Peer to Peer and the Commons: a path towards transition

A matter, energy and thermodynamic perspective

1 Towards an economy that is embedded in, and recognizes, the limitations of our natural world

Céline Piques and **Xavier Rizos**

with the support of **Michel Bauwens**,
Founder of the P2P Foundation

Preface by **James B. Quilligan**,
International advisor and policy analyst in biophysical economics

P2P Foundation

<Left blank for 2-page viewing on screen– to be deleted when printing>

Peer to Peer and the Commons: a path towards transition

A matter, energy and thermodynamic perspective

Volume 1: Towards an economy that is embedded in, and recognizes, the limitations of our natural world

Céline Piques and **Xavier Rizos**

with the support of **Michel Bauwens**,
founder of the **P2P Foundation**

Preface by **James B. Quilligan**,
international advisor and policy analyst in biophysical economics

web version 1.4 - 2017

P2P Foundation

CONTENTS

About the authors

Céline Piques: Trained in mathematics and economics. Céline Piques lives in Paris where she is a researcher, writer, photographer, and feminist activist.

Xavier Rizos: Trained in mathematics and physics. Xavier Rizos lives in Australia where he is a researcher, writer and practitioner on the subjects of technology, strategy, and innovation.

Michel Bauwens: Peer-to-Peer theorist, co-founder and Vision Coordinator of the P2P Foundation. Michel Bauwens is an active writer, researcher and conference speaker on the subjects of technology, culture and business innovation.

Preface

The Commons movement is facing a challenge: to articulate the optimum rate at which a resource can be harvested or used without damaging its ability to replenish itself.

"No major civilization has EVER practiced carrying capacity as a basis for political and economic self-governance; carrying capacity has only succeeded in small communities. Of course, we know this from the modern Ostrom view of the commons; but Ostrom never put her finger on the pulse of **carrying capacity as the self-organizing principle between a species and its environment**. Nor has the commons movement recognized the importance of **an empirical way of measuring the metabolism of society** through the cooperative activities of people using resources to meet their biological needs.

In other words, Ostrom and the commons movement have yet to define the dynamic equilibrium which they seek as the balance between two opposing forces – population and resources – which continually counteract each other. Instead, the commons movement is more focused on counteracting the Market and the State than on **measuring the replenishment of renewable and non-renewable resources and managing them to sustain their yield**. In short, the commons movement does not seem to be producing **alternative indicators for the production and provisioning which can be used to guide policy**.

The book *Secular Cycles*, by Peter Turchin and Sergey Nefedov, made me realize that the commons, as Ostrom viewed it and as others are now envisioning it, is too informal and small-scale **to work in a way that establishes empirical targets that will bring down exponential growth to arithmetic growth levels**; and thus organizing society according to the dynamic equilibrium between population and the availability of food, water and energy. Instead, what we get in the commons movement is a general opposition to **quantitative analysis** because it reminds people too much of the metrics of unbridled capitalism.

My point is that if we don't know how to develop evidence-based policy for a soft landing toward a reasonable level of subsistence — and I've seen very little of this in the commons movement — then I don't know how we expect to create a long-term system for meeting human needs through sustainable yields. **I would hope that the commons movement begins to create the basis for a viable new society by actually focusing on the optimum rate at which a resource can be harvested or used without damaging its ability to replenish itself. That would be something.**

Let me put this in more structural terms. **First, the carrying capacity rate for renewable resources follows a carefully guided policy of maintenance and sustenance to ensure that resources are replenished sustainably in meeting the needs of people** in the present. This requires that social policies are made more equitable to ensure that everyone's needs are met. Meanwhile, the needs of people in the future are in no jeopardy, so long as renewable resources continue to be replenished and provisioned within their carrying capacity. Hence, the carrying capacity rate of renewables is geared toward market coefficients for provisioning resources, goods and services for people at the current time, and will continue to be sustainable far into the future. This carrying capacity rate, based on renewable resources, in no way precludes (in fact, should be accompanied with) the creation of taxes toward a universal basic income and for maintenance of renewable resources.

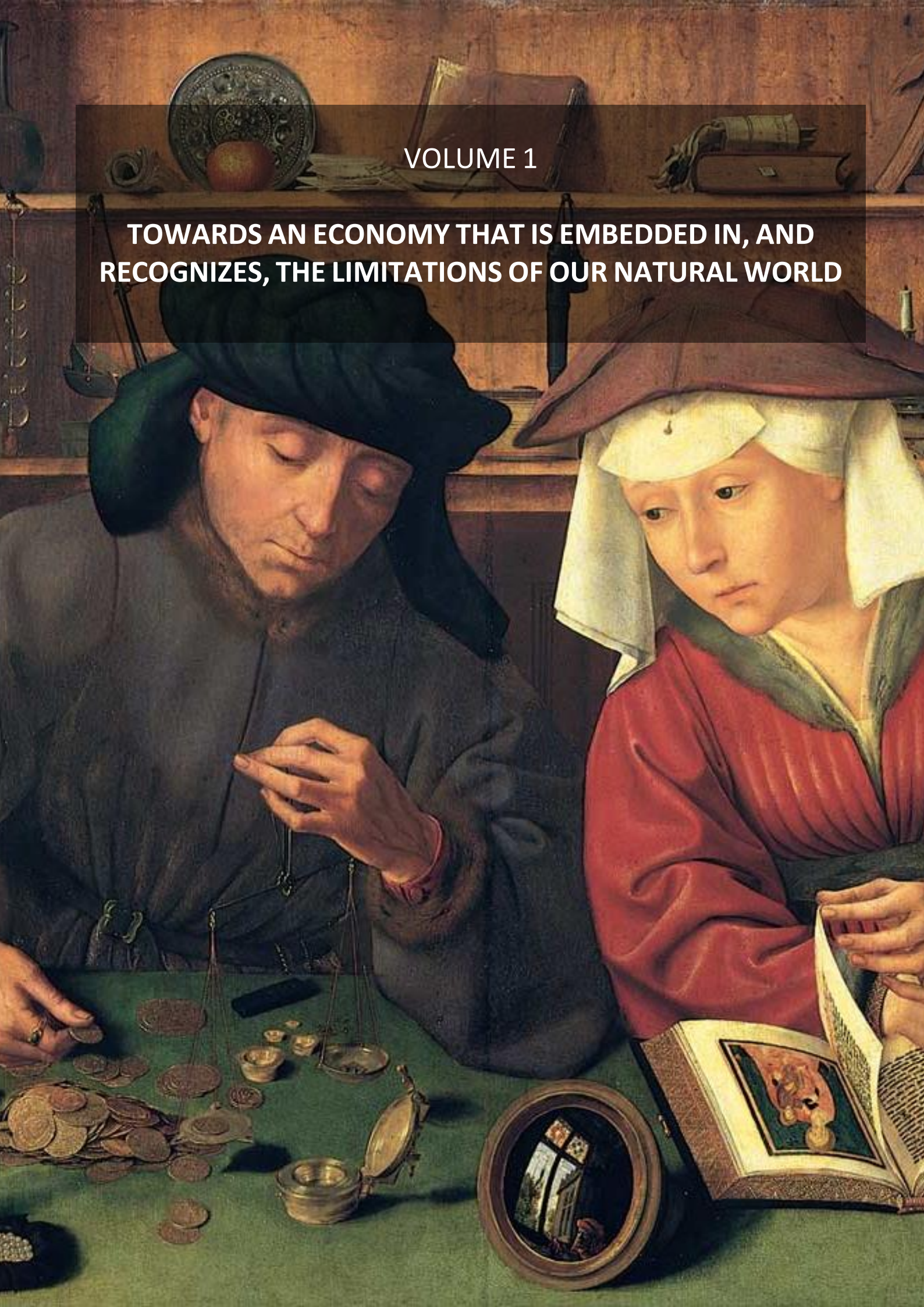
Second, the carrying capacity rates of non-renewable resources are much more challenging and must be treated very differently. Society must decide scientifically how much non-renewable resources to use in the present and how much to save for the future. By guaranteeing that valuable resources will be 'left in the ground' or put away securely into a tamperproof lockbox, as it were, this formula has a benefit which, **in one way, is similar to how gold used to function as a guarantee of reserve asset values and as a disciplining measure for currency exchange rates**. Since a certain percentage of **non-renewables are held in strict reserve for future generations**, adherence to this process creates a value which is entirely *independent of the market* and is based on a relative scarcity index of non-renewable resources. This fraction (how much non-renewables to use for people now / how much non-renewables to set aside for people in the future) provides for a fixed and stable monetary rate that is tailor-made for the valuation of currency in the present.

In a society which is facing net energy loss and steep declines in non-renewable resources, this would be an extremely stable, strong, treasured, desired, sacrosanct and entirely non-marketized value. Instead of looking at productivity indices, commodity market rates, price inflation or unemployment indicators, monetary economists really ought to be turning their attention to the long-term carrying capacity of the planet's non-renewables and their sustainability rates. I am in no way suggesting that the world should return to a gold standard; but **to generate a system in which currency values are fixed to a meaningful measure of non-renewable resources, similar in some ways to the way that gold used to function**. If this is done, the correlation of ecological sustainability with monetary sustainability will become a primary way of steering the world's economy on a middle path between exponential growth and arithmetic growth, ensuring the sustenance and safely of society during a period of economic decline.

It's sobering to realize how very recent the concept of sustainability actually is. It's also dismaying to see how blurred this idea has become since the Brundtland Commission popularized the idea in 1987. Now, Céline Piques and Xavier Rizos have accomplished **what countless other writers on sustainability have failed to do for the past thirty years: to decontextualize sustainability away from the marketplace by untangling the key differences between the First, Second and Third Law of Thermodynamics**. In this major contribution to the field, Piques and Rizos elevate the topic of sustainability beyond the broken mechanisms of supply and demand and mistaken interpretations of how negentropy counteracts or slows entropy. This highly readable report establishes a new baseline for economics within the commons, redefining sustainability as a fundamental measure of the material and energy resources that are available for meeting the needs of a given population. It's a most excellent beginning.”

- James B. Quilligan, August 2017

James Quilligan has been an analyst and administrator in the field of international development since 1975. He has served as policy advisor and writer for many international politicians and leaders, including Pierre Trudeau, François Mitterrand, Edward Heath, Julius Nyerere, Olof Palme, Willy Brandt, Jimmy Carter, and His Royal Highness Prince El Hassan of Jordan. Quilligan was a policy advisor and press secretary for the North-South development commission headed by former German Chancellor Willy Brandt (1978-1984). He has served as an advisor for several United Nations programs and international organizations, including the UN Millennium Development Goals and the International Monetary Fund. He is presently Managing Director of the Centre for Global Negotiations and Senior Advisor of Economic Democracy Advocates.



VOLUME 1

TOWARDS AN ECONOMY THAT IS EMBEDDED IN, AND RECOGNIZES, THE LIMITATIONS OF OUR NATURAL WORLD

Context of this research

Answering the challenge articulated by James Quilligan in his preface is a task that will obviously require more than a couple of reports, but we hope that this research represents a step in the right direction and a meaningful contribution to the public conversation. Our aim is to inject some quantitative analysis into the approach of the Commons movement, which should eventually lead to articulate the optimum rate at which a resource can be harvested or used without damaging its ability to replenish itself, with the view to practice carrying capacity as a basis for political and economic self-governance.

