. It can mobilize resources inside and outside the company, it doesn't limit membership on the platform nor specifies who does what and has an organic approach to tapping the capabilities of many organizations and marshalling resources that help shorten product development and manufacturing ramp up time². It is a platform that is focused on agility rather than efficiency.

Business ecosystems [are] often deployed by companies to innovate in the face of uncertainty; to share risks, scale up faster, react flexibly, and build shared intellectual property

Relying on ecosystems is not exclusive to commercial applications. I have previously documented how the Building and Construction Authority (BCA) in Singapore is developing an ecosystem to improve productivity in the built-environment sector by relying on Building Information Management systems (BIM), investing in prefabricated modules and using alternative materials such as mass engineered timber³. This requires the sector-wide mobilization of partners that may not always be used to collaborate with each other, such as developers, construction companies, engineering companies, architects and regulators.

The cases we described are successful examples of innovation. We argue that part of their success is because they were prepared to build loosely coupled networks akin to biological ecosystems. Such ecosystems have three fundamental characteristics. First of all, it is always about creating additional value, value that a single company could not produce on its own. Secondly, it is about mobilizing a network of organizations and individuals, very often working as peers. And finally, the partners in the ecosystem will co-evolve their capabilities and roles and align their investments. Doing so they often build common IP, which we consider to be ecosystem goods, i.e., knowledge that is common to the ecosystem and differentiates it from competing ecosystems.

We have come to the conclusion that almost all organizations work in ecosystems, but often unconsciously. The challenge we see is how you take leadership in such business ecosystems and steer them in the direction that is favorable to your organization and to ecological transformation.

HOW TO DEVELOP NEW BUSINESS ECOSYSTEMS

Through our many case studies we learned that there are 6 steps needed to kickstart and develop an effective business ecosystem.

First, your partners need to trust that you are truly prepared to work in a partnership of peers, not that you want to control them. Coordination in business ecosystems is built on trust. We saw several cases of large organizations that wanted to leverage the capabilities of smaller specialized startups and decided to acquire them and control them. In many of those cases the intellectual assets were embedded in people, many of whom left after such an acquisition. It is no doubt more difficult to work with such smaller organizations in an ecosystem, but it is probably more effective to collaborate with them.

² Ferdows K, H. L. Lee and X. Zhao 2022. *How to turn a Supply Chain Platform into an Innovation Engine*, HBR July-Aug, p.126-133.

³ De Meyer A and S. Mittal. 2019. *Developing the DfMA ecosystem in Singapore's Construction Industry*, SMU Case Study SMU-19-0036.



The issue of trust becomes even more important when some of your partners are stakeholders with non-commercial objectives, e.g. communities, action groups, government and NGO's. This is often the case when we invest in ecological transformation.

Faced with uncertainty about markets, an ecosystem may operate more effectively when it can co-opt foundation customers, who can provide a better insight into what is needed to create additional value, and who have sufficient incentives to collaborate. Going back to the example of hydrogen, it is absolutely essential to include a transport operator in the ecosystem who can provide a deep understanding of how to use hydrogen as an energy carrier. And the example of Dassault Systemes illustrates that also very well: in each of the sectors in which they wanted to deploy their PLM systems, they worked with a partner who had a deep understanding of the sector and wanted to improve its own design capabilities. For example, with Gucci, they were able to understand fashion design, with Novartis to understand development in pharmaceuticals, or with BHP Billiton to get knowledge about the mining sector.

To cope with uncertainty, the partners in a business ecosystem need also a roadmap. Such a roadmap doesn't have to be very detailed, but it helps the partners in the ecosystem to align their investments and to develop capabilities that will contribute to the ultimate value that the ecosystem wants to deliver. Quite often such road maps are developed together. We saw how ARM, the Cambridge headquartered designer of RISC processors, used in smartphones, developed such a road map during a yearly conference in Cambridge. The conference brought together all the players in the value chain, such as chip designers and producers like TSMC, manufacturers of the machinery for producing and testing chips like ASML, the big OEMs of smartphones like Apple, Samsung, Huawei and others, and software producers. Amazon Web Services (AWS), the dominant provider of cloud hosting, shares its road map during its annual conference with the thousands of service providers that are available in the marketplace for AWS cloud services.

To build effective partnerships the ecosystem leader must analyze which partners are needed, communicate the value of joining, and invest in lowering, if needed, the barriers to entry to join the ecosystem. For Alibaba it may not be that difficult to communicate the value to suppliers of services and goods of joining their platform, but in many cases, they needed to help small suppliers with loans and technical support to get onto the platform.

Finally, when building an ecosystem, one may benefit from bringing on board partners that already have their own often smaller ecosystems. We saw an example of that in Singapore,

when Rolls Royce in the late 2000s, wanted to build a factory of airplane engines. They needed a large group of skilled workers and engineers, which were not available in Singapore. Rather than going directly to the universities, polytechnics and the Institutes for Technical Education to encourage them to develop programs that would graduate engineers and technicians with a deep understanding of aeronautics, they worked together with Singapore's Economic Development Board, which had already its whole of government ecosystem ready to support Rolls Royce.

HOW TO SUSTAIN BUSINESS ECOSYSTEMS

While we have been guided in our research by successful case studies of innovative companies, we need to acknowledge that quite a few of these ecosystems fail. Such failure is often due to three sources: the inefficiencies of working with partners along with the ensuing potential transaction costs, an unfair distribution of the value that might be created, and a lack of understanding what leadership in a business ecosystem requires.

All organizations work in ecosystems, but often unconsciously. The challenge is how you take leadership in such ecosystems and steer them in the direction that is favorable to your organization and to ecological transformation

To overcome the inefficiencies inherent in ecosystems we are convinced that creating mechanisms that help build trust among the partners is probably the most important challenge for the ecosystem leader. We saw how companies were building portals to smooth the path of data exchange between the ecosystem leader and its partners and amongst its partners, always without trying to control all the exchanges. You can also develop a set of systems and organizational solutions to codify and manage the exchange of complex know-how. While we don't argue

for writing extensive contracts, we see the value of contracts that focus on high level outcomes, leave room for flexibility, are perceived to be fair across the whole of the ecosystem, and in particular are clear about dispute resolution. Finally, an ecosystem may suffer from free riders or partners who don't behave according to what the value creation requires, and thus one needs to agree on governance standards and if necessary, penalize bad behavior.

In most cases one develops and grows an ecosystem not for purely philanthropic reasons but because one wants to monetize one's contribution to the value creation. It is obvious that the bigger the value that one creates, the easier it is to distribute said value among the partners in the ecosystem. As always, the bigger the pie the easier it is to divide it. But we also advise participants in an ecosystem need to think about what their unique contribution is and how they can protect it. This has often been called the keystone, like the stone at the top of an arch or a dome that is essential to keep the construction together. It may be a small, quasi-insignificant contribution, but an essential one to the value creation by the ecosystem.





The Water Users Associations Development Project involves many stakeholder and helps improve irrigation and drainage in over 50,000 hectares of land in Azerbaijan. Source: Allison Kwesell, World Bank Photo Collection.

We saw many different keystones. Alibaba had control over data generated through the billions of transactions. For Dassault Systemes it was the quality of the algorithms that are hidden deep down in the software for PLM. For ARM it was the robust design of a quasi-universal RISC processor. And of course, once you have a keystone, you can charge “toll”. But it is important to the ecosystem leader to ensure that the distribution of the value created by the ecosystem is perceived to be fair.

Finally, one should realize that leadership in an ecosystem requires far more than traditional collaborative leadership. A successful ecosystem leader must believe that there is an opportunity to create new value for potential customers combined with a deep conviction that no single company can unlock the value opportunity acting alone. It requires a relentless focus on growing the size of the overall ecosystem pie. You must also be focused on attracting, engaging, and motivating people who are not in your organization, who are not necessarily your own employees.

Effective ecosystem leaders are good listeners. They have the capacity to listen, both to those within their own organization, but also to the weak external signals and messages that come from partners. Your partners may not want to tell you what they really think. Or they may not be able to express their tacit knowledge. Effective ecosystem leaders have the

To build effective partnerships the ecosystem leader must analyse which partners are needed, communicate the value of joining, and invest in lowering the barriers to entry to join the ecosystem

ability to encourage and nudge the ecosystem partners to respond flexibly to uncertainty. And they deploy their soft power, that comes from their vision, their credibility, and the evidence they have to bolster their case, to influence their partners. They get things done through a community of peers.

In fact, it is all about leading beyond your own organization. It is about building consensus and ensuring that a wide group of peers takes ownership of most of the decisions you will make as an ecosystem leader. That requires you to be an active networker, and to become a trusted source of knowledge and information, that others often haven’t yet spotted. And finally, there will be conflicts in an ecosystem. Partners will disagree with each other. Therefore, an ecosystem leader must be prepared to embrace dilemmas

and diversity. Without ever forgetting what is the overarching identity of the ecosystem and the goal that you want to achieve in terms of value creation.

I am convinced that ecological transformation will require companies and governments to innovate in the face of enormous uncertainties. Business ecosystems are the most appropriate organizational design to share the risks, mobilize the assets and develop the required flexibility. To manage the ecological transition effectively we will need to become well versed in managing business ecosystems.



WATER INNOVATION AND ECOLOGICAL TRANSFORMATION: entrepreneurial approaches to advancing sustainable solutions

Scott Bryan
President of Imagine H2O



As President of Imagine H2O, Scott is responsible for leading Imagine H2O in its mission. He initially volunteered with Imagine H2O's launch team in 2008 before joining as its first employee in 2010. Since then, Imagine H2O has supported over 150 startups and expanded its programming internationally. Scott serves on the National Alliance for Water Innovation's (NAWI) Innovation and Commercialization Council and is an advisor to the Environmental Policy Innovation Center. Prior to Imagine H2O, Scott developed ESG and cleantech investment strategies for institutional and private clients at Royal Bank of Canada and Piper Jaffray. He has a BA in Economics from Colorado College.

Imagine H2O is an accelerator that supports water startups with capacity-building, partnerships, mentorships and other resources so that water solutions can have an impact on equity, health, climate and resource availability at scale. This article outlines steps and considerations that are vital for entrepreneurs and intermediaries to understand if they wish to scale ecological transformation solutions.

INTRODUCTION

“Ecological transformation means adapting, improving, and prioritizing sustainable patterns of production and consumption. It means placing ecology at the forefront of our processes, solutions, and most importantly our mindset.”

Climate change and decades of water mismanagement have created a “three-headed” global water crisis.¹ People have contaminated water and depleted water sources, and human activity like deforestation and agriculture has altered rainfall patterns; we face the prospect of a 40% shortfall in freshwater supply by 2030. Meanwhile, climate change, water mismanagement and biodiversity loss interact to cause more frequent and severe episodes of too much or too little water, such as storms, floods, droughts, and wildfires.

Transforming water systems is of the utmost urgency for ecological transformation. We need clean water to be readily available and access to be equitable; we need to prevent unnecessary water loss; we need greater circularity for urban and industrial wastewater; and we need to reduce the footprint of industrial water use. According to Global Water Intelligence, 70% of climate adaptation costs will be in water in some way² – thus water will be at the center of a transition to a more resilient world.

However, transforming water requires not only innovative solutions and commercial scale, but also collaboration and integration with national, regional, and global governments and policies. At the same time, many solutions must be localized and sector-specific; solving a water challenge in one place does not necessarily contribute to solving water challenges globally. This is a key distinction between water and carbon, as GHG reductions, regardless of geography, will have a singular global impact.

Tomorrow's water solutions will undoubtedly be different than the solutions of the past. In short, we must decentralize, decarbonize, digitize, and democratize water management in ways we've never imagined before. Entrepreneurship and innovation can play a critical role in accelerating this transition.

¹ Mazzucato, M., N. Okonjo-Iweala, J. Rockström and T. Shanmugaratnam (2023), *Turning the Tide: A Call to Collective Action*, Global Commission on the Economics of Water, Paris.

² Global Water Intelligence. April 27, 2023. This year's Global Water Summit in numbers.





Epic Cleantec treatment center: A part of Imagine H2Os startup portfolio. Source: Epic Cleantec via Imagine H2O.

THE GROWING DEMAND FOR WATER INNOVATION (AND ACTION)

Historically, the relatively low cost of water has disincentivized action. This is changing as communities, businesses, and citizens begin to see the real costs and risks associated with inaction.

For example, insurers are becoming increasingly concerned about managing water risk from climate-related events. And a 2021 drought in Taiwan and the ensuing global shortage of microchips is just one reminder of the risks to private industry.³

Meanwhile, public consciousness is on the rise, particularly concerning issues like PFAS contamination in drinking water and combined sewer overflows. Armed with data and scientific knowledge, citizens are calling for action from utilities and businesses, which must now adopt novel solutions and approaches.

All of these factors collectively establish a compelling business case for water innovation, unlike anything we've witnessed before. If we delay action and investment, the costs and complexity of the path forward will only grow. We will need

to use even more energy to remediate and treat water sources that will become increasingly affected, directly and indirectly, by warming temperatures.

HOW IMAGINE H2O SUPPORTS WATER INNOVATION

Imagine H2O is a global nonprofit organization that envisions and builds solutions with the world's best water entrepreneurs. Since 2009, our startup accelerator programs have identified and supported over 200 startups. Collectively, our entrepreneurs have mobilized more than \$1 billion in early-stage investment and scaled their solutions to reach more than 1.1 billion people. Our model goes beyond the traditional tech accelerator approach to include pilot resources and funding enabling entrepreneurs to demonstrate their solutions in the communities and sectors in need of innovation. We work in four impact areas; climate, circularity & efficiency, health, and equity.

Our startup portfolio includes an array of solutions tackling our most pressing water challenges, while creating the business case for change.

³ Yang, Stephanie. April 16, 2021. *The Chip Shortage is Bad. Taiwan's Drought Threatens to Make It Worse.* Wall Street Journal.

DECARBONIZING THE WATER CYCLE

Historically, water has been viewed as an adaptation play for the future. As a result, water has often struggled to find its footing as an area for prioritization at climate events such as the COP. However, this is quickly changing as we need to both adapt our water systems to a changing climate and decarbonize this sector.

Globally, water utilities are estimated to collectively contribute 2% of the world's GHG emissions – a level similar to global shipping.⁴ Overall, some 80% of all wastewater is released into nature. The GHG emissions from this untreated sewage and sludge are thrice that of treated wastewater. At the same time, current wastewater treatment methods are energy-intensive, accounting for roughly 70% of the sector's emissions.⁵

A growing body of research and new technologies are making the case for carbon neutral, and in some cases positive, methods to treat wastewater.

Aquacycl's BioElectrochemical Treatment Technology (BETT), a modular, onsite wastewater treatment system is one such solution. BETT can mitigate up to 90% of greenhouse gas (GHG) emissions and is already doing so successfully at a PepsiCo facility in Fresno, California. The system is also creating a 30% reduction in costs – creating the business case for this novel approach.⁶

Methane, both naturally occurring in reservoirs and as a byproduct from wastewater management, represents another massive challenge and opportunity for innovation. BlueMethane, another Imagine H2O startup, is developing a technology billed as a "Dyson vacuum cleaner" that separates methane from water and permanently removes this harmful greenhouse gas.

TURNING WASTE TO VALUE

Water innovation also represents an important tool in turning waste to value across the water cycle, and new technologies are driving resource efficiency.

Gross-Wen Technologies' algae-based wastewater treatment solution recovers and reuses nitrogen and phosphorus to create a valuable algae byproduct. With a grant from Imagine H2O, Metropolitan Water Reclamation District of Greater Chicago's (MWRD's) Stickney Water Reclamation Plant is currently using this technology to offset carbon emissions through algae growth while creating a fertilizer byproduct that can be used on the region's farms.⁷

Climate change and decades of water mismanagement have created a "three-headed" global water crisis; [...] transforming water systems is of the utmost urgency for ecological transformation

Utilities are also tapping a new generation of technologies to tackle the issue of non-revenue water, or water that is 'lost' before reaching the customer. Many cities see non-revenue water rates as high as 40%, meaning that water treated and conveyed through energy-intensive processes and systems simply vanishes into the ecosystem. Detecting leaks and recapturing non-revenue water represents an important opportunity to create economic savings and lower carbon emissions. This host of new solutions ranges from Asterra's satellite-enabled tools, to Smarterra's AI-powered analytics platform, to WEGoT's real-time sensor being deployed in India's residential sector.

SAFEGUARDING OUR ECOSYSTEMS

Sustaining ecosystem health is a cornerstone of access to safe and reliable water supplies while also insulating communities from the most severe effects of climate change. But overuse and pollution are threatening the world's most significant groundwater supplies.

An emerging field of sensors and analytical tools can play an important role in monitoring ecosystem health and safeguarding resources.

For example, iFlux deploys real-time sensor networks to monitor groundwater flux and quality, enabling data-driven decision making for utilities, industrial users, and agricultural users. Meanwhile, Ecospears' emulsified zero-valent iron filtration process removes contaminants from freshwater resources, including

polyfluoroalkyl substances (PFAS), polychlorinated biphenyls (PCBs), and other toxins.

CHAMPIONING EQUITABLE OUTCOMES

Ecological transformation can only be successful if all populations can benefit from these new solutions, including underrepresented communities and emerging markets. Advancing equitable outcomes will often require business model innovations that reflect local needs.

Drinkwell's water ATMs in Bangladesh and India are one such example, providing underserved urban communities living "beyond the pipe" with access to safe water. The company combines arsenic removal technology with RFID-enabled payment cards and a microenterprise model. The result is a compelling alternative to current models in which organized crime taps municipal sources and provides arsenic-laden water at a higher price.

In North America, startups like BlueConduit and 120Water are helping communities and households identify lead and other heavy metals in their supplies. These companies leverage new analytic tools and software offerings to bring affordable solutions to communities that need them the most.

4 IWA. Dec 2, 2022. *Net-Zero: Mapping the route to water utility decarbonization.*

5 Global Water Intelligence. July 14, 2022. *How do we fix wastewater's big carbon problem?*

6 WaterTech Online. Oct 7, 2022. *Case study: How PepsiCo reduced costs and addressed climate and water goals through onsite wastewater treatment.*

7 MWRD.org Jan19, 2023. *Pilot algae reactor at MWRD Stickney plant to test carbon offset, and nutrient recovery.*



THINKING BEYOND WATER

Finally, we must also recognize that the biggest gains in water are sometimes outside water. For example, an estimated 40% of food in the United States goes to waste each year.⁸ Solving food waste, and realizing the associated water benefits, requires innovation in supply chains and consumer behavior. In other areas, removing water from manufacturing processes or cooling techniques could provide important breakthroughs.

SUPPORTING ENTREPRENEURIAL APPROACHES FOR ECOLOGICAL TRANSFORMATION

While entrepreneurship alone cannot solve our water challenges, it plays an important role in unlocking new business models and emerging technologies, or simply applying current technologies in a smarter way. Successful entrepreneurs identify and target critical market pain points where solutions create clear value, and quickly. However, water entrepreneurs often face an uphill battle as they validate their solutions and secure financing to scale their businesses.

If we delay action and investment, the costs and complexity of the path forward will only grow. We will need to use even more energy to remediate and treat water sources that will become increasingly affected, directly and indirectly, by warming temperatures

Imagine H2O offers a critical service to help more ideas get to a yes/no answer faster. Over the past five years, we've ramped up our pilot support resources to help entrepreneurs secure and finance their pilots. We've provided \$2 million in pilot funding through programs like our Urban Water Challenge, the Water Technology Access Partnership with the World Bank, and Accelerating Innovation and Digitalization with the Asian Development Bank.

But innovation is not only about entrepreneurs. It's also about the intrapreneurs within water utilities and businesses who are willing to pilot new solutions. Entrepreneurship and intrapreneurship can play a critical role in challenging the status quo and rethinking business models to bring about the mindset change we need for ecological transformation. We've also partnered with leaders like Veolia to help promising entrepreneurs secure pilots in both the industrial and municipal sectors.

Businesses, utilities, policymakers, and other key actors must identify common challenges, embrace new solutions, and join forces to advance water innovation. The ripple effects of innovation and entrepreneurship include equitable access to clean water and sanitation for all; addressing climate change; protecting ecosystems and natural resources; and generating economic opportunities – contributing to a just and inclusive ecological transformation.

8 FeedingAmerica.org



Drinkwell filtration technology supporting its local community members. Source: Drinkwell via Imagine H2O.



UNDERSTANDING SYSTEMIC CHANGE: innovative approaches to monitoring, learning and adaptation in the UNDP's work to reduce deforestation

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This article explores innovations in monitoring, evaluation and learning being promoted and adopted by the United Nations Development Program in their activities to promote Forest Positive Agriculture. Using the UNDP's new Causality Assessment for Landscape Interventions (CALI) as an illustrative example, it discusses the importance of adaptive and systemic approaches to understanding change for organizations and projects that are seeking to generate positive change or ecological transformation in complex systems. These innovative measurement practices and principles employed by the UNDP to reduce deforestation can serve as inspiration for a range of actors addressing this and other systemic challenges that must be addressed to bring about ecological transformation.

INTRODUCTION

After record-breaking global average temperatures in early July 2023, UN Secretary General António Guterres warned *"Climate change is here [...] And it is just the beginning. The era of global warming has ended; the era of global boiling has arrived [...] We can still stop the worst,"* he said. *"But to do so we must turn a year of burning heat into a year of burning ambition."*

One of the key measures needed to meet that ambition is increasing Forest Positive Agriculture. In its latest Assessment Report¹ published in March 2023, the Intergovernmental Panel on Climate Change identified "Reduced conversion of natural ecosystems" as a key climate change mitigation response, second only to solar power generation and more effective than wind power. "Improved Sustainable Forest Management" offers more potential than switching to electric vehicles.

¹ IPCC (2023). Sixth Assessment Report.



The need to act is urgent, and action is being pursued through innovative approaches including jurisdictional and landscape approaches. Increasingly however, organizations including the UNDP have come to realize that finding innovative new ways to measure the effects and results of actions is as important, to ensure that positive impacts are maximized.

Measurement of the kind of change we pursue is hard. Protecting and restoring forests involves change across complex social, economic and environmental systems, and effective measurement has been an enduring challenge for actors in this space for decades.

The UNDP, with other institutions, has been working to develop a better, more nuanced and systemic approach to measurement that can help us understand the complex changes involved in promoting ecological transformation, thereby developing more effective approaches to achieving it.

Forests harbor most of the biodiversity of the Earth, support the livelihoods of hundreds of millions of people (including many of the world's poorest), and provide a multitude of ecosystem services, including carbon storage and climate regulation, soil protection and flood control, pollution abatement, and fresh water supply².

Nonetheless, forests and the services they provide continue to be under severe pressure: it is estimated that 420 million hectares of forest have been lost since 1990 through conversion to other land uses, with agricultural expansion accounting for the most of this³.

PURSuing CHANGE IN COMPLEX SYSTEMS

Landscape and jurisdictional approaches which promote forest positive agriculture and attempt to address agricultural expansion and the other drivers of deforestation are complex interventions, attempting to transform the interplay of political, economic, and social forces. Their Theories of Change tend to include multiple assumptions and risks and rely on many factors working alongside project intervention efforts.

As these landscape and jurisdictional approaches are designed and implemented in dynamic environments, and trying to pull selected levers for change, implementation teams must be comfortable in dealing with uncertainty, with adaptation becoming a key factor for success. Given the limited focus on managing complexity and education on systems thinking in most countries, this is a difficult requirement to meet. As environmentalist George Monbiot said in his submission to the UK Government's Inquiry on Environmental Change and Food Security:

[The] expansion of boundaries of thinking to encompass a whole system - going deeper into the iceberg - leads to a whole range of new considerations

“One of the great deficiencies of our education is that few of us are taught systems theory. Yet everything of material importance to us – the human brain, the human body, human society, ecosystems, the atmosphere, the oceans, the financial system, the food system – is a complex system. The behavior of these systems, because so few of us study them, repeatedly takes us by surprise... We need a far better public and political understanding of complex systems... to understand the world around us and the means by which we can predict trouble and intervene to prevent it.”

How can we adapt what we do to better comprehend and interact with these complex systems? One approach, being developed by the United Nations Development Programme (UNDP) and its partners, is to change the way we measure and define success.

RETHINKING MONITORING, LEARNING AND EVALUATION FOR POSITIVE CHANGE

Traditional monitoring, learning and evaluation (MLE) frameworks, methods and tools are not capable of supporting interventions operating in complex systems, such as landscape approaches. Too often, project teams devise interventions and then construct MLE systems to watch out primarily for the intended results of their interventions. In doing so, teams and organizations seeking to affect positive environmental and social change may miss other, more significant developments. Sometimes these originate from other parts of the complex system, but on other occasions may be an unexpected outcome of the project team's intervention and therefore well worth capturing as an impact of the project to learn from. Learning itself is often undervalued, leading to limited capacities in project teams to adapt to evolving environments and circumstances.

To better support positive change, MLE practices must evolve to effectively support continuous learning and sensemaking of the complex and often highly volatile environment in which projects and interventions are embedded. Increasingly, change makers recognize that the complexity they are grappling with makes it challenging to determine upfront effective pathways and clearly define intermediate results. As a result, they need to continuously “experiment their way through” their interventions. This challenge is very well recognized by UNDP and the Bill and Melinda Gates Foundation, who recently joined forces to launch a new initiative focused on MLE for systems change. This evolution of approach is supported throughout UNDP, right up to the organization's Strategic Plan:

“The latest strategic plan of UNDP recognises the importance of developing new tools that are better suited to support continuous learning and adaptation for interventions in complex systems. This is especially true for landscape and jurisdictional approaches, which target deforestation in highly volatile and dynamic settings.”

Alan Fox, Deputy Director of the Independent Evaluation Office (IEO) of UNDP

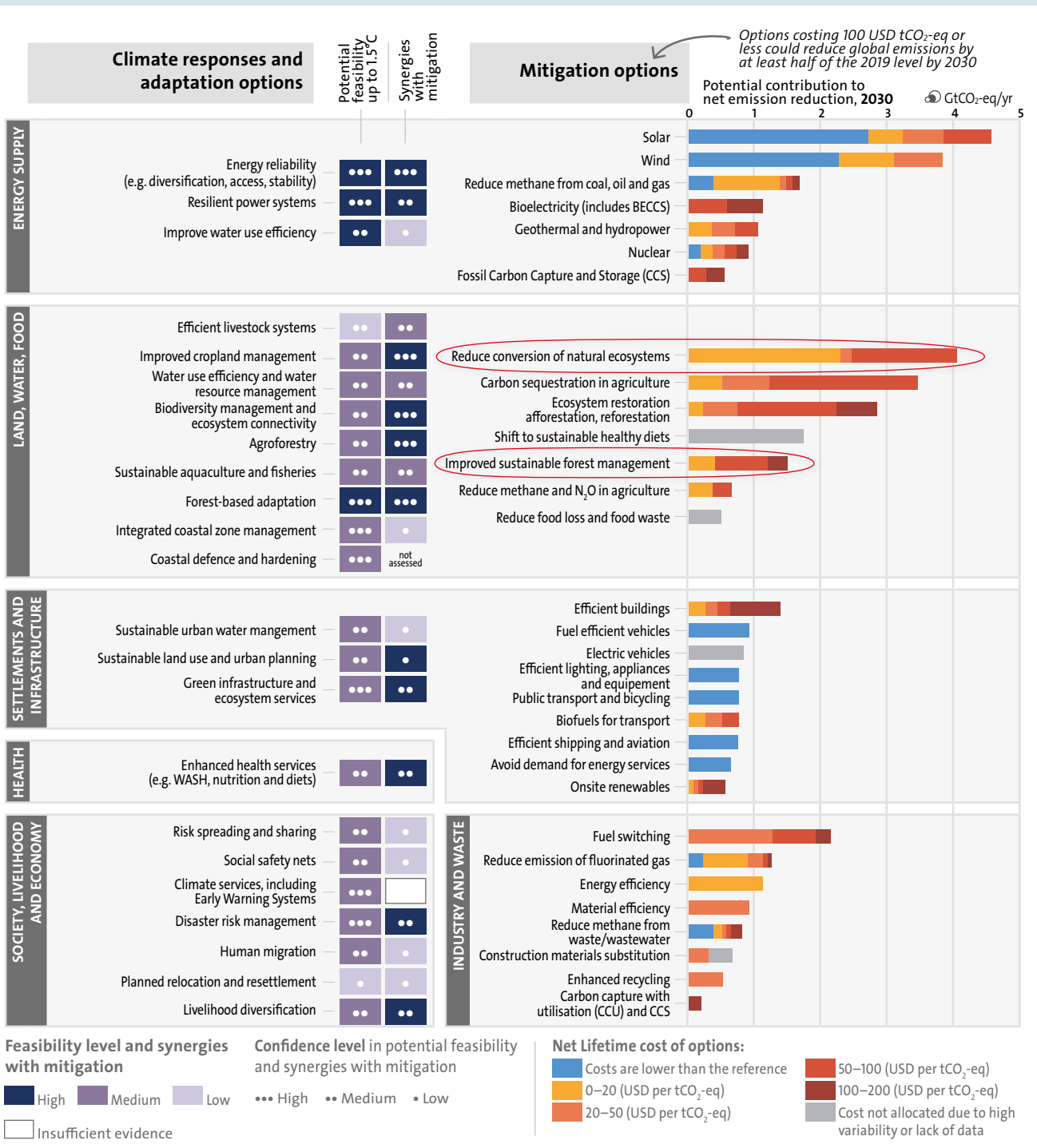
² Ghazoul, J. (2015). *Forests*. Oxford University Press.

³ FAO and UNEP (2020). *The State of the World's Forests 2020 Forests, biodiversity and people*. Rome.



THERE ARE MULTIPLE OPPORTUNITIES FOR SCALING UP CLIMATE ACTION

Feasibility of climate responses and adaptation, and potential of mitigation options in the near-term



CAUSALITY ASSESSMENT FOR LANDSCAPE INTERVENTIONS – A NEW APPROACH

Among the new tools developed and promoted by UNDP, developed by the UNDP's Food and Agricultural Commodity Systems (FACS) MLE team, is the new *Causality Assessment for Landscape Interventions* (CALI) Guidebook. This tool provides a practical methodology for ongoing sensemaking and adaptation for teams. By helping to define and capture indicators of systemic change, it provides a better suited approach through which to oversee and ensure effective implementation of projects that aim to reduce deforestation in landscapes.