*

Our system is stretched ecologically, socially, financially, politically. It has been written, commented upon: our current capitalist paradigm faces a multi-dimensional crisis to the point that some commentators have even coined the catchy slogan, "**Capitalism is not in crisis; capitalism is crisis**".

- The environmental and climate crises have become perpetual headlines, the most recent being the significant reduction of arctic ice in 2016.

- The competitive quest for energy and material resources is causing wars such as in the Middle East: let's not forget that civil war in Syria[1] started in regions affected by the most severe drought in decades.

- The financial and economic instability blamed for the Global Financial Crisis has not been resolved[2], as illustrated by various examples from Europe's ongoing austerity crisis, to the more anecdotal but nonetheless dangerous current housing bubble in Australia.

- Inequalities and social disruption have exploded and showed that the promise of a prosperous post-cold war world has not materialized, as highlighted by the work of French economist Thomas Piketty[3] who illustrated the exploding disparity of the top 1% share of income with a graph that has become a reference:

[1] Tipping point. The Drought That Preceded Syria's Civil War Was Likely the Worst in 900 Years, By Elaisha Stokes, 2016: https://news.vice.com/article/the-drought-that-preceded-syrias-civil-war-was-likely-the-worst-in-900-years

[2] Real estate: Australian banks must learn lessons of US sub-prime crisis, warns ASIC boss: http://www.abc.net.au/news/2017-04-04/australian-banks-learn-the-lessons-of-sub-prime-asic-medcraft/8413542

[3] Thomas Piketty. Capital in the Twenty-First Century (2013) https://en.wikipedia.org/wiki/Capital_in_the_Twenty-First_Century

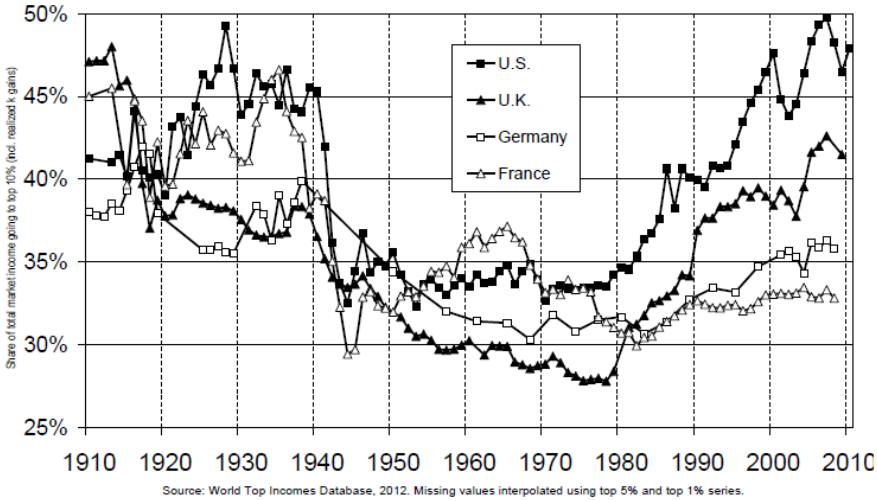


Figure 1- Top Decile Income Shares 1910-2010 (Piketty)

- This is now leading to what was quasi-unthinkable just a few years ago: the questioning of the democratic consensus established after WWII with the rise of a proto-fascist populist leader like Trump in the US, the protracted debt crisis in Europe, BREXIT and the National Front becoming a mainstream party in France[4].

While those **symptoms** are clearly identified, western societies are collectively struggling to find a conceptual framework to explain and analyze how a post-capitalist paradigm would work, let alone how we would transition to it.

This research shows that parts of the answer lie in the need to '**doubly re-embed' the economy** inside the **human/social sphere** as well as the **bio-sphere**.

We analyze the imperative to create so-called **negentropic cycles**[5] in order to meaningfully delay the depletion of our natural resources inherent to their **enclosure** and **extraction** on the global industrial scale we are currently experiencing.

To do so, the only viable and sustainable avenue is to promote modes of exchange that part ways with the classical economic objectives of infinite growth.

Once this premise is accepted, the question then becomes: **what to replace those traditional classical economic objectives with?** What objectives solve the environmental and social problems we are facing; and how to reach those objectives?

Peer-to-Peer and Commons principles offer a sustainable avenue to transform production.

---

[4] Marine Le Pen lost the vote but she won something better https://qz.com/975521/marine-le-pen-lost-the-vote-but-she-won-something-better/

[5] Céline Piques, Xavier Rizos, Michel Bauwens. **Peer to Peer and the Commons: a path towards transition. A matter, energy and thermodynamic perspective. Volume 1: Towards an economy that is embedded and recognizes the limitations of our natural world**.

The Commons, as an idea and practice, has emerged as a new social, political and economic dynamic. Along with **the Market** and **the State**, **the Commons** is a third mode of societal organization. The Commons and Peer to Peer (P2P) together form a system based on the practices and needs of civil society and the environment it inhabits, evolving away from obsolete, centrally planned systems or the competitive dictates of market economies.

As the P2P Foundation puts it in their recent study 'Commons Transition and P2P: a Primer'[6]:

> While the Commons is a concept and practice deeply rooted in human history, it is difficult to settle on a single definition that covers its broad potential for social, economic, cultural and political change. The Commons is now demonstrating its power as a "key ingredient" for change in diverse locations and contexts around the world.
>
> Commons can be described as a shared resource which is cogoverned by its user community, according to the rules and norms of that community.
>
> Commons include natural resources, such as the water and land, but also shared assets or creative work, such as cultural and knowledge artefacts.
>
> The sphere of the Commons may contain either rivalrous goods and resources, which two people cannot both have at the same time, or non-rival goods and resources, which are not depleted by use. These types of goods or resources are either inherited or are humanmade.
>
> The Commons, according to scholar and activist Silke Helfrich[7], can be understood from at least four different perspectives. As a whole, they can be perceived and acted upon as:
>
> 1. Collectively managed resources, both material and immaterial, which need protection and require a lot of knowledge and know-how.
>
> 2. Social processes that foster and deepen thriving relationships. These form part of complex socio-ecological systems which must be consistently stewarded, reproduced, protected and expanded through commoning.
>
> 3. A new mode of production focused on new productive logics and processes.
>
> 4. A paradigm shift, that sees commons and the act of commoning as a worldview.

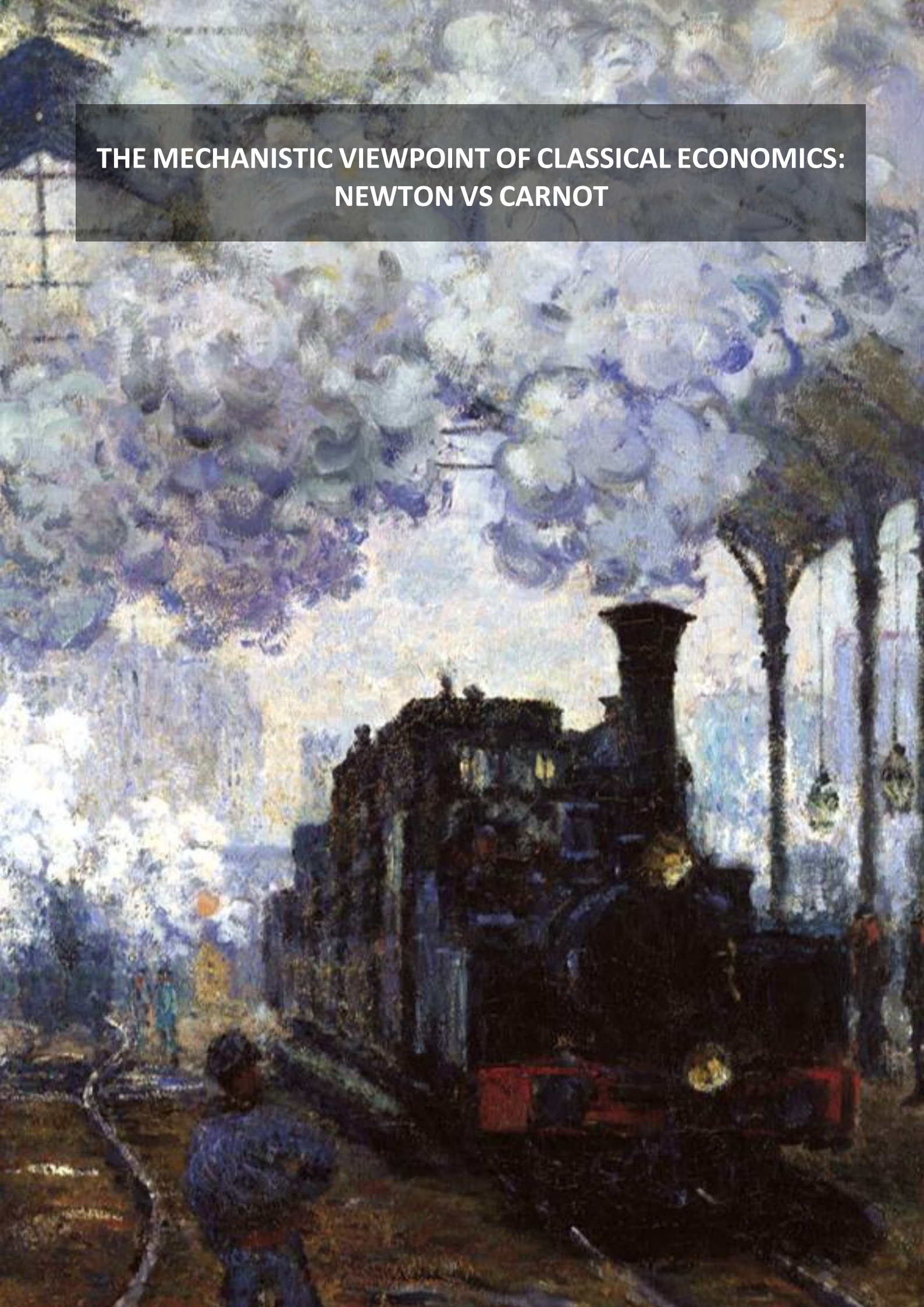
The purpose of this research is to show that a P2P and Commons approach is fit to deliver the desired ecological and social transitions required to share and manage finite resources.

---

[6] Michel Bauwens, Vasilis Kostakis, Stacco Troncoso, Ann Marie Utratel. Commons Transition and P2P: a Primer: https://blog.p2pfoundation.net/commons-transition-and-p2p-a-primer/2017/05/09

[7] Silke Helfrich: http://wealthofthecommons.org/contributor/silke-helfrich

THE MECHANISTIC VIEWPOINT OF CLASSICAL ECONOMICS: NEWTON VS CARNOT



Classical economics was built on Newtonian gravity applied to prices

> ***Key point:*** *Classical economics initiated by Adam Smith was built on an analogy with Newtonian mechanics: prices were seen as obeying a kind of law of gravity that would always bring a balance. This gave us two resilient metaphors: the invisible hand of the market, and Homo economicus.*

Adam Smith initiated classical economics in 1776 with his *Inquiry into the Nature and Causes of the Wealth of Nations*, and from the start, it was profoundly marked by the spirit of its era: the emergence of Newtonian mechanics and the belief that gravity ruled the world.