UNDP FACS Global Head Andrew Bovarnick said:

"What we need to complement systemic interventions are tools to assess, measure and generate insights on how well the interventions are actually catalyzing change in a given system and to what extent, why and how. We need new ways of catalyzing change in food systems. Interventions that address the root causes and not the symptoms. Only with the development and application of such tools, which we want to make easily accessible to everyone, can we evolve technical assistance to truly and effectively transform systems."

For organizations including the UNDP that are seeking to influence deforestation, this expansion of boundaries of thinking to encompass a whole system - going deeper into the iceberg - leads to a whole range of new considerations.

Historically, the focus of many interventions have been on the direct drivers of deforestation - the (legal or illegal) processes or human activities that cause deforestation in the landscape⁴. These include activities including commercial agriculture, subsistence agriculture, surface mining, infrastructure development and urban expansion. Indirect drivers are the complex interactions of social, economic, political, cultural and technological processes that bring about direct drivers. At international level, they include market behaviors (supply and demand), fluctuations in commodity prices and currency exchange rates, and financial flows of investments that do or do not take into account deforestation as a financial risk. At national level, they include population growth, the behavior of domestic markets, national policies that favor non-forest land uses, poor governance and legal frameworks and/or lack of enforcement of national laws, subsidies and incentives and the land market. And, at local levels, dynamics including poverty and food security can also have significant influence on the behavior of local stakeholders. Systems practice-based tools like the CALI help to unveil and incorporate these indirect drivers in how projects and interventions are managed.

⁴ UNEP (2018). "Drivers of deforestation and forest degradation", *REDD+ Academy Learning Journal*.

HOW CALI WORKS

CALI works by bringing landscape stakeholders together in participatory reflections around the workings of the theory of change of the project – including through unpacking causality and examining the soundness of underlying assumptions – always remembering the context of the complex system which is driving deforestation in the landscape.

The assessment can be planned at project design or commissioned throughout implementation, and it can be conducted one or several times depending on the length of the project and extent of changes in system dynamics.

Every assessment results in ideas for a refined theory of change and a strengthened project implementation strategy that takes into account emerging learnings and the latest evolutions of system dynamics. Teams that are delivering interventions always have strong ownership of the process, which helps them better understand causality and the consequences (or not) of their actions.

"The success of initiatives that operate and seek to effect change in complex systems hinges on an ability to continuously learn and adapt. Working in this way requires a new generation of new M&E tools and practices. CALI provides an important contribution to this, offering a solid and practical methodology for guiding project teams to engage with their stakeholders in a process of continuous reflection on the validity of their theory of change – situating it within the complex system in which they operate."

Søren Vester Haldrup, Innovation Facility Fund Manager and M&E Sandbox Lead, UNDP

Another key benefit is increased connectivity among landscape stakeholders – who are engaged in participatory sensemaking, and their understanding of system dynamics – as they are encouraged to "see the system" that drives deforestation in the landscape, as well as their role in it.

This puts them in a better position to contribute to the development of the project's interventions, as well as to more generally and effectively advocate for their interests, by adopting a system perspective. In this way, CALI leverages the collective intelligence of landscape stakeholders to increase the chances of effectiveness of project interventions, but at the same time, it also contributes to enhancing that collective intelligence in the first place.

"The Causality Assessment for Landscape Interventions (CALI), supported by the GEF, helps project teams to ensure that complexities are reflected in their theory of change, and that their evolution informs adaptations to the project implementation strategy. This is all driven by



a participatory process that boosts system connectivity and learning, increasing the likelihood of success of any project addressing deforestation at landscape or jurisdictional level. CALI is therefore an important step toward advancing systems thinking and integrated approach programming to tackle drivers of global environmental degradation.”

Mohamed Bakarr, Lead Environmental Specialist, the Global Environment Facility (GEF)

CALI has already been applied in support to several projects that the UNDP is supporting in Sintang, Pelalawan and South Tapanuli in Indonesia, in North-Wester Liberia, in the Western Region of Paraguay and in a landscape spanning the Ucayali and Huánuco regions of Peru.

The Peru project, for example, included a thorough engagement and dialogue with all key project stakeholders, including representatives of the local and national government, indigenous communities, private sector actors, and other civil society organizations. Beyond adaptation, the assessment has also allowed the whole project team to strengthen their relationships and exchange with these actors, who play a critical role for the success of the project’s interventions. It has also strengthened relationships among the actors themselves, allowing them to better understand each other’s perspectives and thereby deliver their interventions more effectively going forward.

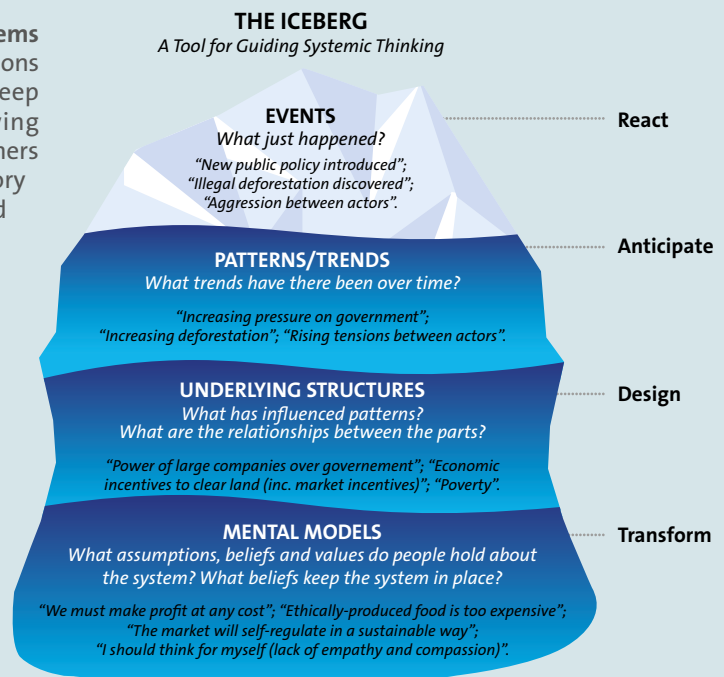
CALI WORKS AGAINST THE GRAIN OF “NORMAL” HUMAN NATURE

It approaches landscape-level analysis through **systems practice**, ie., the approach of making reliable conclusions about the behavior of a system by developing a deep understanding of its underlying structure. Viewing problems from a system perspective helps practitioners to develop a holistic understanding of the trajectory of current developments of deforestation and its underlying complex causes, uncovering the often hidden connections and dependencies between actors and sectors, and as such, building bridges between the functional silos.

In daily life, our attention is often directed towards single events. Most of the information we consume through the news focuses on such single events (e.g., new public policy introduced, illegal deforestation discovered, aggression between actors). However, in most cases, these events are only snapshots in time emerging from underlying **long-term patterns** in a system’s behavior. In other words, such events only represent the tip of the iceberg that is most visible to us, while their underlying **patterns** tell us how the situation affecting a specific landscape or jurisdiction developed and emerged over time (e.g., increasing pressure on government, increasing deforestation, rising tensions between actors).

These patterns of behavior, in turn, are driven by the structure of the system driving deforestation, or in other words how various parts of the system are linked and interact with each other. The structure illustrates the important drivers behind the developments and might unveil the interconnection between different events and patterns. Our decisions to affect the system or some of its parts are based on our understanding of these relationships, i.e. our "mental models" of reality.

Systems practice aims to make these behavior patterns, the system structure, and the mental models which are often implicit and hidden more transparent and visible.



Adapted from "A Systems Thinking Model: Iceberg, Ecochallenge.org."

When assessing the effectiveness of development interventions aimed at reducing deforestation at landscape or jurisdictional level, systems practice allows practitioners to complement and situate the more structured Theory of Change of their projects. This enables them to consider the full range of relevant outcomes that might have been influenced through their interventions, and how those outcomes, in turn, are influenced by the complex system dynamics at play in the landscapes. This allows teams and organizations to develop a systems-informed understanding of the environment in which they operate, which in turn will help them to make more informed decisions and increase the likelihood of success of their interventions.





Mr. Louis, benefited from UNDP seeds after losing his livestock and crops during Hurricane Matthew © UNDP Haiti (2017).

CONCLUSION - WHAT NEXT?

It is important that this evolution of approaches does not take place in isolation within UNDP – everyone should be able to join in, and a new UNDP Guidebook, as well as the instructive example of the CALI, encourages this.

Encouraging Forest Positive Agriculture means changing a complex system which includes several actors with competing demands including smallholders, companies, financial institutions, governments and many others. Many other components of ecological transformation, from resource use to reducing pollution, exist in similarly complex systems. Monitoring and evaluating progress in projects that work with these actors is challenging because (i) different visions exist of what progress is in the context of systems transformation, and (ii) strategies and goals tend to shift quickly and so project objectives are overtaken by events.

Cause and effect is also often unclear, because other organizations and projects will also be working in various combinations to achieve similar goals. So, who took the action that caused the change? Or is it a combination of actions that we should be looking at? How should we change our project plan to adapt to what we are seeing happening in real life? These are the sorts of questions which arise when taking a more broadly-based approach to monitoring, learning and evaluation. And, while innovative tools like the CALI and much of the UNDP's work in this area has focused on the critical challenge of reducing conversion

of natural ecosystems, these same complex questions and need for a new approach to defining and measuring success are as pressing in other sectors and related challenges that are crucial to a successful ecological transformation.

Innovative tools like the CALI can help practitioners, including businesses, to better understand the role they can play in driving wider systemic change. Instead of working forwards from an intervention towards its intended result, actors pursuing positive change need an open mind – and some degree of humility – to look at what changes have happened, whether or not they seem to have resulted from their actions.

The most important thing that change makers must recognize is that systems are in a state of continuous flux. Promoters of ecological transformation need to focus on making sense of these changes and what they mean for their interventions, so as to be able to adapt effectively. CALI's participatory reflection and sensemaking is the ideal methodology to underpin this thinking, increasing the engagement and ownership of stakeholders on project interventions, while bringing them closer to each other as part of the process.

If you are interested to know more about CALI and/or the broader work of UNDP around systems monitoring, evaluation and learning, please reach out to andrea.bina@undp.org.



DON'T LOOK UP: what skills for ecological transformation?

Andreas Schleicher

Director for Education and Skills, Organisation for Economic Co-operation and Development (OECD)



Christel Jacque leads her Wildlife Club of 8-year-old children on an outing to learn about mangroves. Such clubs aim to sensitize pupils to be friendly to the environment and how to become a responsible citizen in Seychelles.
Source: Ryan Brown (UN Women).

Andreas Schleicher is Director for Education and Skills at the Organisation for Economic Co-operation and Development (OECD). He initiated and oversees the Programme for International Student Assessment (PISA) and other international instruments that have created a global platform for policy-makers, researchers and educators across nations and cultures to innovate and transform educational policies and practices. He has worked for over 20 years with ministers and education leaders around the world to improve quality and equity in education. Andreas is the recipient of numerous honours and awards, including the “Theodor Heuss” prize, awarded in the name of the first president of the Federal Republic of Germany for “exemplary democratic engagement”. He holds an honorary Professorship at the University of Heidelberg.

People and places are more connected than ever through modern forces such as globalisation and digitisation, but today’s world is also far more uncertain, complex and prone to shocks – including environmental shocks. Transforming and innovating our economies to be more sustainable, climate-friendly and resilient requires a ‘future-thinking’ education system. A ‘future-thinking’ education system is one that can help equip and prepare humans with the skills, values and attitudes that are required for ecological transformation. Done in the right way, a new approach to education can not only help reset our connection to the planet, but develop values that bridge our social differences too. This article shares lessons and reflections from the OECD on the key skills, values and attitudes that are needed to drive innovation for the ecological transformation and support human flourishing.

Whether you are a film buff or live under a rock, you have probably heard of the film *Don’t Look Up*. Equally acclaimed and panned by the audience and critics, this satirical comedy tells the story of two scientists who discover a super-sized comet on a direct collision course with Earth, and face great difficulties in making themselves heard by politicians and the media.

FUTURE-PROOFING EDUCATION BY LOOKING FORWARD

That comet is coming. Globalisation and digitalisation have connected people, cities, countries and continents in ways that vastly increase our individual and collective potential. But the same forces have also made the world more volatile, more complex, more uncertain and more ambiguous. The world has seen a growing disconnect between the infinite growth imperative and the finite resources of our planet; between the financial economy and the real economy; between the wealthy and the poor; between the concept of our gross domestic product and the well-being of people; between technology and social needs; and between governance and the perceived voicelessness of people.



But while digital technologies and globalisation have disruptive implications for our economic and social structure, those implications are not predetermined. It is the nature of our collective responses to these disruptions that determines their outcomes – the continuous interplay between the technological frontier and the cultural, social, institutional and economic agents that we mobilise in response.

The OECD has long advocated future-thinking in policy making to prepare for shocks and surprises – be it climate change, digitalisation or pandemics. This is important because the future will always surprise us.

So how are education systems responding to current pressures of digitalisation and globalisation? And what lessons can we draw from this experience to ready our societies for the climate transition?

TODAY'S TRENDS AND NEW SKILLS NEEDS

For a start, intangibles are the driver of today's economy, which makes education especially central. An example of their power is the growth of tech companies compared to the declining revenue of the traditional companies that dominated the *Fortune 500* decades ago. The great thing is that unlike tangible assets, knowledge can be used repeatedly and in multiple places at the same time, and that's what explains the rapid growth of companies focused on intangibles.

In education, we should ask ourselves what knowledge and skills are needed for participating in an increasingly intangible economy in which the kinds of things that are easy to teach and test have also become easy to digitise and automate. What knowledge, skills, attitudes and values do we need for generating new ideas and products?

Or for organising and governing new ways of working and producing? And what is the role of new technologies in facilitating learning?

Over time, we have also seen a shift in the way we use our time towards leisure, family and political life, we work less, even if it sometimes doesn't quite look so. Can education help individuals, young and old, to develop the knowledge and skills needed to engage meaningfully across all aspects of life?

Part-time contracts and other forms of temporary work have also been rising over the last two decades, particularly among young workers. In 2020, temporary employment accounted for 24% of dependent employment for youths, compared to 11% for the general population. This corresponds to a 7% increase compared to 1980. What are the consequences for on-the-job learning and training if increasing numbers of workers have no permanent employer to sponsor such education? What does this shift

Future-thinking in policy making [helps to] prepare for shocks and surprises – be it climate change, digitalisation or pandemics



mean for education systems, formal or non-formal, and for education professionals? What is the potential of new training opportunities emerging from the gig economy, such as peer networks and crowd-curated resources, to fill this gap?

Beyond these immediate issues, the digital world will bring its own challenges and opportunities. While in the past our location and physical bodies anchored our identity and relationships, we can now create virtual profiles to suit any purpose and share these with anyone, anywhere. Social media and interest-based platforms have expanded exponentially, giving people tools with which to grow their networks and find support, express themselves, experiment with desired identities, and selectively self-present. However, these opportunities also raise questions about safety, transparency and the boundaries

between exploration and manipulation. Teachers must learn to better leverage these new opportunities, while also helping individuals learn to ethically and responsibly participate in the digital environment.

Knowledge also means power. Whereas only an elite few produced traditional encyclopaedias or the mass media of the 20th century, today's social media and internet sites like Wikipedia are fed by the masses who generate the content. The number of all wiki pages grew from about 10,000 to over 250 million in just 20 years.

But are people ready for this? OECD's Programme for International Student Assessment (PISA) shows that Korea, Singapore and parts of China are the only jurisdictions where more than half of the 15-year-olds are fit for the digital world, like figuring out fake news. In most countries with comparable data, the majority of students have still limited digital navigation skills or not even the basics.