Gravity is a notion borrowed from physics. It represents the attractive force that a body exerts on the mass of another body. It belongs to a deterministic paradigm where you just have to know the position of an item and its movement to be able to know the position it had at any point in time in the past, and the position it will have in the future.

French economist **René Passet**[8] has discussed this analogy between the notion of Newtonian space borrowed from physics and the notion of market developed by classical economics: a space where prices reach equilibrium under the law of supply and demand.

René Passet

This classical paradigm is simple: if an item is over-produced there will not be enough buyers and the price will drop, the production of that item diminishes and will be replaced by the production of other items, which resets an equilibrium. If on the contrary, a good is not produced in enough quantity, its price will go up, which will attract more producers who will increase the output and this will lead to a new equilibrium.

Like an oscillator that always comes back to a still state, **the invisible hand of the market** determines the natural price of goods and services to be produced to maintain the equilibrium outside of any human direct planning or intervention. Adam Smith explains this analogy with Newton: "*The Normal Price*", or as Adam Smith says, *"the natural price is as it were the central price to which the prices of all commodities are continually gravitating. Different accidents may sometimes keep them suspended a good deal above it, and sometimes force them down even somewhat below it. But whatever may be the obstacles which hinder them from settling in this centre of repose and continuance, they*

[8] René Passet. Les grandes représentations du monde et de l'économie à travers l'Histoire. De l'univers magique au tourbillon créateur. 2010 - ISBN : 978-2-918597-08-7. 948 - PRIX DU LIVRE D'ECONOMIE 2010. Mention spéciale

are constantly tending towards it".

Just like Newton's universe is nothing but the sum of its parts, the general interest would come from the spontaneous convergence of individual interests.

David Ricardo[9] and **Jean-Baptiste Say**[10] went further in talking about **general 'laws' of economics**, which would be universal, immutable, and timeless just like the laws of Newtonian physics.

In his *Principles*, **Ricardo reduced the economy to a small number of stable relationships based on postulates such as personal interest and the principles of competition and private property**. In this paradigm, efficiency depends on the division of tasks. The only value considered is the merchant value (or exchange value) defined by the cost-of-production. It is a subjective conception of seeing things in their ability to satisfy needs, which relates to their **utility**. This means that all the things that have a use-value but no exchange value, like the air or water, is ignored by classical economics.

J.B. Say declared that natural resources were infinite which allowed economist to consider nature as a 'free good' which industries should learn to use.

Hence, if considering nature as a free inexhaustible resource was not bad enough, the reduction of our humanity to the selfish pursuit of maximization of wealth achieved to lock the **law of the markets** (also called **Say's Law**) as a quasi-scientific rule.

Thereby homo economicus was born. Classical economics has truly locked itself in a reductionist paradigm which brushes aside the sense of history, its human dimension. In going down that path, classical economics has ignored the precise finalities and goal of human activities, and the issue of finite natural resources.

Consequently, we find the conceptual roots of today's paradigm in the Newtonian vision of our societies: a world that we have structured in a deterministic way, with a strong mistaken dual belief:

- a first belief in **an equilibrium emanating from the gravity of prices,** i.e. the belief that a balance between scarcity and abundance is mediated by the equilibrium of prices, just like a pendulum.
- as well as **the belief that an economy can grow indefinitely**, as measured by a positive 'potential growth rate'.

Those **two notions of price equilibrium and unlimited growth** are supposed to underpin all of the economics thinking today and both are at odds with reality.

---

[9] David_Ricardo: https://en.wikipedia.org/wiki/David_Ricardo

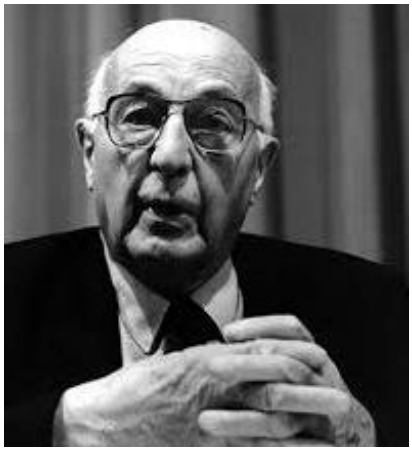
[10] Jean-Baptiste Say: https://en.wikipedia.org/wiki/Jean-Baptiste_Say

From classical economics to biophysical economics

> ***Key point:*** *The theories developed by the founders of classical economics Smith, Ricardo and Say do not pass the reality test. The development of Thermodynamics in the 19th and 20th centuries and the work of Georgescu-Roegen showed that economics cannot ignore the laws governing* ***energy*** *and* ***matter****.*

Two centuries later, climate change, the destruction of biodiversity, pollution and the depletion of natural resources show that the Newtonian vision of a stationary economy cannot be reconciled with physical reality. Beyond its own sphere, it is in **the biosphere (nature)** that the economy finds the natural resources it needs, and it is in the biosphere which could really be called the '**matter**-and-**energy** sphere' - that this economic sphere can dispose of the waste it produces. It is also nowhere else but in **the human sphere (society)** that the economy has its agents and finalities – its 'raison d'être'. Thus, those two spheres (nature and society) supplant economics at all levels, and obey their own laws which economics cannot understand[11].

No price variation set by the human made economic process can alter the natural carbon or water cycles (i.e. the way carbon flows through the biosphere, and the way water evaporates to form clouds). To take those natural cycles into account can only be done while respecting their logic and the way they work. In other words, it is the mechanisms of the biosphere that set the limits of what our economic growth can be, and it is within those natural constraints that economics can operate in a legitimate manner, not the other way around.



Nicholas Georgescu-Roegen

Had **Ricardo** met **Sadi Carnot** and **Rudolf Clausius**[12], the 'fathers of thermodynamics' who put energy and engine power at the center of their thinking, he might have followed a different logic and epistemological pathway.

It took another century and **Nicholas Georgescu-Roegen**[13] for a **new bio-economic paradigm** to emerge. **A paradigm that brings together evolutionary biology and thermodynamics, and which is governed by the laws of entropy**.

---

[11] Among the attempts to make 'economics' more cognisant of the human sphere is **behavioural economics**. It studies the effects of psychological, social, cognitive, and emotional factors on the economic decisions of individuals and institutions and the consequences of this to broader economic outcomes. Behavioral models typically integrate insights from psychology, neuroscience and microeconomic theory; in so doing, these behavioral models cover a range of concepts, methods, and fields that is not restricted to standard economic theories. Behavioral economics has grown as an alternative approach to standard economic theory pursuing more experimental, data-driven methods, without strong association to more traditional theoretical models. http://complexityacademy.io/behavioral-economics/#easy-footnote-bottom-1

[12] Sadi Carnot: https://en.wikipedia.org/wiki/Nicolas_Léonard_Sadi_Carnot
Rudolf Clausius: https://en.wikipedia.org/wiki/Rudolf_Clausius

[13] Nicholas Georgescu-Roegen: https://en.wikipedia.org/wiki/Nicholas_Georgescu-Roegen

THE FOUNDATIONAL NOTION OF ENTROPY AND ITS CONSEQUENCE ON 'SUSTAINABLE DEVELOPMENT'

Introducing the notion of entropy and the limits it imposes on our activities

Entropy is an abstract notion that can be explained through several definitions. For the purpose of this study, we can work with entropy being a thermodynamic quantity representing the *unavailability* of a system's thermal energy for conversion into mechanical work. But history presents multiple definitions. It is also interpreted as the degree of disorder in the system - although the interpretation of high entropy as high 'disorder', popular in normal speech, tends to be replaced in recent times by the concept of 'energy dispersion', to avoid confusion associated with misleading metaphors. Put in simpler words, entropy enables us to appreciate the 'quality' of the energy of a system: **the higher the entropy, the less 'available energy' can be put to work**.

To appreciate the notion of entropy, a metaphor commonly used – albeit wrong from a rigorous scientific standpoint – is that of a bag of confetti spread on the floor. Once a compact bag of confetti is wide open, it spreads all over the floor. The process can be considered irreversible: it takes just one second and very little energy to spread the confetti around, but it would take hours and a lot of effort (energy) to put it back piece by piece inside the bag. The thermodynamic *analogy* is that when the confetti was in the compact bag it had a lot of potential energy to give away and low entropy (they were tightly ordered). Once the confetti is spread around, it has given away its energy which is now low, but disorder has increased significantly so entropy is higher.

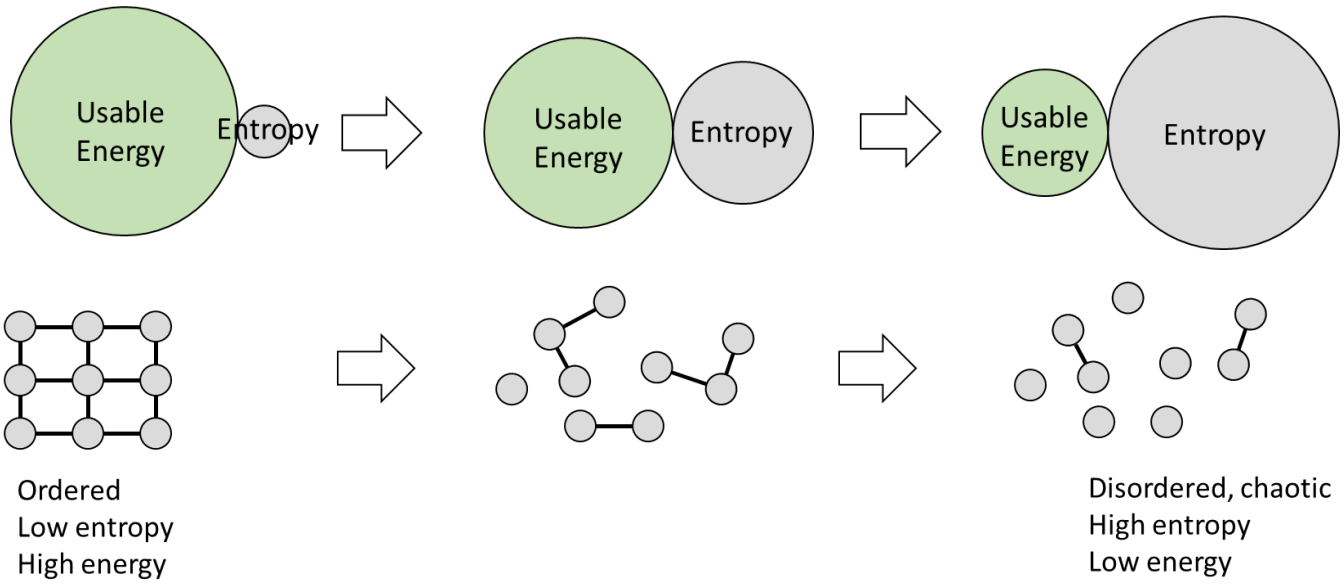


Figure 2- An illustration of entropy

The most commonly understood aspect of thermodynamics is the 1st law which is **about energy itself**. It says that in a closed system, energy is conserved: it is the famous "*nothing gets created, nothing gets lost, everything is transformed*" enunciated by French physicist **Antoine Lavoisier**[14] just before the French Revolution.

A subtler aspect is the 2nd law of thermodynamics which is specifically **focused on entropy and irreversibility**. It says that **the entropy of a closed system – i.e. the amount of *un*usable energy in this system - inexorably increases**, in an irreversible manner. The 2nd law of thermodynamics reflects the inescapable arrow of time. This is the useful mnemonic to remember about entropy: *it goes from low to high* – i.e. entropy always gets higher. When a piece of coal gets burnt, its chemical energy neither diminishes nor increases (the 1st principle) but the energy and matter it initially contains gets dissipated as heat, smoke, and ashes that cannot be recovered. The piece of coal cannot be unburnt. It is because of this 2nd law that a steam engine cannot keep running to produce a constant stable motoring force (i.e. a stable temperature) without a constant input of fuel.

A given thermodynamic system has **low entropy (it has free energy) if it is available to be used** and put to work and produce economic output. It has **high entropy if the energy has become unavailable for economic use**. So this means that all living organisms extract low entropy from their environment to compensate for the higher entropy inexorably created by their metabolisms which degrades nutrients and cells.

Or to quote Georgescu-Roegen[15] to plainly grasp those concepts:

> "From the viewpoint of thermodynamics, matter-energy enters the economic process in a state of low entropy and comes out of it in a state of high entropy. (...)
>
> Energy exists in two qualitative states, *available or free energy*, over which man has almost complete command, and *unavailable or bound energy*, which man cannot possibly use. The chemical energy contained in a piece of coal is free energy because man can transform it into heat or, if he wants, into mechanical work. But the fantastic amount of heat-energy contained in the waters of the seas, for example, is bound energy. Ships sail on top of this energy, but to do so they need the free energy of some fuel or of the wind.
>
> When a piece of coal is burned, its chemical energy is neither decreased nor increased. But the initial free energy has become so dissipated in the form of heat, smoke, and ashes that man can no longer use it. It has been degraded into bound energy. Free energy means energy that displays a differential level, as exemplified most simply by the difference of temperatures between the inside and the outside of a boiler. Bound energy

[14] In French and in Lavoisier's own words, perhaps one of the most famous scientific proverb taught in High Schools "Rien ne se perd, rien ne se crée, tout se transforme."

[15] Nicholas Georgescu-Roegen. The Entropy Law and the Economic Problem, 1973: http://webpage.pace.edu/dnabirahni/rahnidocs/law802/The%20Entropy%20Law%20and%20the%20Economic%20Problem.pdf

is, on the contrary, chaotically dissipated energy. This difference may be expressed in yet another way. Free energy implies some ordered structure, comparable with that of a store in which all meat is on one counter, vegetables on another, and so on. Bound energy is energy dissipated in disorder, like the same store after being struck by a tornado. This is why entropy is also defined as a measure of disorder."

Key point: *Our entropic 'footprint' reveals our unique human nature. We degrade significantly more energy than the minimum required by our natural metabolism: it is this surplus of degraded energy that has been used to build our civilizations.*

Like we explain below, the added twist and specificity of the human species is that we have, more than any other species, developed what is called **'exosomatic' processes**, on top of the purely biological 'endosomatic' metabolism of our body which is the 2,400 kcal we burn on average every day. These 'exosomatic' processes emanating from our industrious nature irremediably degrade energy, i.e. increase entropy.

Indeed, for most species, the main thermodynamic process is their basic natural metabolism: they feed, defecate, move around, reproduce, and die. **We humans, on the other hand, have added our technological footprint to build civilizations**. So the processes we have developed go well beyond our bodily metabolism. This is what makes us unique, and this could be really considered as the thermodynamic definition of human civilization: the accelerated dissipation of accessible low entropy resources (wood, fossil fuels) to turn them into higher entropy via exosomatic processes: we burn, extract, degrade at a frantic pace to build roads, to power engines, develop industries to build our civilizations.

The consequence is that the economic theory and **the economic analysis of productive processes cannot be done without taking into account their entropic dimension**: it is because **the creation of higher entropy is the ultimate law that cannot be broken**.

Georgescu-Roegen argued that the economic system is actually a sub-system that must be **re-embedded**[16] inside the Earth's global ecosystem. He also showed that the inexorable irreversible increase of entropy in a closed system dictated by the 2nd law of thermodynamics also says that at the ecosystem level **there cannot be industrial output without waste**, and **there cannot be 100% 'clean' recycling**.

In other words, what the alchemists of past ages were dreaming to accomplish has been finally proven impossible by the 2nd law of thermodynamics: **we cannot 'cheat' nature**. We cannot create gold out of dirt or rocks; we cannot create a pendulum, no matter how technically perfect it will be, that will work for ever. The energy in every transaction will degrade. Even when we change this tendency in a small neighborhood (i.e. reduce the

[16] In the work of Georgescu-Roegen, 'disembedding' describes the influence of modernity on social relationships. It also shows how Human-Nature relationships have been affected. Modern societies have become 'disembedded' from the context of local ecosystems, resulting in diminishing knowledge of, and attention to, ecosystem services. The emergence of general purpose money is presented as a key factor in the disembedding process because it has brought with it the message of substitutability and the possibility of an increasing appropriation of distant ecosystems.

entropy), in the wider region the entropy will always increase. This is why there cannot be 'clean' or 'sustainable' industrial output.

Critics of this view have retorted that the Earth is not a totally closed system where energy would inexorably degrade and entropy inexorably increase (as per the 2nd law). They say that the Earth is actually a 'semi-closed system': it is closed in terms of matter, because apart from the asteroids falling from space, the amount of terrestrial matter is fixed. Yet, it is also open in term of energy because it is constantly receiving solar energy in large amounts, and it is dissipating heat in the form of infrared radiation out of the atmosphere into space. The difference between what is received and dissipated is what makes it possible to keep our planet warm for life to develop.

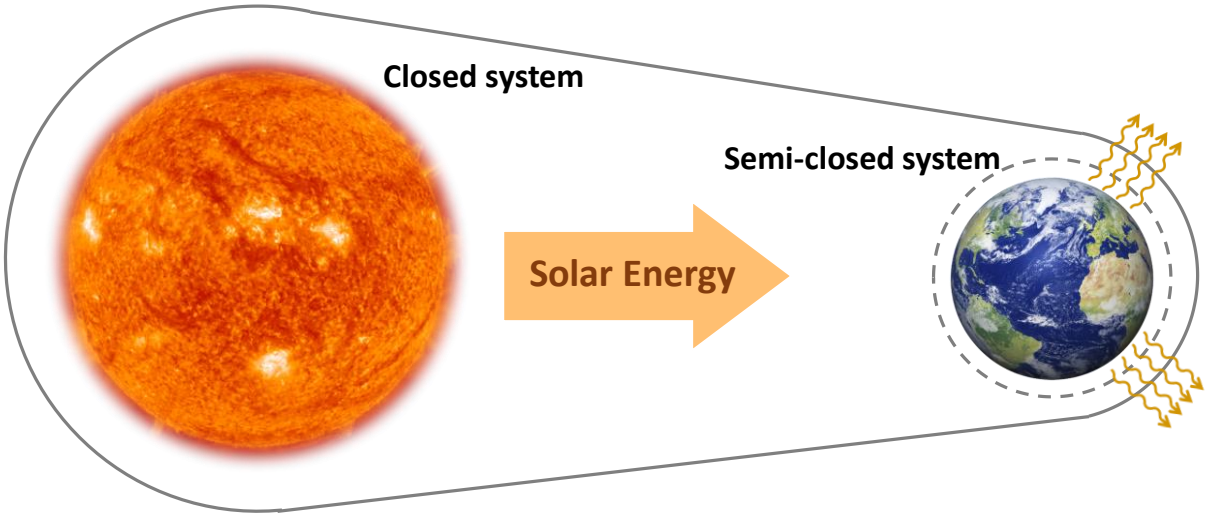


Figure 3 - The Earth is a semi-closed system

However, seeing the Earth as an open system receiving infinite energy from the Sun can be misleading and was indeed misinterpreted by industrialists. Their misinterpretation led them to believe that while we are obviously consuming a lot of energy and resources in the process of economic development, conceptually these high levels of consumption do not really matter because the laws of thermodynamics are telling us that:

1 – energy is constantly transformed *but never lost* in the closed system that is the Earth. So if energy is never truly lost, why worry?

2 – *even if* we did not consider the Earth as a closed system but as an open system receiving energy from the Sun, it would be all the better because that would mean that we are constantly rebuilding our stock of 'burnt' energy, and therefore the Earth gets energy to "heal" or "regenerate". So according to those critiques of Georgescu-Roegen it is not true that "the entropy law makes it impossible to recycle the entire quantity of waste".

Key point: *We consume energy and matter faster than we can regenerate them making 'Sustainable Development' impossible.*

The trouble with these views - *and this is a fundamental point* – is that eventual regeneration happens on a much longer time scale than the dissipation made irreversible

by the 2nd law. Just think that a piece of coal is consumed in a few minutes through the process of being burnt, while it would take millions of years to regenerate that rock of coal through the much slower process of degradation of dead plants at the bottom of the sea.

Or if an oyster pearl was dissolved in the ocean, it would take infinite time for the fine grains of calcium carbonate to be reassembled into a new pearl. This is why the thermodynamics laws of irreversibility apply to natural resources, and **why there is a fundamental ontological error inherent to 'Sustainable Development'** that stemmed from the idea that energy could be recycled indefinitely and that human industrial development could be truly sustainable. This hypothesis does not hold true when you consider fossil fuels that eventually get depleted well before the environment has the chance to recreate them.

There are ways of slowing down this ineluctable increase of entropy – under specific conditions

> ***Key point:*** *In the very long run entropy will eventually grow to the point of thermodynamic standstill (the death of the Sun and the end of life on Earth), hence respecting the 2nd law. In the meantime, it is possible to create 'negentropic cycles' which can locally[17] bring entropy down and meaningfully buy us time to delay depletion.*

The term '**negentropy**' comes from the amalgamation of 'negative' and 'entropy' and makes it important to properly understand the **difference between processes that decrease entropy (hence the vocable 'negentropy'), and processes that increase entropy**.

- **Photosynthesis is the main way to create negentropic cycles on Earth**. Plants store part of solar energy that would otherwise be degraded as heat. This stored energy of high quality is available for later use, for example by eating plants, burning wood, etc. So the creation of biomass through photosynthesis is a negentropic process which produces usable energy linked to low entropy.

- On the other hand, coal is also an accumulation of solar energy but one that took millions of years to build up, while its exploitation and depletion can be accounted for in just a few decades. **So the coal cycle can be considered 'entropic' (i.e. it produces entropy): its regeneration takes so long that its depletion can be considered irreversible**.

[17] About the concept of 'local': it is important to clarify that the mention of 'local negentropic cycles' is not a pseudo-scientific argument in disguise to be interpreted as pro-'localist'. What the study of thermodynamics says is that the eco-system as whole increases its Entropy, and any chance to bring it down must happen in pockets, which are by definition 'local'. It doesn't say that the local is '*the*' alternative to the global, but that simple, material production needs to happen at the lowest appropriate level to have a chance to delay the overall increase of entropy.

This is the fundamental dual picture we face: **the formation of bio-mass contributes to create negentropy in localised pockets**, **while the broader overall economic process is entropic** because the natural degradation and decay of non-renewable resources increase entropy as a whole in the ecosystem (not to mention the universe), and because the pace of creating negentropy is slower than the pace at which humankind creates entropy.