So how can we better support all individuals to access and use knowledge effectively? What types of education are needed to enable students, teachers and education leaders to do that effectively? And what (digital) skills and attitudes are needed to effectively evaluate the quality and trustworthiness of information? How can we support teachers to validate the knowledge they use in their practice? Our social circles also influence our access to knowledge. Should educational institutions work more actively to strengthen (digital) social ties? If so, how?

One thing is clear: the kind of things that are easy to teach and test have become easy to digitise and automate. We know how to educate second-class robots, people who are good at repeating what we told them. In this age of accelerations and artificial intelligence, we need to think harder about what makes us human.

EDUCATION MUST PREPARE FOR ENVIRONMENTAL SHOCKS

Likewise, education has a pivotal role to play in our fight against climate change. Climate impacts will pose massive disruption to societies, economies, and education systems. Meeting the global goal of net zero emissions by 2050 will require bold action. As demand for renewable energy solutions has risen and their technology has improved, for example, the costs of renewables have fallen. However, even as the availability and affordability of renewables have increased, we continue to burn fossil fuels like coal, oil and natural gas at an unsustainable rate and our carbon footprint keeps growing.

Education is key to provide all citizens not only with an understanding of the science behind the climate crisis but also its socio-demographic, political and moral implications – what it means to be human in a changing world. Moreover, education can make a fundamental contribution by offering learners the space to take direct action in their communities while fostering pro-environmental attitudes and behaviours.

Most obviously, education provides people with the scientific knowledge and skills that underpin a green economy. And knowledge about the science of the environment is the single best predictor for the environmental attitudes and behaviour of young people. Education also shapes individual behaviour that influences political commitments, whether that is financing parties or social activism. It can shape behaviour that impacts on local communities, think of volunteering or community services, or behaviour that influences business practices, think about changes in consumption and lifestyle patterns, personal investment choices or employment choices. And of course, our own behaviour will always influence the behaviour of others.

But education influences knowledge and behaviour in complicated ways. PISA shows that the quality of education can put countries into very different positions. For example, Singaporean, Korean and Canadian students excelled when they had to explain how carbon-dioxide emissions affect global climate change. Yet just a minority of Singaporean and Korean 15-year-olds said they would choose certain products for ethical or environmental reasons even if they are a bit more expensive, so knowledge doesn't automatically translate into behaviour.

PISA demonstrates that more students act for the environment when they are in schools where other students are also more involved in environmental actions. In other words, school culture is a far more powerful predictor than what's written into lesson plans. So schools can empower students to take environmental action by learning through and from action. It's not enough to teach students something. If we want to educate the next generation for their future rather than our past, we need to do a better job to help them build agency to mobilise their cognitive, social and emotional resources, and to live with themselves, with other people, and with the planet. Education must encourage collective agency that helps students see how the whole is always bigger than the sum of its parts, and that the present shapes somebody else's future.

As we transition towards greener economies and societies, training systems must boost resilience by supporting people to continuously learn, unlearn and relearn. In parallel, our research systems need appropriate policies and resources to engage in the kind of long-term, risk-taking research that we need to innovate our way out of our current unsustainable growth model while still ensuring shared prosperity.

Finally, as large employers and consumers, education systems must "green up" their infrastructure and operations, enhancing their environmental performance while preparing for the challenges already underway, such as the increased likelihood and severity of extreme events like floods and droughts. These are not issues from a distant future; they are happening now.

Education is key to provide all citizens not only with an understanding of the science behind the climate crisis but also its socio-demographic, political and moral implications – what it means to be human in a changing world

RETHINKING EDUCATION

The conventional approach in education is often to break problems down into manageable bits and pieces and then to train students how to solve these bits and pieces. But modern societies create value by integrating different fields of knowledge, making connections between ideas that previously seemed unrelated, connecting the dots where the next innovation will come from.

In the past, schools were technological islands, with technology often limited to supporting and conserving existing practices, and students outpacing schools in their adoption of technology. Now schools need to use the





Mother and young son in a sustainable melon farming garden in a glass house in Bogor, Indonesia. Source: Pramod Kanakath / Climate Visuals Countdown.

potential of technologies to liberate learning from past conventions and connect learners in new and powerful ways, with sources of knowledge, with innovative applications and with one another.

The past was divided – with teachers and content divided by subjects and students separated by expectations of their future career prospects; with schools designed to keep students inside, and the rest of the world outside; with a lack of engagement with families and a reluctance to partner with other schools. The future needs to be integrated – with an emphasis on the inter-relation of subjects and the integration of students.

In today’s schools, students typically learn individually and at the end of the school year, we certify their individual achievements. But the more interdependent the world becomes, the more we need great collaborators and orchestrators. Schools need to help students learn to be autonomous in their thinking and develop an identity that is aware of the pluralism of modern living. At work, at home and in the community, people will need a broad understanding of how others live, in different cultures and traditions, and how others think, whether as scientists or as artists. The foundations for this don’t all come naturally. We are all born with “bonding social capital”, a sense of belonging to our

We should ask ourselves what knowledge and skills are needed for participating in an increasingly intangible economy in which the kinds of things that are easy to teach and test have also become easy to digitise and automate

family or other people with shared experiences, common purposes or pursuits. But it requires deliberate and continuous efforts to create the kind of “bridging social capital” through which we can share experiences, ideas and innovation with others, and increase our radius of trust to others.

We must rethink education and skills if we wish to harness our collective agency to act for the planet; to close the gaps between infinite growth imperatives and finite planetary resources, or between gross domestic product and human well-being; and to make the most of the opportunities that the climate transition presents.

WE SHOULDN’T IGNORE THE TRENDS SHAPING EDUCATION

Whether you’re a fan or not, *Don’t Look Up* raises an important message, reminding us that, in our global and interconnected world, incremental threats like climate change as well as abrupt systemic disruptions like COVID-19 will continue to challenge our ways of living, working and learning. Most importantly, the film tells us that we cannot and should not look away from these trends.



INNER DEVELOPMENT GOALS: FROM INNER GROWTH TO OUTER CHANGE

Doreen Ankrach (Marketing Coordinator), with contributions from Jamie Bristow (Policy and Advocacy), Daniel Hires (Director of Partnerships and Marketing) and Jan Artem Henriksson (Executive Director)



INNER DEVELOPMENT GOALS

Transformational Skills for Sustainable Development

Inner Development Goals (IDG) is a non-profit and open-source initiative for inner development. We research, collect and communicate science-based skills and qualities that help us to live purposeful, sustainable, and productive lives. Supported by a growing community of practitioners, researchers, organisations and governments, IDG seeks to bridge the gap between personal growth and global transformation. In keeping with the spirit of IDG, this article is a testament to co-creation and collaboration, made possible by every member of our organisation, partners, and community.

In an era where attention to external factors and mechanistic solutions often take precedence, the concept of Inner Development Goals (IDG) emerges as an innovative approach for communicating the value of personal growth to collective sustainability and systemic change. Unlike conventional goals that focus solely on material gains, the IDGs delve into the realm of integrated development, encompassing emotional, psychological, social, and spiritual well-being to better equip us for the unprecedented challenges we face today.

Rooted in extensive interdisciplinary research, the premise is straightforward: without a foundational shift in human values, understanding, and leadership capacities, external solutions may prove to be too slow, inadequate or short-lived. Whilst the IDG Framework is itself innovative, the IDG organisation that co-created it has consistently adopted a creative approach to addressing some of the most pressing challenges of our time.

A CONTEXTUAL OVERVIEW

The dawn of the 21st century brought with it an acute realisation of the multifaceted challenges that the global community faces. Recognising the pressing need for a cohesive and comprehensive strategy, in 2015, the United Nations introduced Agenda 2030. Central to the agenda

lies an inclusive set of 17 Sustainable Development Goals (SDGs) – targets for a future where everyone has an equitable opportunity and our planet's health is restored and preserved.

Having just passed the halfway point to the deadline, the unfortunate reality is that progress has so far been disappointing and is still far off track. Data released in the 2023 Sustainability Development Report shows that based on the current pace of progress, less than 20% of the SDG targets are on track to be achieved.¹ In fact, it indicates that we are further off-track than four years ago as a consequence of the ongoing pandemic, rising inflation and the cost-of-living crisis, planetary, environmental and economic distress, along with regional and national unrest, conflicts, and natural disasters.

While possessing the necessary resources and technology to achieve the goals, considering the SDGs solely as technical problems solvable through structural policy instruments or other external methods might be contributing to our lack of progress. The SDGs provide a tangible roadmap, but a crucial question arises: do humans currently possess the capacity to navigate this intricate and interconnected landscape of challenges?

Our evolutionary history, which has us primed for immediate threats and short-term decision-making, often falls short when confronted with long-term, abstract problems. The complexity of our modern environment and societal issues often outstrips our innate cognitive capacities, triggering our unconscious psychological barriers such as denial, rationalisation or discordance, among other 'dragons of inaction'.²

Addressing our global challenges necessitates a change in the underlying mindsets that originally caused them. It requires an innovative approach to identify, rectify and reshape the fundamental origins of these issues – human behaviour. Fortunately, modern research shows that the inner abilities we need to face and overcome these complex challenges can be developed. This was the starting point for the Inner Development Goals initiative.

¹ Sachs, J.D., Lafortune, G., Fuller, G., Drumm, E. (2023). *Sustainable Development Report 2023, Implementing the SDG Stimulus*. Paris: SDSN, Dublin: Dublin University Press, 2023. 10.25546/102924.

² Gifford, R. (2011). "The dragons of inaction: Psychological barriers that limit climate change mitigation", *American Psychologist*, 66, 290–302.





One of the Nordic retreat centres - Folkhögskola, 1890.

BOTTOM UP AND INSIDE OUT

Personal growth and development are by no means new concepts in humanity's history – ancient civilisations and religions have long recognised their importance. Whilst interpretations and practices differ across cultures and belief systems, personal growth, ethical conduct, and inner development have been cross-cultural and enduring aspects of human life for millennia. What has gone astray in our modern relationship to these fundamental concepts? Has the fast-paced nature of today's world impacted the time and importance allocated to self-reflection and inner development? And most importantly, in what ways can we reintegrate these principles to address contemporary challenges and enhance well-being and human flourishing?

Answers to these crucial questions begin to emerge from the broader history of personal growth movements and psychological approaches, such as humanistic, transpersonal and positive psychology, that have sought to investigate human well-being and inner development since the Industrial Revolution. A particularly illuminating perspective, and one that has been instrumental in shaping the IDG initiative, can be gleaned from the cultural, historical, and philosophical underpinnings

of Nordic societies – renowned for their unique approaches to governance, education and welfare.

In the book *"The Nordic Secret"* Lene Rachel Anderson and Tomas Björkman (a co-initiator of IDGs) describe in detail how the Nordic countries transitioned from poor, agricultural and authoritarian societies in the 1860s to wealthy, industrialised democracies just a few generations later. This remarkable transformation was achieved due to the facilitation of personal development in the state-sponsored – but not state-organised – retreat centres all over the Nordic countries.³

The retreat centres were located in nature, away from the complexity of rapid social change. Here, young adults could spend up to six months with the expressed goal of finding their inner compass and becoming active co-creators of the emerging new social order. At the turn of the 19th century, there were approximately 100 retreat centres like this in Denmark, 75 in Norway, and 150 in Sweden, with up to ten per cent of each generation of young adults participating in these programmes.

³ Tomas Björkman, Lene Rachel Anderson, *The Nordic Secret: A European Story of Beauty and Freedom*, Editor: Det Andersenske Forlag, 2020, ISBN 8792240763, 9788792240767.



The authors present a compelling argument for reevaluating traditional models of societal development and governance. Echoing the Nordic principles of self-awareness, community cohesion and sustainable growth, they call for a greater focus on human development, empathy, trust and cooperation as crucial elements for building sustainable and harmonious societies. They propose that in times of uncertainty and rapid change, the only way to build truly stable societies is to build them from the bottom up and from the inside out, with real change beginning in the mind – both collective and individual.

THE EMERGENCE OF THE IDGs

The inspiring insight behind the formation of the Nordic retreat centres was somewhat forgotten over the course of the 20th Century. Fortunately, in recent years, there has been a growing focus on the notion of inner transformation and related methodologies for societal change. This heightened interest is evident across various domains, such as sustainability science, education and policy-making, as demonstrated by the growing number of academic articles dedicated to the topics of inner development and sustainability progress.⁴ Reflected in the literature is the urgent need for more integrative approaches that link sustainability's inner and outer dimensions to facilitate transformation at various scales, including the individual, collective, and systemic levels.⁵

Between 2019 and 2020, a significant undertaking took place on Ekskåret Island within the Stockholm archipelago. During this period, a group of adult development scholars, which included prominent figures like Otto Scharmer, Amy Edmondson, Peter Senge, Jennifer Garvey Berger, and Robert Kegan, collaboratively authored and endorsed the "*Growth That Matters Manifesto*". The manifesto, serving as a call to action, highlighted the pressing need to work systemically with human growth in adults in order to better meet the accelerating complexity of societal challenges.

⁴ Ives, C.D., Schöpke, N., Woiwode, C. et al. IMAGINE sustainability: integrated inner-outer transformation in research, education and practice. *Sustainable Science* (2023).

⁵ Denton, F., K. Halsnæs, K. Akimoto, S. Burch, C. Diaz Morejon, F. Farias, J. Jupesta, A. Shareef, P. Schweizer-Ries, F. Teng, E. Zusman, 2022: Accelerating the transition in the context of sustainable development. In IPCC, 2022: *Climate Change 2022: Mitigation of Climate Change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khouradje, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA.

Amidst these developments, the Ekskåret Foundation, in collaboration with the 29k non-profit organisation and The New Division, led by founder Jakob Trollbäck, who notably led the design of the iconic SDG logos, engaged in concerted efforts to advance this innovative approach to confronting the world's "wicked issues". These initiators established connections with various stakeholders, including companies, researchers, and other interested parties aligned with the IDG project's vision. The aim was to synthesise a complex field of inner development into a simple framework that helps to name, understand, communicate and facilitate the 'inner' changes that are needed for an 'outer' change to occur.

A series of meetings were organised with founders, CEOs, HR managers, sustainability managers and influential figures in both the private and public sectors, as well as many discussions with researchers and leaders from prominent academic institutions. With collaboration, they succeeded in formulating a key survey question that could collect as much relevant input as possible on which skills and qualities are most important in order to work more effectively towards the SDGs.

SHAPING THE IDG FRAMEWORK

The IDG global survey activities, forming the basis of the IDG framework, involved three innovative phases. Phase 1 developed and distributed the survey in March 2021 to capture the varied insights from people with a professional relationship to sustainability issues. Participants were asked which "*abilities, qualities or skills are essential to develop, individually and collectively, to get us significantly closer to fulfilling the UN Sustainable Development Goals*". After analysis and several iterations, led by two independently working researchers, 23 skills were identified and, in order to have a more pedagogical framework, organised into 5 dimensions.

Phase 2, developing the IDG Toolkit, engaged over 3000 collaborators, including world-leading scientists, educators, organisations and government representatives. The IDG Toolkit is an evolving, open-source project that provides free and practical tools grounded in scientific research, helping individuals and collectives to develop each of the 23 skills.