The thermodynamic origin of human labour and the concept of 'carrying capacity'

Whilst almost all life on earth depends on photosynthesis (with exceptions like hot vents on the ocean floor), it isn't the only biological process where negentropy works. Negentropy is also at work within the human body, where synchronistic systems work together to sustain life. Our cells actively identify the body's needs and produce the solutions to biophysical needs through genetic cell structures.

The cells generate a protein when it is needed; this is automatically generated by the flow of DNA to RNA[18] as that need for the protein arises. **It is here, at the biological cellular level, where labour actually begins**. The body works to generate energy internally, thus empowering the human being to express this energy outwardly through physical labour. Georgescu-Roegen didn't know about this form of negentropy because it hadn't been introduced to him yet from molecular biology when he was writing.

In many ways, this process is a general model for a future sustainable economic system which we attempt to paint in volume 2 of this study.

It is a good illustration of **the concept of 'carrying capacity'** mentioned by James Quilligan in the preface of this paper: identify the need and the need will be satisfied with energy. 'Need Demonstrated is Need Met' is the way molecular biologists say this. We could say **'Need Measured is Need Met'** when it comes to developing the metrics for carrying capacity, which is the dynamic equilibrium between needs of Earth's expanding population, and the shrinking level of resources which are available to everyone.

In other words, the carry capacity is the middle path between the entropic faster geometric[19] growth rates of human population, individual consumption and economic production, and the negentropic slower, arithmetic[20] replenishment rates of water, food and fossil fuels.

---

[18] RNA: Ribonucleic acid is a polymeric molecule essential in various biological roles in coding, decoding, regulation, and expression of genes. https://en.wikipedia.org/wiki/RNA

[19] Mathematicians call 'geometric' progression a sequence of numbers where each term is found by *multiplying* the previous term by a given ratio: eg 2, 6, 18, 54 is a geometric progression with ratio 3. Those progressions grow very fast.

[20] Mathematicians call 'arithmetic' progression a sequence of numbers where each term is found by *adding* a given number to the previous term. For instance, the sequence 2, 4, 6, 8, 10, 12,.. . is an arithmetic progression by adding 2 to the previous term. Those progressions grow steadily.

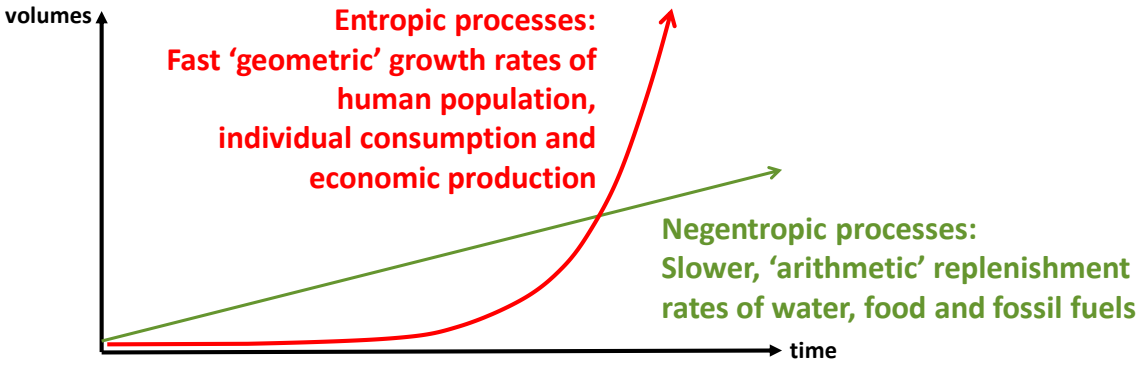


Figure 4 -illustration of the different pace between the entropic and negentropic processes

This highlights why the notion of 'need' is essential. This approach forces us to ask ourselves and as a society what the fundamental basic needs are, what the 'nice-to-have needs' are, and what we could call our 'superfluous needs' are – 'superfluous' with respect to the limited carrying capacity of our environment. To be clear, this is not meant to imply that some central authority will dictate to each individual what is essential and what is superfluous. On the contrary, it implies that we, as a society, will have to invent a collective way of appreciating, measuring and balancing this myriad of individual needs so that the global envelop stays within the limits of our carrying capacity in order to prevent renewable and non-renewable resources from being consumed beyond their maximum sustainable yield.

*

To summarize this section:

The early classical economists intuited that some kind of dynamic balance was underpinning economics, and under the Newtonian influence**, the price system became an incomplete and misaligned explanation of the essential relationship between resources and population**. In other words, **balancing supply and demand emerged as a weak substitute for balancing resources and population** -- mainly because classical economics followed the first law of thermodynamics, rather than the second, third or fourth law, which were still unknown.

Then Georgescu-Roegen's pivotal contribution was:

- **To rewrite economic theory, taking into consideration the constraints and laws of thermodynamics.**
- **To extend those thermodynamic considerations from pure energy to 'matter'**, which degrades and increases its entropy. **Georgescu-Roegen's 4th law of thermodynamics says that usable matter also degrades irreversibly just like energy**. This means that 'recycling' or so-called 'low-energy industrial processes' might slow down the depletion of resources but cannot totally stop it. This means that the concept of "sustainable development" as it is presented today is a false promise.
- **However Georgescu-Roegen's work also shows how it is possible to make this**

slow-down happen. He concluded that whenever possible energy extracted from Earth's resources should be replaced by solar energy. A crucial aspect is that because solar energy is available as a flux and not as a stock like natural resources, a generation using solar energy cannot confiscate this energy to the detriment of future generations. This might sound obvious in 2017, but back in the 1970s it was fairly ground-breaking and contributed to providing a theoretical foundation to the various environmental movements.

RE-EMBEDDING THE ECONOMY INTO NATURE AND SOCIETY

The mistake of classical economics about 'Growth'

> ***Key point:*** *The Growth Model emanating from classical economics relies on technology innovation as a substitute for natural resources depletion, creating the belief that technical change can effectively de-couple economic growth from environmental services.*

Coming back to classical economists, **until the 1970s only labour and capital were considered as factors of production, perpetuating the belief that natural resources are unlimited and free**. This view made its way into the equations governing classical economics.

For example, **Robert Solow**, creator of the **growth model**[21] which does not include resources at all, articulated in a famous paper in 1974[22] that 'human capital' can substitute 'natural capital', and that:

Robert Solow

> "As you would expect, the degree of substitutability is also a key factor. If it is easy to substitute other factors for natural resources, then there is in principle no "problem". The world can, in effect, get along without natural resources, so exhaustion is just an event, not a catastrophe. […] If, on the other hand, real output per unit of resources is effectively bounded - cannot exceed some upper limit of productivity which is in turn not too far from where we are now - then catastrophe is unavoidable. In-between there is a wide range of cases in which the problem is real, interesting, and not foreclosed. Fortunately, what little evidence there is suggests that there is quite a lot of substitutability between exhaustible resources and renewable or reproducible resources, though it is an empirical question that could absorb a lot of more work then it has so far."

While Solow is often misquoted and demonized for implying that "the world can, in effect, get along without natural resources", which he never meant, he symbolized the mistakes of classical economics. His real error wasn't to make the assertion that we don't need natural resources at all, but to be naively technology-optimistic and to believe that technology will always allow us to remediate the depletion of natural resources.

---

[21] Robert Solow's Growth Model: The Solow–Swan model is an exogenous growth model, an economic model of long-run economic growth set within the framework of neoclassical economics. It attempts to explain long-run economic growth by looking at capital accumulation, labor or population growth, and increases in productivity, commonly referred to as technological progress. Source: https://en.wikipedia.org/wiki/Solow–Swan_model (wikipedia)

[22] Robert Solow's Richard T. Ely Lecture, 1974: http://msl1.mit.edu/classes/esd123/2003/bottles/Solow.pdf

To Solow's deference, his paper starts by mentioning the *'Limits to Growth' Meadows report* to the Club of Rome[23]. He was also likely inspired by Georgescu-Roegen's seminal book *The Entropy Law and the Economic Process* published in 1971, when he invoked the laws of thermodynamics at the onset of his lecture to explain why materials recycling could not prevent the eventual exhaustion of all non-renewable resources and, indeed, why eventually all life on earth will come to an end.

However the ecological model behind his analytical effort fails to address all relevant ecological aspects at stake: he used the laws of thermodynamics only to focus on 'ecological efficiency'. For him, the continual substitution of new natural resources for depleted ones has no thermodynamic consequence. Indeed he neglected a key dimension of natural ecosystems, which are inevitably impacted by the resulting increase of the mass-energy scale of the economic process.

While Solow had an environmental intuition, he was mainly concerned with a classical economics approach. This means that instead of being concerned by the exhaustibility of natural resources as a limit to the economic process, he was more focused on 'the optimal social management' of the stocks of non-renewable but essential resources.

For Solow, the solution would come from the likelihood of technical progress eventually saving natural resources - what is called today ecological efficiency of the production process. One of his main arguments is the naïve notion of '**backstop technology**'. The naïve idea that when a resource becomes more scarce, its extraction cost increases, which creates the incentive for economic actors to seek and develop alternative ('backstop') technologies to address this scarcity.

The consequence of this view has been a misleading interpretation of **standard growth theory**: that substitution and technical change can effectively de-couple economic growth from resources and environmental services, that depleted resources or degraded environmental services can be replaced by more abundant substitutes, or by 'equivalent' forms of human-made capital (people, machines, factories, etc.)

The lack of realism of the ecological model behind Solow's analytical schemes relying on classic economics was first made clear by Georgescu-Roegen in his 'entropic' criticism of economic theory. Not only the standard growth theory ignores the full implications of the entropy law, but it also ignores the very existence of critical ecosystem services. Ecosystems are complex and interrelated structures. Their depletion trajectories follow unforeseeable non-linear patterns that cannot be fixed just by injecting capital. Indeed, contrary to the belief that markets always correct themselves through feedback mechanisms, the violation of 'critical resilience thresholds' actually prevents them from bouncing back to normal.

---

[23] The Limits to Growth is a 1972 book about the simulation of exponential economic and population growth with finite resource supplies. Commissioned by the Club of Rome: https://en.wikipedia.org/wiki/The_Limits_to_Growth

What came to be known as 'Economics of Pollution', as distinguished from 'Economics of Exhaustible Resources', evolved to deal precisely with this key dimension.

Even 'mainstream' economists such as **Joseph Stiglitz**, **Partha Dasgupta** and **Geoffrey Heal**[24] argued that in Solow's growth model consumption per capita would eventually decline to zero after an initial period of economic growth because resources and ecosystem services are depleted faster than capital can be accumulated to replace them. They anticipated that if the rate of use of natural resources is constant (or growing) over time, we will eventually run out. The only possible steady state is with natural resource use declining sufficiently rapidly that we do not run out.

So contrary to what classical economics implies, the possibility to decouple growth from resource use is a myth

> ***Key points**: Natural resources cannot always be substituted by Capital and Labour. Moreover, future generations which are also the people who will need these natural resources in the future are not here to propose their price in the market mechanism supposed to operate this substitution.*

The notion of 'backstop technology' resonated with the enthusiasts of **Schumpeterian innovation**[25] and its 'creative destruction' mantra that posits that technical progress will always enable an improvement in the consumption of resources and that we will ultimately find new sources of energy and new ways to harness them.