To reduce any Western-centric bias and ensure the framework’s global applicability, Phase 3 of the research is currently in progress. The latest survey aims to reach over two million people and is anticipated to yield 100,000 responses from more than 100 different nations. The survey opens up the co-creation to more voices in a well-structured, inclusive and truly global dialogue that will shape the future of the IDG Framework and iterate the early draft of the IDG toolkit into a more user-friendly version.

UNVEILING THE IDG FRAMEWORK

The intended function of the IDG Framework is primarily pedagogical and is, first and foremost, a communications tool for the conceptualisation and cultivation of inner developmental capacities. The Framework uses purposefully simple language that is comprehensible and effective for practitioners to incorporate the IDGs into their respective governments, organisations, institutions or personal lives. The idea is that establishing this framework will draw interest, foster engagement, and spur further development with collaborative partners and institutions.

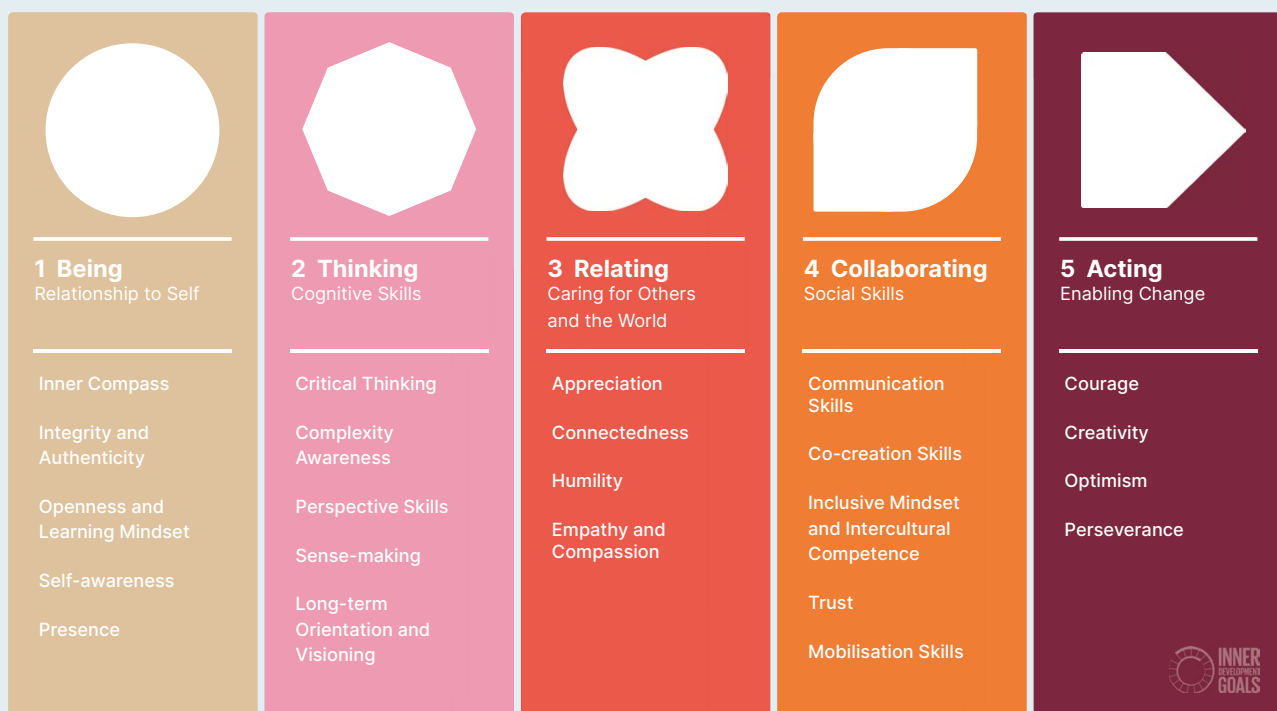
This innovative and collective endeavour aims to popularise and integrate these crucial skills into diverse aspects of individual and societal life. The Framework is a map that can assist us in navigating the landscape of our inner lives. It identifies areas of growth so that we can better handle complexities, deepen our connection to ourselves, others and the world, and fundamentally enhance our effectiveness as change agents and leaders, paving the way to a more sustainable future.

To provide a better understanding of each of the 5 dimensions, a small description accompanies each one, explaining their distinct attributes and significance:

Being: Cultivating our inner life and developing and deepening our relationship to our thoughts, feelings, and body help us be present, intentional and non-reactive when we face complexity.

Thinking: Developing our cognitive skills by taking different perspectives, evaluating information and making sense of the world as an interconnected whole is essential for wise decision-making.

Relating: Appreciating, caring for and feeling connected to others, such as neighbours, future



The IDG Framework covers 23 skills, organised into 5 dimensions.



generations or the biosphere, helps us create more just and sustainable systems and societies for everyone.

Collaborating: To make progress on shared concerns, we need to develop our abilities to include, hold space and communicate with stakeholders with different values, skills and competencies.

Acting: Qualities such as courage and optimism help us acquire true agency, break old patterns, generate original ideas and act with persistence in uncertain times.

ADDRESSING CRITICISMS AND EMBRACING ADAPTABILITY

When positioned alongside other frameworks, the unique focus of the IDGs becomes evident. While many developmental strategies, like the SDGs, provide an overarching view of global challenges, IDGs zero in on both the individual and collective role within these larger systems. It's not a replacement for broader frameworks but rather a complementary perspective, emphasising that macro-level change is inextricably linked to micro-level transformations.

A potential criticism that emerges is the interpretation of the term "inner" within the IDGs and its framework. There is a common misconception that "inner" solely pertains to individual introspection and personal qualities. Whilst it is true that the term implies individual personal growth and self-awareness, when applied to broader contexts, "inner" can also encompass the core values, principles, culture and ethos of collectives and organisations. This broader definition emphasises the importance of aligned group dynamics and the interconnection of personal and collective growth in driving systemic change.

A further criticism of the framework is the perceived subjectivity of the 23 skills. While frameworks like the SDGs provide quantifiable targets, the IDGs' emphasis on inner qualities and personal growth can be seen as less tangible. How does one measure self-awareness or empathy without depending on self-reports? Can such intangible goals be universally applied, given the diverse cultural and societal contexts across the globe?

Such questions continue to be addressed through discourse and research, but it is essential to recognise that the strength of the IDG Framework lies in its flexibility. While it offers a map for inner growth,

it does not prescribe a one-size-fits-all approach, nor does it represent a training curriculum in itself. Its simplicity is a design principle, both keeping it easy to communicate and relatively 'naked' or decontextualised, ready to be re-contextualised within specific training or personal development approaches. This adaptability allows it to be tailored to diverse cultural and societal contexts, ensuring its relevance across different settings. By recognising its limitations and continuously refining the framework in response to feedback, the IDGs can become an increasingly robust and globally transferable tool in the quest for a sustainable and equitable future.



IDG volunteers outside the 2022 Summit in Stockholm, Sweden.

PRACTICAL APPLICATIONS AND IMPLICATIONS

IDG works in four main areas: Communication, Movement Building, Policy Development and Research Co-creation, which are vital in disseminating



the message and strategies of IDG to a broader audience. The primary stakeholders working with IDG are companies, NGOs, governments and academic institutions because of their vast potential to facilitate collective learning and drive systemic change. Furthermore, whilst there are various domains where adult development matters, the workplace plays a central role by providing repeated chances to encounter diverse perspectives, tackle challenges, receive feedback and take on responsibility – areas for which the IDG framework becomes particularly valuable.

In pilot countries, such as Costa Rica, where ministers and parts of the public sector have formally adopted the IDG Framework, collaborative efforts with IDG Country Centres have been initiated to develop and strengthen leadership capacities across various sectors, ensuring a more integrated approach to sustainable development that includes both external and inner dimensions. Furthermore, multinational corporations like Google, Ikea, Ericsson, and Spotify are among the first collaborating partners to incorporate IDGs into their organisations and more intentionally work on the inner skills needed for sustainable change within the company. IDGs now has more than 50 global corporate and institutional partners and 500+ multiplying organisations.

When working with the primary stakeholders, the IDG Framework is used to help leaders perceive and develop a wide range of cognitive, emotional and relational capacities that will help them to take on challenges and better contribute to sustainable development within their respective organisations. Furthermore, the IDGs facilitate the systematic development and application of critical inner skills by offering leadership workshops and masterclasses, working closely with agents of change within organisations and governments, and providing regular events and an annual summit where participants can immerse themselves in transformative experiences, engage with experts, and collaborate on innovative solutions for personal growth and societal advancement.

At an individual and community level, IDG organises monthly online gatherings that act as the steady heartbeat of the global community; it empowers individuals around the globe to start their own IDG hubs (currently over 350) – connecting the community based on the shared understanding of

the IDG Framework, and finally, it provides an open-source online toolkit with more than 30 evidence-based approaches that individuals and teams can use to cultivate each of the 23 skills.

LOOKING FORWARD

The IDG initiative, having been established in 2020, is at its beginnings, yet its influence on the global landscape is already significant. As recognition and acceptance of the Framework spreads, the potential for further transformative impact is exponential. With the commitment of change agents, both in positions of influence and among everyday citizens, the IDGs are capable of catalysing positive shifts on personal, organisational, communal, and global levels.

The journey ahead is not without challenges, as the dynamic nature of global ecological issues necessitates continuous adaptation and innovation. By emphasising the symbiotic relationship between individual growth and societal progress, the IDGs offer a novel perspective on the path to ecological sustainability. The challenges we face as humanity are an invitation – an invitation to rethink, reimagine, and rebuild; to consider who we need to be in this next chapter of civilisation. The IDGs serve as a compass in this journey, pointing towards a future where individual transformation drives societal progress.

This is a call to action for researchers, policymakers, leaders and employees in all types of organisations, educators, independent practitioners, and readers alike to consider exploring and applying the IDGs within their professional and personal spheres. Inner development is not a supplementary activity to be pursued once all other tasks are completed, nor can external systemic changes wait until the inner work has been done. Both are mutually reinforcing and shouldn't be seen as competing demands. Furthermore, inner development is not a journey to be undertaken alone or as a one-off; rather, it is best understood as a continuous and collective process of inquiry, growth and learning through action in a supporting context. Only by cultivating our inner capacities can we hope to overcome the multitude of challenges before us, ensuring that our outer achievements are firmly rooted in inner wisdom, compassion and resilience.



APPLYING CLIMATE PSYCHOLOGY PRINCIPLES AND METHODS TO THE WORK OF LEADING ECOLOGICAL TRANSFORMATION

Renée Lertzman

Psychological strategist and advisor based in the San Francisco Bay Area



Renée Lertzman PhD is a psychological strategist and advisor based in the San Francisco Bay Area. She works with leaders and organizations who seek to scale impactful engagement across stakeholders, consumers and employees on ESG, climate and ecology. Her speciality is helping high impact teams and leaders evolve from cheerleaders and educators to "guides" drawing on decades of experience and psychological training. Clients include Google, VMware, Unity, and numerous start-ups and philanthropic organizations.

Dr Lertzman has an MA from University of North Carolina Chapel Hill, and a PhD in Social Sciences from Cardiff University. She is a frequent guest speaker and lecturer at institutions around the world, and has been featured at Stanford University, Yale University, Columbia University, Oxford University, Climate-KIC, TED, and numerous industry and public events.

She has published *Environmental Melancholia* (Routledge 2015), and is currently working on a trade publication about applying the psychology of climate and ecological threats to our business and personal practices.

To shift today's economies and societies from ecological *transition* to ecological *transformation*, i.e at speed and scale, we need to apply psychology principles and methods. This article outlines a framework for how those leading ecological transformation efforts in an organization or community can apply psychology principles to guide and accelerate innovation for transformation. Guiding principles include attuning, revealing, convening, equipping and sustaining.

INTRODUCTION

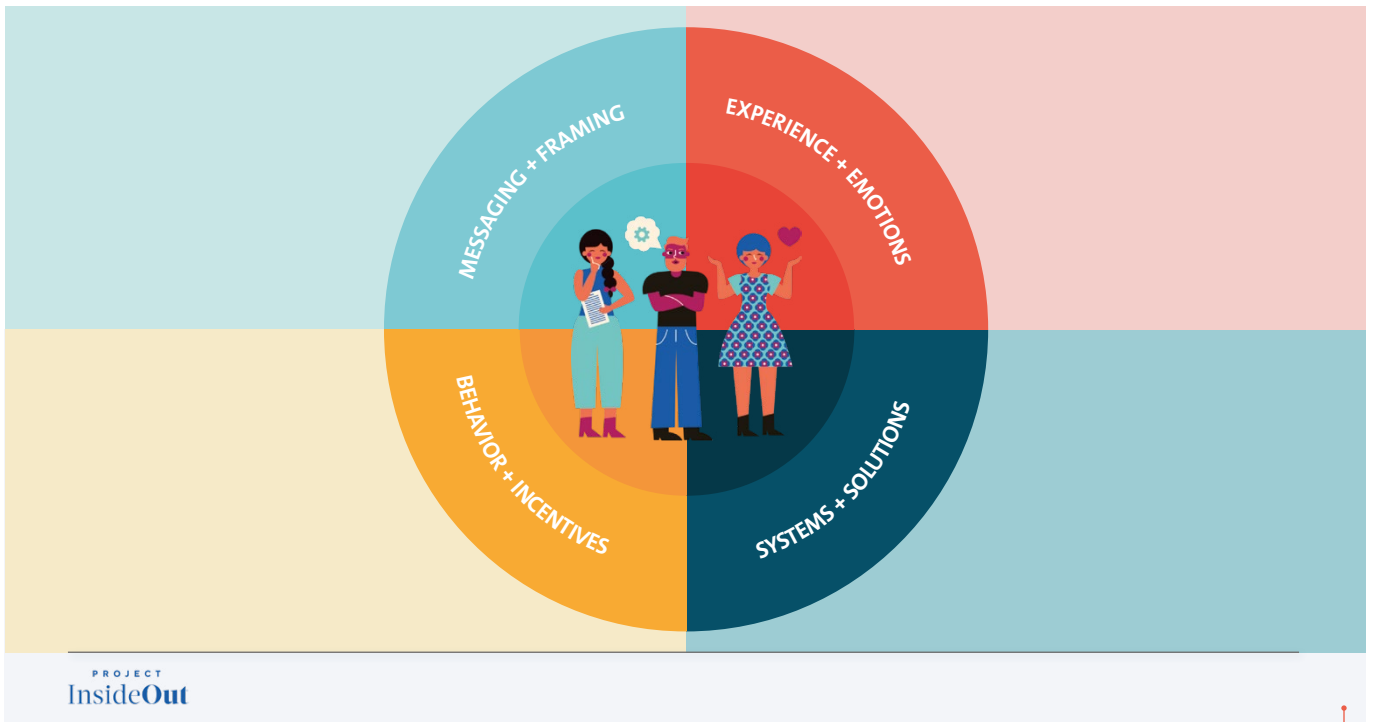
A decade ago, the conversation around climate psychology focused on one field: behavioral psychology, popularized by Nobel economics laureates Daniel Kahneman and Richard Thaler, who pioneered the integration of psychology into how people make economic decisions. The study of climate decision-making often centered on encouraging people to change their consumption behavior or other actions through 'nudges' such as charging for supermarket plastic bags or comparing one's energy usage to that of neighbours. A behavioral-psychology approach also involved studying public perceptions and beliefs on climate so the right levers could be selected to change behavior.

But nudges work only at the individual level. While individuals acting in concert can have significant power to drive change, ecological transformation requires systems-level change. It requires change not only in the ways we consume, but in the ways we act as citizens, as employees, and across our other identities and roles throughout communities, economies and societies.

To accelerate and scale change in our current systems to better address climate change and its impacts, we need to expand the conversation beyond the nudge.

Applying psychology principles to climate change engagement and other ecological transformation is about much more than just behavioral nudges. Many practitioners have strongly entrenched 'theories of change' and approaches on how best to engage people on climate and sustainability.





The Quadrants of Engagement - the four main orientations towards theories of change. Source: Renée Lertzman via Project InsideOut.

These include:

- **Behavioral change and behavioral sciences:** Behavioral science approaches today often center on encouraging individuals to change their behavior through ‘nudges’, as well as identifying the right levers for behavior change.
- **Messaging and framing:** The linguist George Lakoff, for example, highlights the importance of framing – not just as a means of persuading people to act, but the conceptual structures by which people understand climate change and other environmental issues.¹ At the Yale Program on Climate Change Communication, program director Anthony Leiserowitz studies public beliefs, attitudes and behaviors about climate change and sustainable development; Leiserowitz and his colleagues have identified six segments of people by the way they view climate change, ranging from ‘Dismissive’ to ‘Alarmed’.²
- **Designing better systems and solutions:** Design thinking is the iterative process of ideating, prototyping and testing solutions, founded on an understanding of user experience. Its application to social impact was first popularized by organizations like IDEO and Ashoka.

To accelerate and scale change in our current systems to better address climate change and its impacts, we need to expand the conversation beyond the nudge

- **Emphasizing experience and emotions:** Practices and initiatives that build community, belonging and connection; foster emotional intelligence at all levels; address climate anxiety and emotions; and encourage leaders to be vulnerable and human, are also effective ways of engaging people on climate. Examples include the Extinction Rebellion activist community and its ‘fire circles’, the Climate Coaching Alliance, and the Climate Psychology Alliance.

In fact, we need all of these approaches, and we need to combine and integrate them in creative ways, for effective climate change engagement.

FOSTERING INNOVATION FOR ECOLOGICAL TRANSFORMATION

We know these approaches are important – but the art lies in using them. How should we guide change to foster innovation for ecological transformation?





A NOTE ON THE THREE AS: ANXIETY, AMBIVALENCE, AND ASPIRATIONS

In nearly every encounter with climate change, we experience the ‘three As’.

¹ George Lakoff (2010) *Why it Matters How We Frame the Environment*, Environmental Communication, 4:1, 70-81, DOI: 10.1080/17524030903529749

² Verner, M., Marlon, J., Carman, J., Rosenthal, S., Ballew, M., Leiserowitz, A., Buttermore, N., & Mulcahy, K. (2023). *Global Warming’s Six Audiences: A cross-national comparison in nearly 200 countries and territories worldwide*. Yale University. New Haven, CT: Yale Program on Climate Change Communication.



<h2 style="text-align: center;">Cheerleader</h2> <p style="text-align: center;">A focus on solutions and keeping things positive, hopeful, inspiring and uplifting. However, it has blind spots or can be ineffective when it does not acknowledge people's anxieties and ambivalence</p> 	<h2 style="text-align: center;">Righter</h2> <p style="text-align: center;">Includes advocacy; making the moral and ethical case for the right thing to do; and highlighting the urgent need for ecological transformation. Sometimes focusses only on what has gone wrong and demands change without a clear pathway or motivation for how to get there</p> 	<h2 style="text-align: center;">Educator</h2> <p style="text-align: center;">Focuses on raising awareness and providing people with the right information, on the basis that having this information will spur people to act differently. Like cheerleading, educating can often fail to acknowledge anxiety or ambivalence and focus only on aspiration</p> 	<h2 style="text-align: center;">Guide</h2> <p style="text-align: center;">Emphasizes listening, questions, conversations, and relationship-building as a means of building capacity to learn, grow, evolve and transform.</p> 
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PROJECT
InsideOut

The different types of changemakers and their key characteristics. Source: Renée Lertzman via Project InsideOut.

One is **anxiety**. Grappling with a massive, complex problem like climate change can be anxiety-inducing. We may feel guilty or ashamed that we aren't doing more about it, or paralyzed when we don't know what to do or how to do it. In climate engagement, we need to acknowledge and confront anxiety, as it has a direct impact on how we think, feel, process information and relate to one another.

Another is **ambivalence**. Ambivalence refers to feeling pulled in multiple directions by simultaneous, conflicting desires, motivations, attachments and values. For instance, perhaps someone fears for the last biodiverse spaces on the planet, yet wants to visit them all – a trip that would hasten their demise – before they disappear. We may feel tugged in different directions as citizens, caregivers, consumers or employees. In climate engagement, ambivalence is a key ingredient in how we wrestle with new solutions, behavioral changes, and collective actions. The more we recognize and acknowledge it, the more readily we can work out new ways of engaging effectively.

The third 'A' is **aspiration**. As humans, we have some fairly universal aspirations, such as autonomy, agency, and purpose. When it comes to climate change, we want to

be part of the solution, to make a difference, and to have a positive impact.

To help organizations or communities achieve ecological transformation that addresses climate change, it's essential to acknowledge and address all three 'A's – not just speak to people's aspirations or try to frighten people into action.

We'll explore this more deeply in 'How to be a guide' below.

To help organizations or communities achieve ecological transformation that addresses climate change, it's essential to acknowledge and address all three 'A's (Anxiety, Ambivalence, Aspiration) – not just speak to people's aspirations or try to frighten people into action

HOW TO BE A GUIDE FOR CHANGE: THE FIVE GUIDING PRINCIPLES

There are many different ways that advocates and changemakers have sought to drive ecological transformation, but the only one that is truly effective is Guiding.

Because it operates in the context of relationships with people and acknowledges and addresses all three 'A's, Guiding it is the most effective method for driving transformation in a community or organization. It can encompass and integrate elements of Righting, Educating and Cheerleading where they are relevant. Other practices



do not fully acknowledge how people view ecological transformation: Cheerleading and Educating can often fail to acknowledge anxiety or ambivalence and focus only on aspiration, while Righting can sometimes focus only on what has gone wrong and demand change without a clear pathway or motivation for how to get there.

So how might Guiding be applied to climate transformation? In 2019, I convened a group of experienced clinical psychologists, sustainability professionals, researchers, and design thinkers in San Francisco to think through what practices can best guide people to shift deeply entrenched behaviors and promote sustained long-term transformation over short-term change.

The output became the five Guiding Principles of Project InsideOut that are grounded in evidence-based research, best practices, and years of clinical experience. They are:

- **Attune: Understand your people.**
 - When trying to create change in any group – in a business unit or department, for instance – you must first understand *yourself* and have compassion for the range of your experience and emotions.
 - Then, understand and address the three ‘A’s that may arise in the group, and seek to experience your campaign from their point of view – not just the call to action. Understand the dynamics in your organization that may stem from the three ‘A’s of your people, and correct course in real-time if needed.
- **Reveal: Go deeper.**
 - Revealing means providing opportunities for vulnerable, personal sharing – from leaders driving transformation, and from your people. The typical ‘heroine’ narrative involves overcoming a tough challenge to emerge triumphant. Don’t forget to leave room to talk about the struggles along the way, such as doubting oneself or facing skepticism from others.
 - Can you create a culture in your organization or community where people feel safe to reveal the extent of their struggle without being shot down?
- **Convene: Less talking at, more talking with.**
 - When we focus on the urgency of ecological transformation, it can be tempting to promote, tell, lecture or pitch – to get people to care, donate, or change their behavior. But transformation depends on relationships, which over time are the most effective drivers of change.
 - This means viewing organizations as conveners rather than messengers. Can you enable people to work in small groups or pairs to build relationships with each other? Can people get to know each other socially while engaging with ecological transformation?
- **Equip: Be a gardener, grow your people.**
 - The more that changemakers can build the skills and capacities of others, the lighter our individual burdens

Transformation depends on relationships, which over time are the most effective drivers of change

get and the stronger our organizations become. But it’s not just about uni-directional upskilling or lecturing. As leaders, we need to confer on people a sense of autonomy, control and purpose around ecological transformation. We can draw on methods like peer-to-peer learning, mentoring, and train-the-trainer models to accelerate people’s growth.

- **Sustain: Go beyond the pledge.**
 - While eliciting a commitment or getting signatures on a pledge is exciting, ecological transformation demands sustained change. How do we make actions stick in the long term?
 - Again, changemakers can plan for this. We can make sure there are resources and infrastructure available after the pledge or commitment is reached. Being attuned to your people can also shed light on where they’re at, what they are struggling with, and what they need to support and sustain transformation. And the most powerful way to sustain engagement is, of course, involving people in co-design, co-creation and co-ownership of the change they’d like to see.

PUTTING IT ALL TOGETHER: AN EXAMPLE

How might the five Guiding Principles play out to accelerate and scale companies’ and organizations’ contributions to ecological transformation?

Recently, I worked with the technology company VMWare to support its ESG engagement strategy – first outlining the company’s ESG agenda and goals for its next several years, then engaging in listening across the organization and hearing where people were in relation to these ESG goals.

Next, we held a series of dialogues with a variety of stakeholders within the organization. Over time, they were able to articulate their principles.

Most importantly they developed the skills and tools to guide internal stakeholders, teams and business units to establish a deeper connection and understanding of the company ESG agenda and goals. They did this by going through a process of learning how to implement the Guiding Principles, gain awareness of their theory of change, and translate this into their own unique culture.

Now, the organization is in an early stage of rolling these principles out organization-wide, in a way that is a true collaboration across different business units and teams. The Guiding Principles are not applied in a one-off manner. Rather, we enable people within an organization to develop skills, evolve their mindsets, and work in ways that enable them to continually experiment and practice.



REGENERATIVE LEADERSHIP: what it takes to transform business into a force for good

Emmanuelle Aoustin
Seedlings - Regenerative Leadership Mentor,
Advisor & Consultant



An accomplished mapmaker and traveler of the regenerative transition, Emmanuelle Aoustin has a rich background in environmental science and has dedicated her career to fostering positive, scalable impact in business. As a chemical engineer, she's held significant roles from shaping impact strategies at Veolia and leading Quantis, a multinational sustainability consultancy, to launching the Regenerative Alliance. In 2022, Emmanuelle co-founded Seedlings, a pioneering initiative combining coaching, consulting, and expertise to guide the shift towards a regenerative economy, emphasizing the importance of human-centered, systemic change and drawing inspiration from living systems.

Ecological transformation will require a fundamental shift in the purpose of business and the global economy as a whole. This change will not only require new ideas, but a new type of leader. This article presents frameworks created by Seedlings – a pioneering initiative combining coaching, consulting, and expertise to guide the shift towards a regenerative economy – that can help leaders to understand the role of businesses in supporting regenerative transformation, and develop the mindsets and skillsets required to drive that change. These regenerative leadership qualities are vital if we are to succeed in innovating new models for business safeguard prosperity for people and planet.

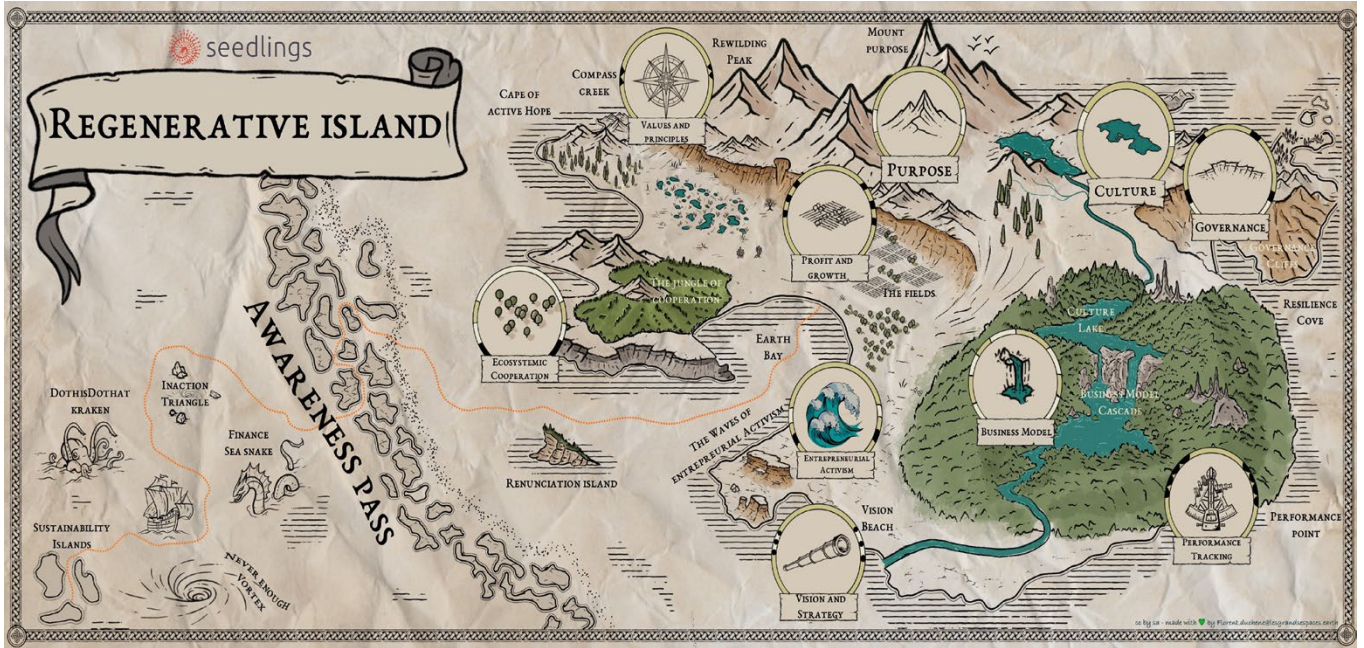
INTRODUCTION

Businesses have a major role to play and a unique ability to lead the ecological transformation. They are able to influence, empower and align actors up and down value chains, within communities, across geographies, cultures, and socio-economic groups. It's a hugely exciting prospect, but not an easy one.

The regenerative transformation – how my organization, Seedlings, would characterize ecological transformation – is a radical shift for the business world, from being reactive and doing less harm (traditionally the responsibility of sustainability leaders) to being proactive and thriving while solving our world's biggest problems (the responsibility of all business leaders). This requires multiple innovations that fundamentally redefine what it is to be a company and a profit-making enterprise.

This change will not only require new ideas, but a new type of leader. The magnitude of the transformation requires change agents who are well-equipped to steer their businesses into a new paradigm. These leaders are those who are brave enough to lead beyond the status quo, to truly align their values and actions, and to make an impact in the world.





IMAGINING A MAP OF RADICAL BUSINESS TRANSFORMATION

Embracing a world where 9+ billion people can live well and where ecosystems thrive can only be achieved through urgent and significant transformations of our businesses and wider economy.

Regenerative transformation is very much a journey to new territories. In Seedling's illustration, we mapped out the Regenerative Island with 10 different ecosystems: meadows, rivers, cascades, peaks and coves, each representing a regenerative business characteristic. Organizations that are leading the transformation have brought about radical change across all of these strategic aspects. These metaphorical ecosystems are in fact the 10 fundamentals of a business; each needs to be thought through with a regenerative lens in mind.