The trouble is that if Labour and Capital can be swapped between each other for an efficient allocation of resources (i.e. we can replace a human being with a machine), the same cannot be done for natural resources because they do not operate at the same level of abstraction as Capital and Labour. In fact, not only can natural resources not be substituted by Capital and Labour, but they are also necessary to the renewal of Capital and Labour.

Natural resources' distinct feature is to be extracted but not produced, and sold for a price to the best bidder. The trouble is that the future generations which are also the people who will need those resources in the future are not here to propose their price.

Consequently, the price of oil is structurally determined by the equilibrium between immediate demand for consumption, and immediate offer determined among other things by the strategic and political choices made by the OPEC countries, and not by the needs of the next generation. This means that the intergenerational consequences of the rapid depletion of the resource are ineffective at influencing the price or at slowing down

---

[24] Joseph Stiglitz: https://en.wikipedia.org/wiki/Joseph_Stiglitz , Partha Dasgupta: https://en.wikipedia.org/wiki/Partha_Dasgupta , Geoffrey Heal: http://www8.gsb.columbia.edu/cbs-directory/detail/gmh1

[25] Joseph Schumpeter: https://en.wikipedia.org/wiki/Joseph_Schumpeter

consumption. So in this market paradigm, 'price' is incapable of reducing the rate of depletion of the natural resource.

To fix this, advocates of the various branches of 'sustainable development' propose to pass on the cost of negative externalities like pollution as tax. However even such a measure would be far from perfect: internalizing pollution that way would only take into account the degradation incurred by nature *within the limits of its economic cost as it is (badly) measured today*. It means that everything else, which includes damage inflicted to the reproduction of the ecosystems would not be covered by this approach: **how do we price the bio-diversity that will never be born in decades because of the damage done today?** How can we conduct evaluations of today's items which are non-commensurable because their valuation cannot capture their long-term issues and future values.

Then once the damage becomes so important that they really start to have an economic impact, it is too late to react. So, under the pretense of sustainability this approach considers nature only through the present economic mindset and assumes it will be able to fix the very problems it initially created.

British writer **George Monbiot** captured it in a lecture in 2014[26] when he wrote:

> "You haven't changed anything by sprinkling money over the problem, you have merely called it something new. You have called it a market as opposed to a political system. (..) But you still need the regulatory involvement (..) to make that market work. Because we persuade ourselves that we don't need it anymore because we have a shiny new market mechanism, we end up fudging the issue of power and not addressing those underlying problems."

Without the re-embedment of the economic logic into the physical constraints required to sustain the biosphere, and without putting the question of the goal and finality of human activities at the forefront of our logic, the problem cannot be truly resolved.

The double re-embedment of economic logic – and the modes of exchange

This re-embedment (or re-subordination) of economics needs to happen at two levels.

First, the economic logic must be re-embedded inside the human/social sphere.

Second, this human/social sphere must be subordinated to the bio-sphere which runs on natural metabolic cycles ultimately limited by the laws of thermodynamics.

In this system of nested spheres - just like Russian dolls - each sphere, or paradigm, must respect the laws of the upper level.

---

[26] George Monbiot, The Pricing of Everything: http://www.monbiot.com/2014/07/24/the-pricing-of-everything/

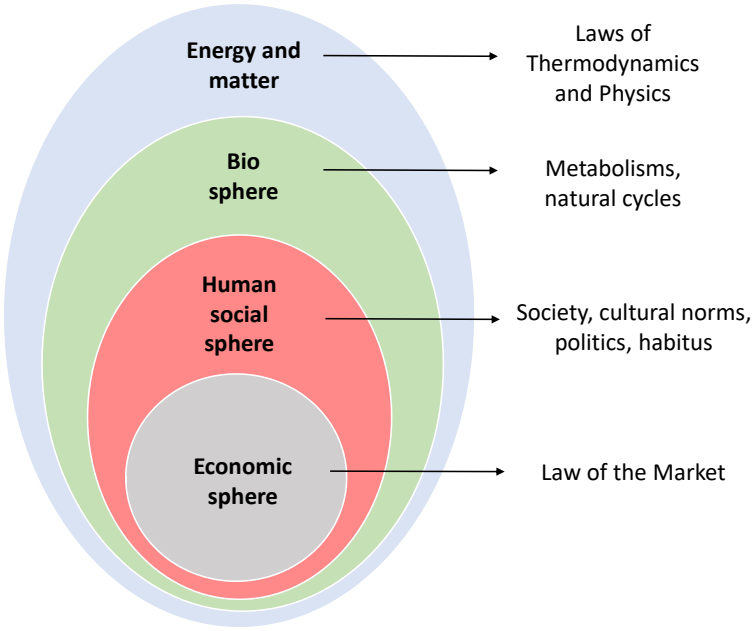
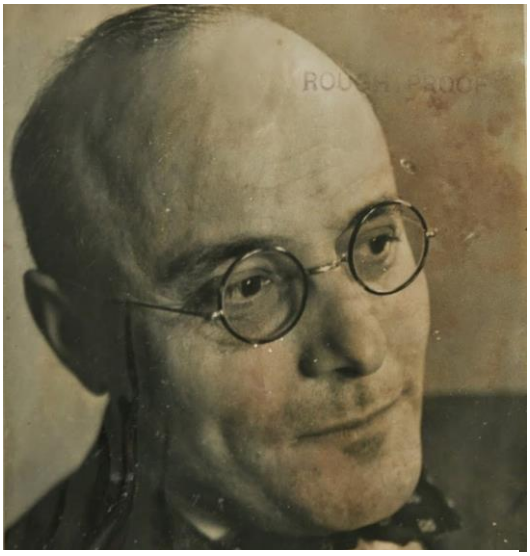


Figure 5- The re-embedment of economic logic inside the human, bio and energy spheres

Regarding the economic sphere, we have traditionally defined the economy as the rational management of useful and rare resources of this world in order to satisfy human aspirations at the optimal price. Economic historian **Karl Polanyi**[27] defined "formal economics" as the pure reign of calculating reason in the context of scarcity of goods when the ends are given. However this "pure economics" only covers a subset of all human activities and endeavours: the commercial part. Around this commercial sphere, there are much broader domains that touch the arts, free activities that do not lead to a commercial transaction, and socio-cultural values, which are the values that ultimately give meaning to life and drive behaviours.

Polanyi raised the question of the relationship between society and the market in his book ***'The Great Transformation'***[28]**.** He observed that **the market was not a feature exclusive to capitalism. It has always existed but it used to play a secondary role** among other economic and social relations:

> « Aristotle was right: man is not an economic, but a social being. He does not aim at safeguarding his individual interest in the acquisition of material possessions but rather at ensuring social good will, social status, social assets. Man's economy is, as a rule, submerged in his social relations. »



Karl Polanyi

For Polanyi, economies are embedded and enmeshed in social relations and institutions.

[27] Karl Polanyi: https://en.wikipedia.org/wiki/Karl_Polanyi

[28] The Great Transformation: https://en.wikipedia.org/wiki/The_Great_Transformation_(book)

Economics and its 'obsolete mentality' are valid as long as one is sufficiently myopic to see the unsustainable market system of the 19th century in all economic life. The 'self-acting device' of the 19th century - the market system - cannot be the reference point for grasping 'the reality of society' in economic life because, before its rise, markets were isolated and regulated by other social institutions.

Indeed, the issue with a pure 'financial' mindset applied to economics is that it ignores the number of **non-commercial activities that abound around us**. Tribal communities are obvious examples, but even in the modern western world families and circles of friends are prime cases of social structures where interactions between individuals are based on gifting and sharing communal resources.

This means that instead of being restricted to pure monetary and financial calculations, the economic logic must take into account the energetic and material dimensions of the resources which enable the flows it is measuring. In other words, and to link it back with the work of Georgescu-Roegen, economics really needs indicators about the flows of matter and energy. It must also reflect the time horizon of natural cycles. A renewed economic logic must also integrate the human dimension and systemic complexity that make up society. **In other words, the question here is of restricting the possible scope of 'classical' economics while introducing a degree of anthropological complexity.**

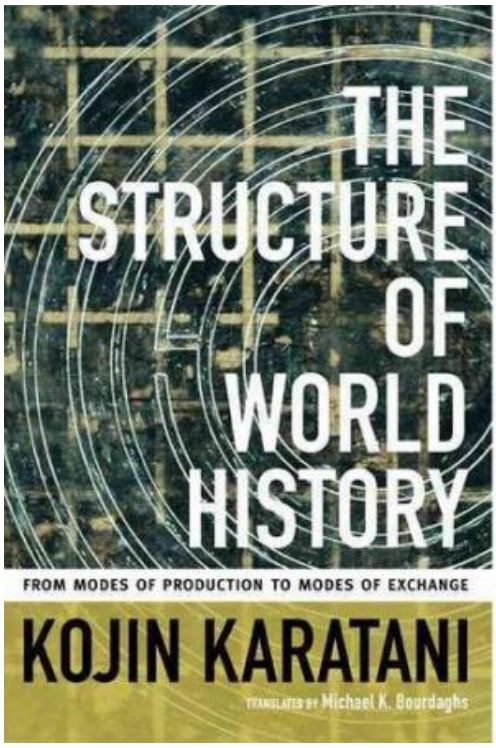
So from a scientific standpoint, the efforts of free market theorists to put the economy on top are doomed to fail. **However, the very misleading simplism[29] of market liberalism is a source of its extraordinary intellectual resilience**.

Only after the last tree has been cut down
Only after the last river has been poisoned
Only after the last fish has been caught
Only then you will find out that money cannot be eaten
Native American saying which pretty much captures
in four lines the essence of Polanyi's thesis

[29] Definition of simplism: the act or an instance of oversimplifying; especially the reduction of a problem to a false simplicity *by ignoring complicating factors*. https://www.merriam-webster.com/dictionary/simplism

How to counter this intellectual resilience of the utopianism of market liberalism? Understanding the complexity of the modes of exchange to escape economic reductionism

> ***Key point**: A way to refute the intellectual resilience of the simplistic utopianism of market liberalism is to show that the 'market' is not the alpha-and-omega of our economic and social order, and that other modes of exchanges have existed throughout history across societies. The 'market' is only one of many functions that make up our economic and social fabric. Japanese philosopher Kojin Karatani provides useful tools to analyze this.*



A useful perspective to understand how those spheres function is the notion of "mode of exchange" developed by Japanese philosopher **Kojin Karatani**[30] in his **"***The Structure of World History: From Modes of Production to Modes of Exchange*". **He distinguishes four such modes of exchange: 'the community', 'the state', 'the market', and a fourth hypothetical mode made of a mix** of those first three and that is meant to transcend them.

Those modes of exchange can be explained through an historical approach. **Michel Bauwens** and **Vasilis Niaros** from the P2P Foundation have summarized Karatani's conclusions[31] who recognizes different major transitions throughout History: each modality changes as it constrained by the domination of other modalities. For example, the form of community is first the band (under nomadism), then the tribe, then the agricultural or territorial community under imperial systems, which eventually becomes the nation under the domination of capitalist systems.