Most of the discussion about regenerative business today focuses on transformation of the Business Model. And for a reason. It's indeed the key topic, and a very difficult one. Most current business models are based on volume and growth, and have detrimental social and environmental impacts - decoupling growth and impact has been an utopia long enough and it's now time to shift. Organizations must rethink their value proposition from its conception through to its distribution, delivery, and monetization. This is a radical change in the conception and production of products & services.

The regenerative business model builds upon and goes beyond existing concepts such as circular economy, sharing economy, eco-design, eco-efficiency, green chemistry, net-zero, etc. These approaches are intrinsic to "do no harm" models that seeks to minimize impacts, and to the "restorative" business model -

The learning mindset is a combination of an inquiring mind and the willingness to embrace change. This is not a given when it comes to business leaders

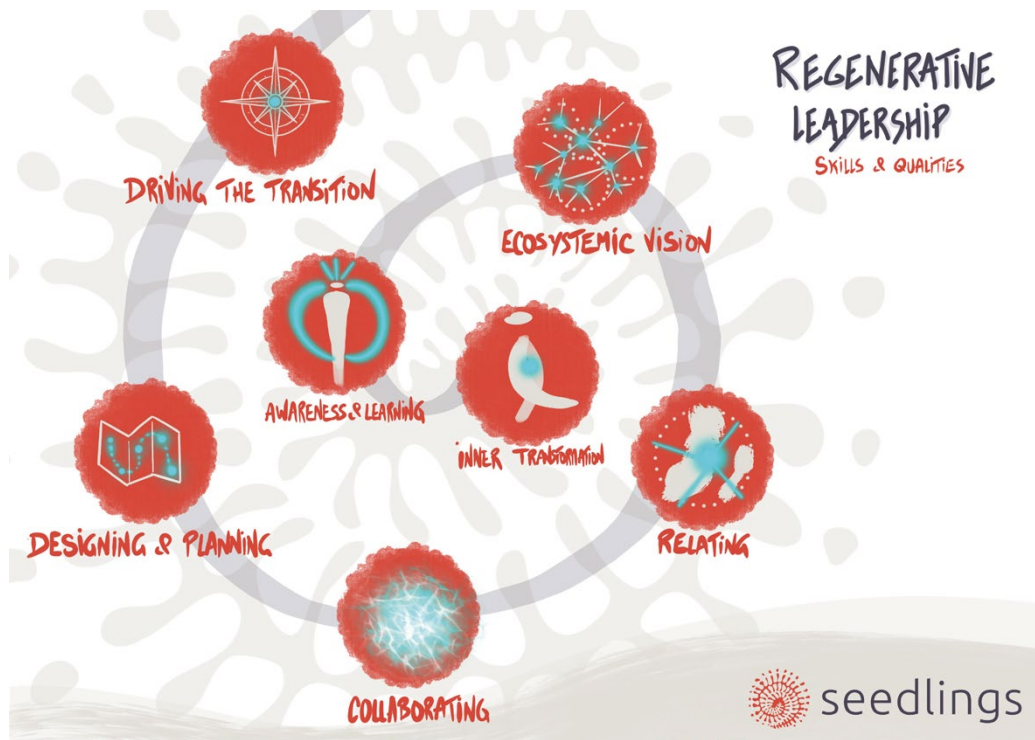
the "do good" model, also called "Net Positive", but a regenerative model goes further¹. Fundamentally, the "regenerative" business model works with and within the cycles of the living world². It operates "within the doughnut" (meeting the needs of all people within the means of the living planet³) and seeks harmony with life, protecting Earth's life-supporting systems. Beyond the ecological aspects of regeneration, it also embraces social regeneration; enhancing social justice, diversity, participation and collaboration.

While the question of business model may sit at the heart of any regenerative transformation, there are many different paths and starting points from which businesses can go on their journey. The other 9 ecosystems of Regenerative Island lay out the characteristics of the business they will need to explore to reach the end of their journeys: Purpose, Values & principles, Vision & strategy, Profit & growth, Performance tracking, Culture, Governance, Eco-systemic cooperation, and Entrepreneurial activism.

All these fundamental business characteristics are interconnected. This means that starting to shift one will also bring others into motion. On the other hand, not addressing some of these areas, consciously or not, can hinder regenerative transformation. Leaders should look at the whole map of the regenerative island from time to time and identify the ecosystems they have yet to fully explore.

1 Paul Polman & Andrew Winston (2021). "Net positive: How courageous companies thrive by given more than they take". Harvard Business Review Press.
 2 Giles Hutchins & Laura Storm (2019) Regenerative Leadership: The DNA of Life-affirming, 21st Century Organisations.
 3 Kate Raworth (2017) Doughnut Economics. Random House.





DEVELOPING REGENERATIVE LEADERSHIP QUALITIES

Creating a clear picture of what a regenerative business would look like is only part of the challenge, however. To succeed in radical transformation, we need to overcome resistance, inspire and engage a wide range of stakeholders to innovate an entirely new model of business and economy. What are the qualities of leaders that can do all this?

Based on the emerging literature in the field from organizations and authors including the Inner Development Goals, Giles Hutchins and Laura Storm, and Otto Sharmar, and refined by our experience, at Seedlings, we have identified 7 fundamental qualities and competencies of regenerative leaders.

1. AWARENESS AND KNOWLEDGE

To make sound and informed decisions that benefit planet and people, leaders need to be up-to-speed with many fast-evolving areas including climate science and regulations as well best practices and innovations in their respective fields. This requires dedicated attention to continuously building one's awareness & knowledge.

The learning mindset is a combination of an inquiring mind and the willingness to embrace change. This is not a given when it comes to business leaders: it implies being curious about fields of expertise beyond our core experience, being humble and accepting that we don't know much. It also requires being

patient and committed to re-learning; the science of our planet is complex and always evolving. Because no-one can know everything, leaders need to trust others to be able to leverage humanity's collective intelligence.

Regenerative leaders have the courage and humility to un-learn traditional business approaches and engage into new ways of thinking. They must not only be technically competent but also emotionally intelligent. They will need engage all the different forms of intelligence: body, mind, heart and soul. They are able to unlock not only knowledge, but also meaning, passion and willingness to act in others.

Regenerative leadership is not only required of 'traditional' leaders of today – politicians, CEOs, etc. The magnitude of the environmental & social we face today

mean that leaders across all levels of business – and indeed all parts of society – must also reach this higher level of awareness and knowing.

2. DESIGN AND PLANNING

Awareness and knowledge as only useful when applied; leaders need design and planning skills to translate their understanding into real-world action. These include the capacity to redefine success and business purpose, to innovate and design new business models, to shape new governance and accounting approaches, and to shape a vision and a strategic plan to realize change that stretches far outside of our current understandings of "normal" business.

We cannot transform our organizations without understanding what transformation truly means... it is about a fundamental shift in the purpose of business and the global economy as a whole



Together with designing comes planning: the magnitude and urgency of the transformation calls for leaders who can grasp that we have as little as one generation to achieve the change required. This means engaging with processes of innovation and experimentation, but at huge scale and speed. Ultimately, with the time we have left, a doer's mindset that is critical.

3. INNER TRANSFORMATION

Those leaders that are actively engaged in shifting business are actively engaged in their own personal journey. In other words, changing the world starts with ourselves; our own inner transformation is a prerequisite to any sustainable change.

Inner transformation consists of deep, reflective inner work exploring or re-exploring our own values, purpose, and contribution to the world, thus shaping a deeply felt sense of responsibility and commitment. Practices that promote this development include self-reflection, presence & mindfulness, and deep listening. They can give leaders the ability to act with sincerity, honesty and integrity in alignment with one's values as a person, as a parent, a friend, a citizen, and as a member of all generations of humanity. Leaders we speak with say this has helped them drop the mask they were wearing in the corporate world and "show up as a whole".

4. RELATIONSHIPS

A fundamental mindset shift to accelerate regenerative transformation is to focus on regenerating human connections: connection to ourselves through better alignment with our values and deepest beliefs, connection to others through resonance and sharing, and greater solidarity and connection to our environment. Who and what we care about is where our attention will be focused.

Regenerative leaders have developed a sense of interconnectedness, a feeling of belonging in the greater web of the world, as in the Buddhist concept of "interbeing". With interbeing, leaders have shifted their mindset from an ego perspective to an eco-perspective, feeling the oneness with nature. And even further, they can shift to a selva perspective, when they can embrace empathy and radical love⁴. This is also sometimes referred to as "ubuntu", a Nguni Bantu term that translates into "I am because we are", acknowledging that we are part of a larger and more significant relational, communal, societal, environmental and spiritual world.

It is a significant leadership shift to go beyond leading people or teams, to managing relationships and focusing on what is disconnected and needs reconnection: shifting from extraction to relation, from doing to meaning making.

Foundational mindset shifts are needed to underpin both the transformation of businesses and of individual leaders. Crucial among these is putting humanity at the heart of decisions and reconnecting to the wisdom of living systems

5. ECO-SYSTEMIC VISION

Developing an eco-systemic vision⁵ starts by realizing the crisis we are facing is a systemic one: it is a polycrisis that goes well beyond climate change. 6 out of 9 planetary boundaries have already crossed⁶, and the world is more unequal than it has been for centuries⁷. The challenges we face are global and they are also completely intertwined: for example, low- and middle-income countries suffer greater climate change impacts than their richer counterparts.

Eco-systemic vision involves understanding that we are all interconnected and interdependent. That applies not only to value chains, sectoral initiatives, or stakeholder engagement, but also to the relationship between business and ecosystems: business cannot thrive if ecosystems die. Businesses cannot thrive if the lives of people deteriorate. The health of every business is intrinsically linked to the health of the system as a whole, and every action has ripple effects that can be felt across each system. Leaders need to expand their worldview, embrace eco-systemic complexity, planetary boundaries, ecosystem cycles, long-term thinking, and face a broader responsibility. They need to recognize the effects their business has, and can have in this context, and find ways that they can contribute to treating the causes of our current ills, not just the symptoms.

6. COLLABORATION

Shaping a collaborative culture is a major transformation that regenerative leaders have to embrace. Engaging all stakeholders calls for deeper and extended collaborations with a greater number of people. It starts inside businesses by breaking the silos that prevent transformation to happen, and continues with active engagement with suppliers and clients, as well as with legislators, innovators, investors.

Thus, enabling collaboration at all levels is a core quality of regenerative leaders. Eco-systemic collaboration includes the ability to facilitate intense cooperation in a decentralized system; promoting co-creation and fostering collective intelligence. It involves such qualities as deep listening and the ability to communicate in the "language" of a range of stakeholders and perspective. It means moving away from the traditional competitive mindset and developing "Both/And" thinking to embrace creative tensions.

7. DRIVE

Ultimately, regenerative leaders can only be judged a success if they bring about transformation. It takes a delicate combination of audacity, resilience, and ability to engage others to steer an organization towards this path, and stick to it.

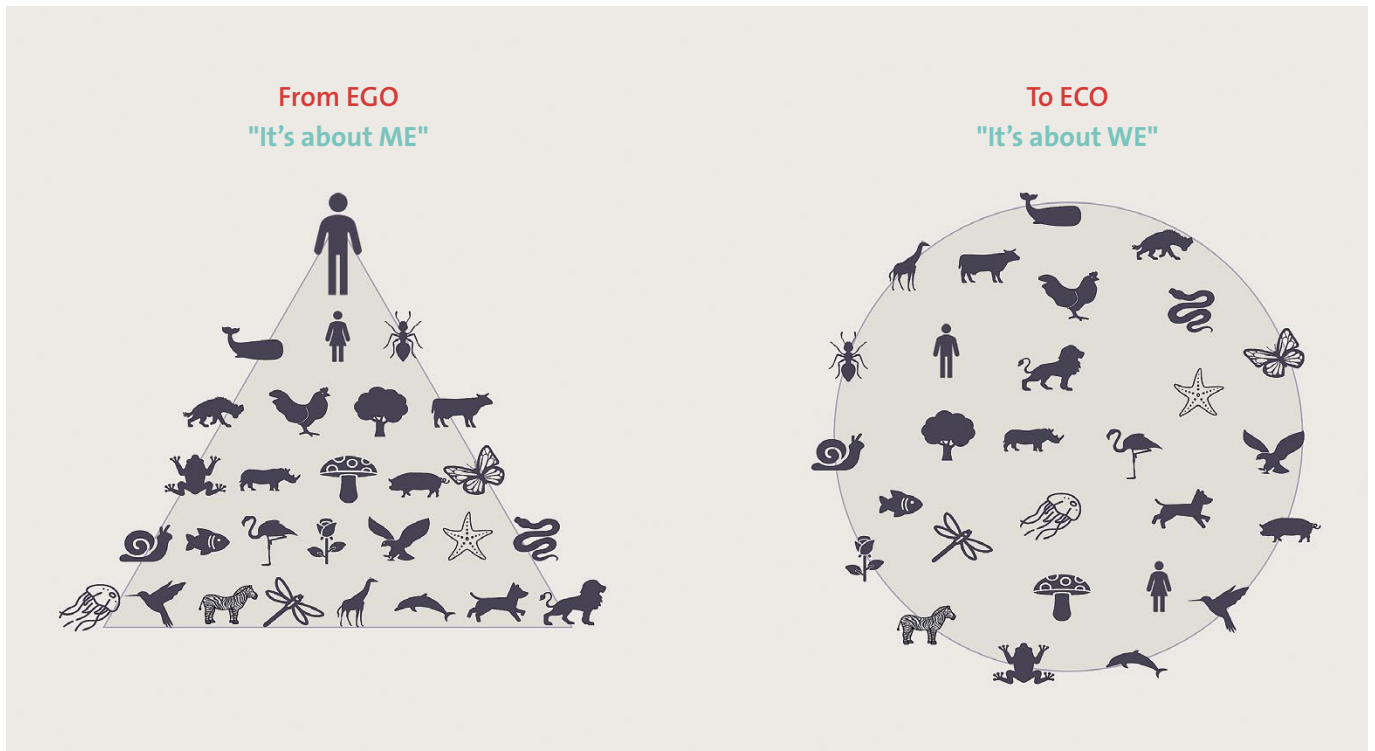
⁴ Satish Kumar (2023) *Radical Love: From Separation to Connection with the Earth, Each Other, and Ourselves*. Random House.

⁵ Donella H. Meadows (2008) *Thinking in systems*. Reed Elsevier.

⁶ Potsdam Institute (2022) *Planetary boundaries update: Freshwater boundary exceeds safe limits*.

⁷ World Inequality Report (2022).





It takes courage to dare push for the unknown, to give-up on unsustainable business models and explore new ones⁸. It takes bravery to challenge the status-quo and accept being a singled-out at time. It also takes audacity to give-up on short-termism where decisions are guided by quarterly profit targets: the regenerative leader is one that does not shy away difficult conversations with its shareholders and investors.

Leaders who lead the regenerative transformation also demonstrate a high level of resilience. It takes determination and the ability to bounce back to maintain the new direction over the years despite inevitable challenges.

The largest challenge is possibly how to engage the broader ecosystem both inside the company, and with all its other stakeholders. Most important to this ability to be able to share an inspiring vision, a story of the benefits it will generate, how you will get there. Such regenerative leaders inspire because they are able to talk with their hearts, not only their heads. Their power to convince stems from the human being they are, beyond the professional: the parent, the citizen, the community member, the person that cares about the planet and future generations.

SHIFTING TO A REGENERATIVE MINDSET

Foundational mindset shifts are needed to underpin both the transformation of businesses and of individual leaders. Crucial among these is putting humanity at the heart of decisions and reconnecting to the wisdom of living systems.

⁸ Brené Brown (2018) *Dare to Lead: Brave work. Tough conversation. Whole hearts.* Random House.

ENGAGING WITH THE HUMAN DYNAMICS OF CHANGE

Scientific paradigms alone have proven ineffective in engaging with the exponential change that's requested. We know, yet we don't act, and certainly not at the speed and scale that's needed to maintain our existence on this planet. We also must recognize that it is a cognitive dissonance involved in inventing a new future, whilst still being on the old playing field.

There are many human reasons and obstacles that prevent our awareness, contradict decisions, limit commitment, delay engagement and hinder action. They can be organizational factors such as capacity, priority conflicts or power struggles. They can also be individual or social factors such as beliefs, habits, fears, or sense-making.

Only by understanding and accepting the human factors of change will we be able to engage in the regenerative transition. By integrating all aspects of the human dimension of the company, leaders can reinforce the desire and capacity to act of their stakeholders and activate a deep and lasting transformation.

RECONNECTING TO THE WISDOM OF LIVING SYSTEMS

The dominant worldview pervading our businesses, institutions and societies is flawed by an illusion of separation. We believe that humans are separate from nature. As we see it today,





Aerial drone image of fields with diverse crop growth based on principle of polyculture and permaculture - a healthy farming method of ecosystem.

living systems and the planet in general are a set of resources to be used for human betterment, ripe for our exploitation: nature can be measured, monitored, controlled and managed, and has no intrinsic worth other than to humans. This disconnect is the root cause of the systemic crisis we are facing – more leaders must identify with the essential message behind the Extinction Rebellion slogan; “We are nature defending itself.”

Reconnecting to life and living systems goes beyond understanding the challenges of overcoming planetary boundaries. It also means rediscovering our capacity for wonder, understanding our intrinsic dependence on nature, recognizing how precious ecosystems are, observing the principles of cooperation and interdependence, and being inspired by them.

CONCLUSION: EMBRACING RADICAL TRANSFORMATION

Many features of our current mindsets stand in the way of transformation. Most organizations are still helmed by leaders who believe in a linear and technical solutions-driven transformation, deceiving themselves that solving a systemic crisis can be done from within the same system that caused it. Over the next decade, we need to unlock change in a way – and at a rate – that has so far eluded us.

We cannot transform our organizations without understanding what transformation truly means. Regenerative transformation is not simply a social and environmental agenda: it is about a fundamental shift in the purpose of business and the global

economy as a whole⁹. A mindset of reinvention is called forward; innovation and “new” thinking in the truest sense.

Regenerative leadership qualities and awareness cannot be united in a single providential man or woman “at the top”. It is a whole collective that must shift: the leaders, the pioneering agents of change in all departments, as well as all employees and business partners. Our institutions too, which are the play book we have created for our economy and societies, have to shift: redefining value to reward true value creation, not value extraction; redefining education and learning. redefining governance and our collective vision of what success is.

This article provides a framework to inspire leaders at any level and in every part of society to cultivate the mindsets and skillsets that can help them to drive regenerative future, channeling human innovation towards purpose, not profit.

The harsh truth is that we are moving closer to critical planetary boundaries and the limits of social cohesion and stability. Being a leader for regenerative transformation will take courage, alongside all other features discussed in this article, but answering the call is vital. There is more work than ever to be done, and it is more urgent than ever that we do it.

⁹ WBCSD. 2020. *Time to Transform: Vision 2050*.



WHAT SKILLS AND MINDSETS ARE ESSENTIAL FOR EMPOWERING INNOVATION FOR ECOLOGICAL TRANSFORMATION?

Cécile Renouard

Co-founder and President of the Campus de la Transition; Research Director of the Companies and Development (CODEV) programme at ESSEC Institute for Research and Education on Negotiation (IRENE)



Campus de la Transition, 2019, credit HLeclerc.

Born in 1968, Cécile Renouard is a graduate of ESSEC Business School, has a doctorate in political philosophy (EHESS) and a canonical licence in theology. She is at the origin, with Gaël Giraud and other researchers, of the Relational Capacity Index (RCI).

She is a member of the scientific council of the Foundation for Nature and Mankind, a member of Michelin's external stakeholder committee and co-chair of the EDF Group's stakeholder committee.

Ecological transformation goes beyond technical skills or new technologies; it demands new mindsets and ways of thinking. This article outlines the Campus de la Transition framework of the “Six Portes”, or Six Gates into understanding and acting on ecological transformation. We also discuss how organisations and companies might adopt systems thinking and other mindsets and approaches for innovation that tackles contemporary global problems at scale.

The phrase “ecological transformation” implies or invites a *systemic* (‘ecological’) *approach* to contemporary global problems. At the Campus de la Transition, which you and your colleagues created in 2018, how do you train students and professionals to think and act systemically to tackle global issues? How do you encourage systems thinking for *just* innovation that is not only technological but develops strategy consistent with systemic responsibility?

Cécile Renouard: If we want to meet today’s climate, environmental, energy and social challenges, we need to think about new economic models, new ways of producing and consuming, and how to manage existing resources or relate to the long-term at a global scale.

With this thought in mind, we set up the Campus de la Transition in June 2018, located in Forges, near Montereau, 80 km from Paris (an area which is itself in a transition process). The aim was to create a community in an eco-place, to be able to experiment and see what it means to reduce the carbon and ecological footprint.

The Campus de la Transition is an academic and research laboratory introducing new programmes, projects and pedagogical practices. It provides training for students as well as professionals, in partnership with a number of universities and institutions. We wrote the *Great Transition handbook* [English version]. It is organised in 6 chapters, considered as six ‘gates’ through which we should enter to fully understand the climate



and biodiversity crisis. The Six Gates are meta-skills or meta-competencies which offer people the keys and analytical tools to understand the problem, no matter where they start out.

- We decided to use the Greek etymology of the words "ecology" and "economy".
- The Greek root "eco", in "**Oikos**" or household, means our common home, house, and hope. This is about the science of climate change and planetary boundaries, and building a common understanding that we have only one planet.
- Then, we focused on the other parts of the words "economy" and "ecology". The word "**Nomos**" [law and metrics], refers to the rules of the game -- the laws, metrics, political institutions and economic models. For instance, the concept of gross domestic product leaves out non-monetary value.
- The other root "**Logos**" is about narratives and how we inspire the moral imagination to understand what is going on and help people look at the future in a constructive way. We need to go beyond technical knowledge and thinking.
- The **Ethos** or ethics gate is about discernment and decision-making at a personal and collective level. What is a good life for ourselves and for others?
- **Praxis** or practice came naturally because if we think differently, we also have to act. The main skill here is about collective action, reflecting on the role of different actors and different scales.
- Finally, **Dunamis** or **Dynamis** is related to how we reconnect to ourselves, to others, to nature, God, and spirituality in the broad sense. People are cautious when talking about religion in the public sphere, but Dunamis is really about integrating eco-spirituality or eco-psychology and the psychosocial skills that we have to promote if we want to change the way we look at the world, our day to day activities within it, and how our institutions are built.

How might innovation for ecological transformation look different, when those pursuing it have absorbed the mindsets you talk about?

C.R.: When we talk about innovation, very often people think in terms of technical innovation. At the Campus de la Transition we have public funding from ADEME, the French government agency on energy and ecological transition, to study low-carbon technologies - and these are not necessarily high-tech. In fact, part of this work is discerning where high-tech is useful for the ecological transformation and where it is contradictory.

Innovation is also about social and psychosocial innovation. We have to acknowledge and integrate our feelings about the ecological transition, about the disasters that are already happening all over the world. We have to look at our day-to-day lives and try to express what a meaningful or fruitful life is. We see that it's about quality relations with ourselves, with others and with the Earth, and we can try to innovate in order to foster this kind of fruitful life where relations matter. In fact, social innovation should and must come first before technological innovation can follow.

What does the Six Gates approach to ecological transition mean for business? How can business and business leaders effectively adopt these perspectives?

C.R.: Over the course of my fieldwork into multinational companies, including very large companies such as Total, Lafarge, Unilever, Danone and Michelin, I studied how these companies relate to territorial development, and from these studies we built a Relational Capacity Index to measure the capability of economic actors to interact with and be part of social, economic and political networks. It was very interesting to look at their contribution to territorial development, and to try to raise with them the ethical and political issues related to sustainable development and what we would call ecological transformation today. For many companies, there was a gap between what they currently do and what should be transformed in their business models to respect planetary boundaries.

For top executives and CEOs of multinational companies to take leadership on this, they need to be convinced that changes are necessary. That's why I think the Six Gates approach can be very fruitful, because it can help leaders reflect from a narrative perspective to design the kind of society they would like to live in within 20 or 30 years, and help them design the role of their company in achieving these goals. Of course, it means they have to advocate for new regulations and new metrics, so it can help them reflect on political responsibility at a national and international level. They have to promote changes





Campus de la Transition, aerial view 2022, credit Lucas Gosset.

in regulations and in the rules of the game. For example, if we don't change the accounting standards to integrate ecological and social issues, if we don't change taxation, if we don't reflect on the distribution of wages along value chains, we won't be able to achieve the goals set out in global agreements like the Paris Agreement.

In my fieldwork, we also found that pure corporate philanthropy does not work. What does work, however, is developing capabilities among populations to *be* and *do*. This means promoting bottom-up participation, empowering people and increasing their awareness so they want to create change themselves.

Companies have an impact on the relations of the people amongst themselves. When a company's impact on its environment and community is analysed, many companies fail to shore up social relations with local communities. So it is crucial for companies to create social relations and lasting social cohesion with the communities in which they are located. This will require a mindset change and a long, hard look at how a company can help local development – not only in the short-term but also over the long-term.

Innovation is also about social and psychosocial innovation. We have to acknowledge and integrate our feelings about the ecological transition, about the disasters that are already happening all over the world

You've talked about how leaders' mindsets need to change, and how the Six Gates approach can help. What about employees, and what kind of changes can they make for ecological transformation when mindsets shift?

C.R.: What I find very interesting, at least from my observations in France, many employees - especially younger ones - are really willing to try and change things from within, whether that is through conversations or pressure on top executives to change management practices and day-to-day operations. And they're also willing to leave if they feel the company is not up to the challenge. So to retain talent, companies have to really implement actions for ecological transformation, from management and strategy all the way to ground-level. Some top executives I've spoken with do see the need for change.



What all this means is that there is room for employees to act. There are movements like Les Collectifs in France that enable employees to combine efforts to change from within. Employees can also build connections to other organisations such as NGOs, civil society movements and local authorities to act from different starting points but in a convergent way.

How is the Six Gates approach already driving innovation? Are there examples of organisations following these principles to pursue change?

C.R.: Since 2020, the CY Cergy Paris University has asked the Campus de la Transition to accompany them on their ecological transition. We started with the Engineering

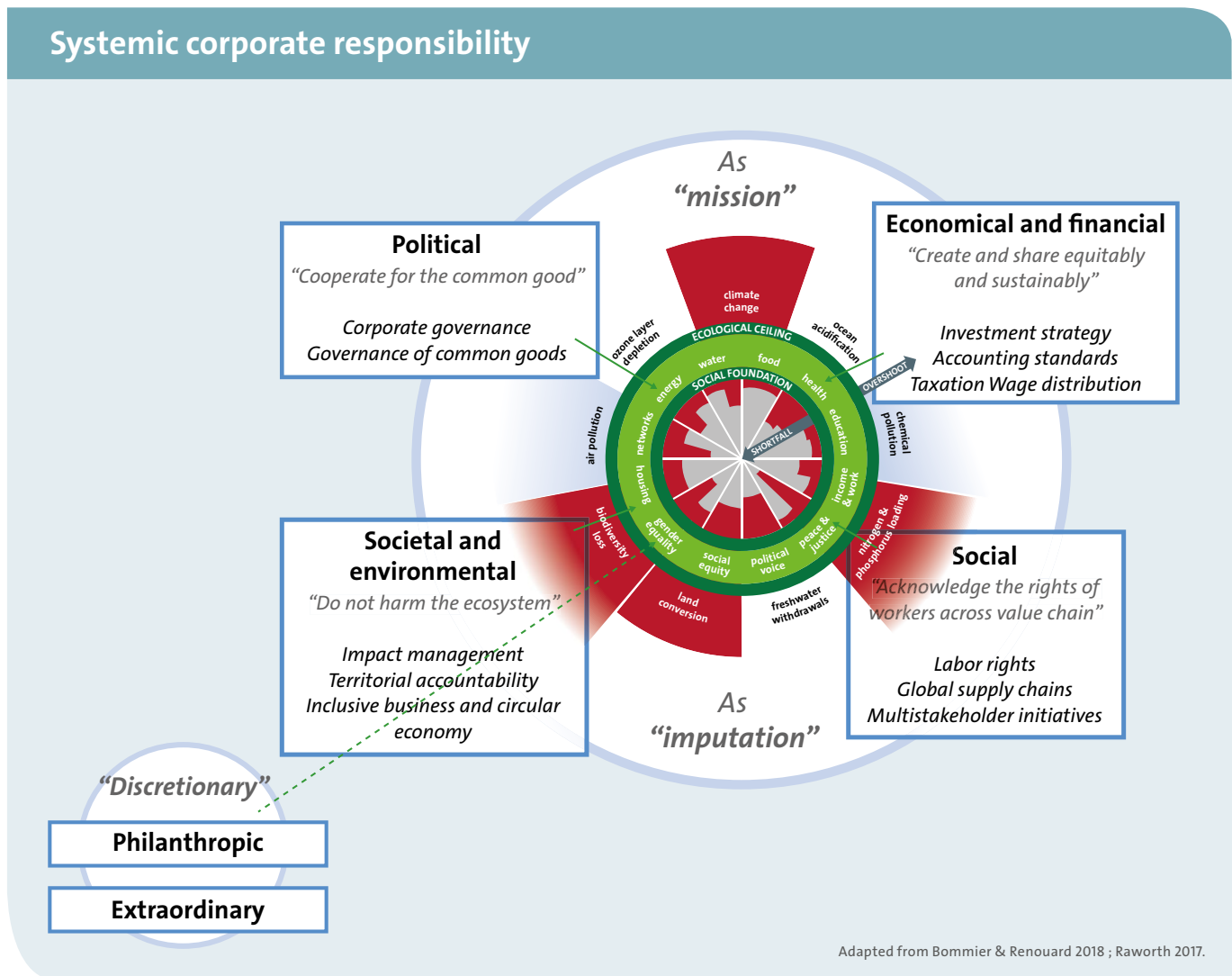
The Six Gates are meta-skills or meta-competencies which offer people the keys and analytical tools to understand the problem, no matter where they start out

school, to integrate an ethical perspective on technical innovation for engineering students, and now are working across the whole university. Together with Cergy professors, we've designed a module that will be compulsory for all new students, integrating the Six Gates approach.

The Campus is a young institution so it's too early to say our pedagogy has been concretely helpful, but we've received many confirmations that it helps people think differently.

It is crucial to promote 'just' innovation which is not only technical, but that companies ensure that their innovations

develop a strategy which is consistent with systemic responsibility. The Six Gates approach can help leaders, managers and employees think systemically and creatively about just innovation.



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"There is no strictly local solution to the world's biggest problems. The only way out is to share in actions and solutions, including innovations."

Philippe Kourilsky
Honorary Director General of the Pasteur Institute
and Member of the Veolia Institute's Foresight Committee