- The form of community is the first stage under nomadism: this is where the pooling of resources is the dominant modality. A first transition occurs when the **pooling of resources** in nomadic bands is replaced as a dominant modality of exchange by the **reciprocity-based gift economies of tribal systems**. This allows a scaling from bands to clans, tribes and inter-tribal systems and, therefore, creates a world that consists of a collection of tribal mini-systems
- Then tribes become agricultural or territorial communities under imperial

[30] Evolution of the Structure of World History Through Modes of Exchange: http://wiki.p2pfoundation.net/Evolution_of_the_Structure_of_World_History_Through_Modes_of_Exchange

[31] Value in the Commons Economy. By Michel Bauwens and Vasilis Niaros - co-published by Heinrich Böll Foundation and the P2P Foundation: http://commonstransition.org/value-commons-economy/ - Michel Bauwens the P2P Foundation: http://commonstransition.org/#team2

systems. With this second transition the reciprocity-based systems of tribes is replaced by **state systems**, based on the logic of 'plunder and redistribute' or 'rule and protect'. This allows scaling to inter-tribal and inter-community levels and, thus, creates a world of world-empires that compete with each other.

- The empire eventually becomes the nation under the domination of capitalist systems. This third transition occurs when imperial systems are replaced by the **market form** as the dominant form of exchange. This creates a global world-market system in which nation-states compete with each other, which Karatani characterizes as a world-economy.

- Finally, Karatani posits a new transition towards a mode of exchange that integrates the preceding ones but is dominated by the pooling that was originally dominant in the early nomadic groups. Karatani calls this modality 'associationism'.

With these modes, it becomes easy to recognise them as 'elementary bricks' underpinning all societies across various historical periods. It also confirms - if need be - that with respect to the history of humanity, capitalism is really recent and so should not be considered as the "only alternative".

This is a first key point in Karatani's thesis: the fact that the four modes can and will coexist and interwork. This means that **in today's Capitalist paradigm the market mode dominates** but does not exist on its own. The State which "plunders and redistributes", and the reciprocity of gift between people which operates for example in the family structure and communities are still key modes of exchange.

As for the strength of the "Market Mode", it comes from its support from **the triarchy Capital, Nation and State**, which reinforce each other and act as a mutually interrelated system to protect the Capitalist system.

Michel Bauwens highlights that it is quite different to see capitalism as a mere mode of production, and then to declare the state and the nation as mere epiphenomena of capital (as marxists used to do), or to insist (as Karatini does) that capitalism is really a triarchy combining Capital-State-Nation. Though 'capital' dominates, the two other modalities are just as essential for the survival and organization of the system as a whole.

This constitutes an essential second point emanating from Karatani's work. Today we are in a singular situation where the Market has colluded with the State, which explains why the State is not the solution to the issues we are trying to address. And hence the ongoing disappointment with the current Left political parties, which systematically betray the general interest to favour the interests of the elite – precisely because of this Capital-Nation-State collusion. As illustrated by a recent study[32] conducted in the US which shows

[32] Testing Theories of American Politics: Elites, Interest Groups, and Average Citizens, by Martin Gilens and Benjamin I. Page, 2014: https://scholar.princeton.edu/sites/default/files/mgilens/files/gilens_and_page_2014_-testing_theories_of_american_politics.doc.pdf

that economic elites and organized groups representing business interests have substantial impacts on U.S. government policy, while average citizens and mass-based interest groups have little or no influence.

> To quote Michel Bauwens's analysis of Karatani: "*the Capital-Nation-State trinity is so strong, because each will always come to support when the other ones are threatened.*" Bauwens explains that faced with the strength of that trinity, the focus on the P2P triarchical model of productive commons-organized civil society, cooperative marketspace, and enabling 'partner' state models makes sense "*since the attempts to change the capitalist nation-state, seem so impossible today. Karatani makes the strong and in my view realistic point, that the community integrating functions of the nation are not likely to disappear, nor the redistribution functions of the state.*"

Michel Bauwens

This is in effect a call for new (multimodal) balance instead of a unipolar dominance of either Capital or State or Market-power. So the question becomes how we allow those other modes already **cohabitating with market mechanisms** to grow and reach critical mass **to displace market capitalism as the dominant form** and shift the system beyond capitalism?

To do this, it now flows logically that the laws of economics must remain "embedded" inside society (to use Polanyi's concept), and the way to achieve that is **to augment the voice of the non-market modes in the TIMN quartet (Tribes, Institutions, Markets, and Networks)**[33].

The following table summarizes Karatani's modes of exchange:

Types of mode exchange	**Mode A**: Community	**Mode B**: State	**Mode C**: Market	**Mode D**: Association
Description	The reciprocity of the gift (or 'pooling' through commons)	Ruling and protection (also called: 'plunder and redistribute')	Commodity exchange (capitalist market)	It transcends the other three (the return of mode A at a higher level of complexity)

Table 1 - Modes of exchange The four types of Kojin Karatani for the evolution of the means of exchange (Karatani, 2014).

[33] David Ronfeldt, "Institutions, Markets, and Networks: A Framework about the Evolution of Societies" (1993): https://www.rand.org/content/dam/rand/pubs/papers/2005/P7967.pdf, David Ronfeldt on the TIMN Framework: http://wiki.p2pfoundation.net/David_Ronfeldt_on_the_TIMN_Framework

INTRODUCING THE COMMONS

After discussing the **mechanistic origins of classical economics**, its **contradictions revealed by thermodynamics**, and the **necessity to displace market capitalism as the dominant form of exchange**, we now conceptualize what a **systemic alternative to displace capitalism** across key domains would represent.

At one end of the spectrum described by Karatini we find the 'capitalist market' supported by the Nation-State and the unsustainability of this format that generates biospheric destruction and social and psychic dislocation as attested by the current backlash spreading across western democracies: the moderately radical Syriza movement in Greece was put under a European protectorate and had to abandon Greek sovereignty; progressive governments in Latin America are struggling to effect change. While the electorate may vote for parties that promise to change the status quo and eventually bring to power movements like Podemos, a Labour Party under the leadership of Jeremy Corbyn, or a Democratic Party strongly influenced by the Sanders movement, their capacities for change are severely restricted[34].

Figure 6 – Bernie Sanders at a Black Lives Matter[35] protest

On the conservative side, the likes of Trump and Le Pen represents the 'national' business interests, trying to mobilize the declining white middle class and workers behind their interests.

The key insight from this global trend is that the direction at the city and nation-state level should be to increase the capacity for the autonomy of citizens and the new economic forces aligned around the Commons. Simply initiating left-Keynesian state policies will not be sufficient and will, in all likelihood, be met with stiff trans-national opposition from the financial oligarchy.

This is the core idea behind aligning around the Commons: to displace the **structures of**

---

[34] Syriza: https://en.wikipedia.org/wiki/Syriza, Podemos: https://en.wikipedia.org/wiki/Podemos_(Spanish_political_party), Jeremy Corbyn: https://en.wikipedia.org/wiki/Jeremy_Corbyn, Bernie Sanders: https://en.wikipedia.org/wiki/Bernie_Sanders

[35] Black Lives Matter: https://en.wikipedia.org/wiki/Black_Lives_Matter

extraction, the **structures of oppression** and the **ideological structures** underpinning them.

Hence the work of Elinor Ostrom who helped theorize the Commons

> ***Key point**: Elinor Ostrom shows that 'the Commons' are not just the available resources, but also the rules and ways of managing them for the collective interest: without Commons, there is no community; without community, there is no Commons.*

The 2009 Economics Nobel Prize laureate[36] focused on examining how common pool resources could be managed. She explained that common pool resources included lakes and fisheries because they could not be easily divided into private property, meaning they had to be managed by some of form of collective agreement. She highlighted **modes of exchange which are not based on individual interests and mercantile value**. Her theory of the Commons marked the limits of a strictly economic logic. She was recognised for showing how shared assets can be efficiently managed by associations of users.

Ostrom compared the attempts of our contemporary capitalist system to privatise and control access to contemporary Commons such as knowledge, the natural environment, or networks, to the **English enclosures**[37] of the 17th and 18th centuries. This movement led by landowners (*proprietaries fonciers*) aimed at ring-fencing communal land and resources (such as grazing fields and dead wood in forests) in order to prevent farmers and commoners from using them for free. The goal for the landowners was to privatise those resources in order to make a profit from them. This was **the starting point of the primitive**

[36] Elinor Ostrom: https://en.wikipedia.org/wiki/Elinor_Ostrom

[37] The Enclosure movement: https://en.wikipedia.org/wiki/Enclosure

accumulation of capital that enabled the development of modern Capitalism.

Ostrom also refuted the "free rider" neoliberal thesis of sociologist **Garret Hardin**[38] who argued that selfishness drives humans to over-exploit resources without looking after them, until they are exhausted; hence penalizing the whole community. Ostrom's refutation was concerned with two essential problems: how resources could be managed in an ecologically sustainable way, and how a self-governing system could be promoted.

She showed that **'the Commons' are not just the available resources, but also the rules and ways of managing them for the collective interest**. This is the core of her legacy: to show there are no Commons without community, and there is no community without strong collective rules that go beyond individual profits. It is this mindset that is paramount when it comes to managing natural resources.

		EXCLUSION	
		Difficult	**Easy**
RIVALRY (SUSTRACTABILITY)	**RIVALROUS (Low subtractability)**	**Common pool (or common property) resources** e.g. Land, air, water, irrigation systems, fish stocks, wild game, pastures, forests, natural resources, libraries If those resources are subordinated to markets, their exploitation generates negative externalities worn by people who don't interact on those markets.	**Private Goods** All good traded on **markets**: e.g. food, clothing, cars, everyday electronic devices.
	NON-RIVALROUS (High subtractability)	**Pure Public Goods** e.g. Immaterial common goods such as un-encoded media, but also street lights, useful knowledge, sun-light. Everything is that non-rivalrous and non-excludable cannot be anything else but a commons.	**Toll or club goods** e.g. Journal subscriptions, paywalled media, most social services These are paying goods and services which marginal cost is null.

Table 2- Commonly used "Spectrum of Rivalry" which helps understand Ostrom's work – adapted from "Introduction: An Overview of the Knowledge Commons - Charlotte Hess and Elinor Ostrom"

Ostrom showed that a commons is either **an open-access resource, freely available to all, or a common-pool resource, regulated by rules of use**.

Her work alongside researcher **Charlotte Hess**[39] highlighted specific examples of the

[38] Garrett Hardin and the Tragedy of the Commons: https://en.wikipedia.org/wiki/Tragedy_of_the_commons

[39] Charlotte Hess: http://wiki.p2pfoundation.net/Charlotte_Hess

natural commons and the knowledge commons:

- **The natural commons** (such as water and the air) are to be managed with an objective of sustainability: Ostrom has used the example of water resources managed by a community.
- **The information and knowledge commons** that are non-rival and non-excludable which have exploded with the development of the internet: a prime example is Wikipedia in which knowledge production is based on voluntary contributions allowing free and accessible knowledge for all.

Why the commons and commons-based peer production are the right paradigms for the new economy

***Key point**: With a proper definition of the Commons enunciated, we move to making the case for the Commons - i.e. explaining why it is the right paradigm to tackle the sustainability issues we are trying to solve.*

Yochai Benkler

One evolution for collective action around the commons theorized by Ostrom has been **Commons-Based Peer Production**. This term was coined by Harvard Law School professor **Yochai Benkler**[40] who, partly relying on the work of Ostrom, developed it between 2002 and 2006, as a way to grasp the characteristics of a new model of production that loomed behind the surprising success of experiences like the **Free/Libre and Open Source Software**[41](**FLOSS**) and Wikipedia. It describes a new model of socioeconomic production in which large numbers of people work cooperatively, and has been made possible on a global scale for the knowledge commons thanks to the development of the Internet.

[40] Yochai Benkler: https://en.wikipedia.org/wiki/Yochai_Benkler, Yochai Benkler. The Wealth of Networks: How Social Production Transforms Markets and Freedom: https://cyber.harvard.edu/wealth_of_networks/Main_Page

[41] Free and open-source software: https://en.wikipedia.org/wiki/Free_and_open-source_software, FLOSS and FOSS by Richard Stallman: https://www.gnu.org/philosophy/floss-and-foss.en.html

Figure 7- Illustration of the delimitation of Commons-Based Peer Production. Mapping 30 areas of activity[42].

Benkler's notion had the merit of highlighting the emergency of the 'information commons' as detailed in his seminal book '***The Wealth of Networks: How Social Production Transforms Markets and Freedom***'. Since Benkler outlined the notion, the understanding of Commons-Based Peer Production has continued to progress.

The Commons, as an idea and practice, has emerged as a new social, political and economic dynamic. As shown by Kojin Karatani, along with **the Market** and **the State**, **the Commons** is a third mode of societal organization. The Commons and Peer to Peer (P2P) together form a system based on the practices and needs of civil society and the environment it inhabits, evolving away from obsolete, centrally planned systems or the competitive dictates of market economies.[43]

> If "Commons" is the "what", "P2P" could be considered the "how"[44]. P2P - "peer to peer", "people to people", or "person to person" - can be called a relational dynamic through which peers freely collaborate with one another to create value in the form of shared resources, circulated in the form of Commons.
>
> The relationship of P2P with the Commons is one of enabling capacities for contributive actions. P2P facilitates the act of "commoning," as it builds capacities to contribute to the creation and maintenance of any shared and co-managed resource (a Commons).
>
> In brief, P2P expresses an observable pattern of relations between humans, while the Commons tell us the specific what (as in resources), who (the communities gathered

[42] Delimiting Commons-Based Peer Production: https://p2pvalue.eu/delimiting-commons-based-peer-production/

[43] Michel Bauwens, Vasilis Kostakis, Stacco Troncoso, Ann Marie Utratel. Commons Transition and P2P: a Primer: http://commonstransition.org/commons-transition-p2p-primer

[44] *Idem*

around the resources) and how (the protocols used to steward the resources ethically and sustainably for future generations) of these relational dynamics.

Basing civil society on P2P dynamics and Commons practices could enable a more egalitarian, just, and environmentally stable society; this is the aim of a Commons transition.

We will now use the terms **Commons-Based Peer Production**, **Peer-to-Peer** and **P2P** interchangeably.

There is no shortage of analysts to lay out a moral and political argument for P2P. Much has been written about the *political intuition* and the case for the Commons (Elinor Ostrom, Michel Bauwens, David Bollier, Pierre Dardot and Christian Laval[45]) so there is probably little value in repeating it here.

However one particular angle might be worth reinforcing here: it is the question of the sense of urgency and depth of the post-capitalist transition. The current political and environmental crises present us with choices along a few dimensions:

1 – **reframing one's form of civilization** (i.e. "changing the frame itself[46]"), *as opposed to* a change *within* the same form of civilization (i.e. "changing within the same frame"). This dimension is basically calling for truly radical alternatives, as opposed to just accommodating the existing system with "green and social washing". This advocacy of a radical transformation is for instance the line followed by French economist Frédéric Lordon, major figure of the "Nuit Debout" movement of 2016[47].

[45] David Bollier: http://www.bollier.org, Pierre DARDOT, Christian LAVAL. COMMUN, Essai sur la révolution au XXIe siècle: http://www.editionsladecouverte.fr/catalogue/index-Commun-9782707169389.html

[46] In the words of French philosopher Frédéric Lordon: https://scinfolex.com/2016/06/28/ce-que-lon-apprend-sur-les-communs-en-lisant-frederic-lordon/ (article in French)

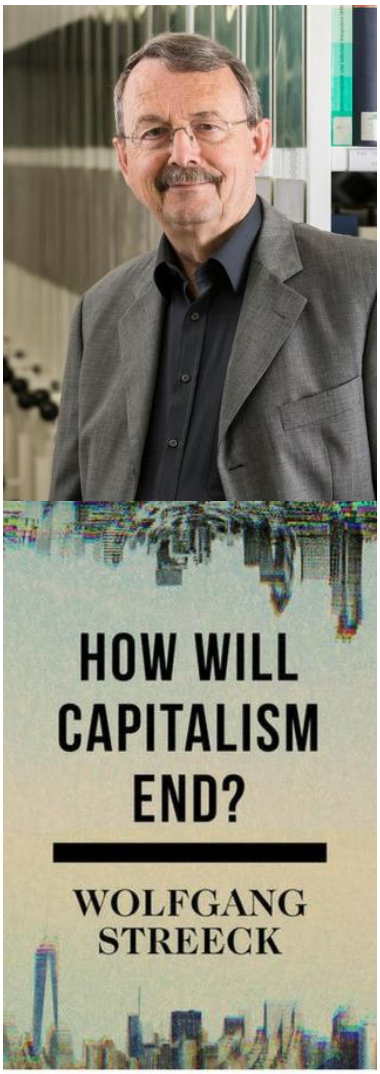
[47] Nuit Debout is a French social movement that began on 31 March 2016, arising out of protests against proposed labor reforms known as the El Khomri law or 'Loi travail'. It has been compared to the Occupy movement in the United States and to Spain's anti-austerity 15-M or Indignados movement: https://en.wikipedia.org/wiki/Nuit_debout

2 – a rapid concerted **conscious civilisation change**, *as opposed to* a slow **unconscious change** (i.e. 'suffered' vs 'chosen').

This last point about the 'conscious' argument is crucial. The conscious vs unconscious implies the eminently political nature of the argument. It is not a thermodynamics argument; it is a political argument supported by thermodynamics findings.

The need to '**reframe one's form of civilization'** (i.e. to displace market capitalism as the dominant form or exchange and reframe the system beyond capitalism) and to do it in a '**conscious manner**' (i.e. in a political manner) makes the thermodynamics approach work the other way around. First, we need to declare the goals; *we want a system with the lowest possible externalities, a system with the lowest possible entropy degradation.* This would translate into "we want 100% renewable energy", then we examine which type of mode of exchange system fits best our goals for each social activity, with the view of following a P2P/Commons approach when it makes sense.

This point is far from rhetorical or splitting hairs on logic. It is for example at the heart of the impasse of Sustainable Development which has not delivered on its expectations. The laws of thermodynamics on energy and matter give us the framework and parameters we need to consider to shift the model, but they do not tell us '*how*' it should be done, except from displacing market mechanisms as the dominant form of exchange, which will primarily remain a political topic.



So what might happen if we don't do it consciously? To echo the works of analysts who have focused on systemic collapse (such as **Wolfgang Streeck**'s How Will Capitalism End[48], **Thomas Piketty**[49]'s analysis of the consequences of inequalities) the adjustments will be imposed on us violently, such as what happened in the 20th century and before:

- through ecological collapse and resource depletion,
- through social collapse, explosion of populism flirting with fascism embodied by Donald Trump.

Once we have established this strategic intent about the transition, we can now focus on what the Commons proposes in effect.

[48] Wolfgang Streeck. How Will Capitalism End: https://www.theguardian.com/books/2016/dec/09/wolfgang-streeck-the-german-economist-calling-time-on-capitalism https://newleftreview.org/II/87/wolfgang-streeck-how-will-capitalism-end

[49] Thomas Piketty. Capital in the 21st century: http://piketty.pse.ens.fr/en/capital21c2

REFERENCES

Tipping point. The Drought That Preceded Syria's Civil War Was Likely the Worst in 900 Years, By Elaisha Stokes, 2016: https://news.vice.com/article/the-drought-that-preceded-syrias-civil-war-was-likely-the-worst-in-900-years

Real estate: Australian banks must learn lessons of US sub-prime crisis, warns ASIC boss: http://www.abc.net.au/news/2017-04-04/australian-banks-learn-the-lessons-of-sub-prime-asic-medcraft/8413542

René Passet Les grandes représentations du monde et de l'économie à travers l'Histoire. De l'univers magique au tourbillon créateur. 2010 - ISBN : 978-2-918597-08-7. 948 - PRIX DU LIVRE D'ECONOMIE 2010.

The Entropy Law and the Economic Problem - Nicholas Georgescu-Roegen: http://webpage.pace.edu/dnabirahni/rahnidocs/law802/The%20Entropy%20Law%20and%20the%20Economic%20Problem.pdf

Robert Solow's Richard T. Ely Lecture, 1974: http://msl1.mit.edu/classes/esd123/2003/bottles/Solow.pdf

The Limits to Growth is a 1972 book about the simulation of exponential economic and population growth with finite resource supplies. Commissioned by the Club of Rome: https://en.wikipedia.org/wiki/The_Limits_to_Growth

Joseph Stiglitz: https://en.wikipedia.org/wiki/Joseph_Stiglitz , Partha Dasgupta: https://en.wikipedia.org/wiki/Partha_Dasgupta , Geoffrey Heal: http://www8.gsb.columbia.edu/cbs-directory/detail/gmh1

Joseph Schumpeter: https://en.wikipedia.org/wiki/Joseph_Schumpeter

George Monbiot. The Pricing of Everything: http://www.monbiot.com/2014/07/24/the-pricing-of-everything/

Karl Polanyi: https://en.wikipedia.org/wiki/Karl_Polanyi

The Great Transformation: https://en.wikipedia.org/wiki/The_Great_Transformation_(book)

Kojin Karatini. Evolution of the Structure of World History Through Modes of Exchange: http://wiki.p2pfoundation.net/Evolution_of_the_Structure_of_World_History_Through_Modes_of_Exchange

David Ronfeldt, "Institutions, Markets, and Networks: A Framework about the Evolution of Societies" (1993): https://www.rand.org/content/dam/rand/pubs/papers/2005/P7967.pdf, David Ronfeldt on the TIMN Framework: http://wiki.p2pfoundation.net/David_Ronfeldt_on_the_TIMN_Framework

"Value in the Commons Economy" By Michel Bauwens and Vasilis Niaros - co-published by Heinrich Böll Foundation and the P2P Foundation: http://commonstransition.org/value-commons-economy/

Testing Theories of American Politics: Elites, Interest Groups, and Average Citizens, by Martin Gilens and Benjamin I. Page, 2014: https://scholar.princeton.edu/sites/default/files/mgilens/files/gilens_and_page_2014_-testing_theories_of_american_politics.doc.pdf

Elinor Ostrom: https://en.wikipedia.org/wiki/Elinor_Ostrom

Garrett Hardin and the Tragedy of the Commons: https://en.wikipedia.org/wiki/Tragedy_of_the_commons

Vincent Ostrom: https://en.wikipedia.org/wiki/Vincent_Ostrom

Charlotte Hess: http://wiki.p2pfoundation.net/Charlotte_Hess

Yochai Benkler: https://en.wikipedia.org/wiki/Yochai_Benkler

Michel Bauwens, Vasilis Kostakis, Stacco Troncoso, Ann Marie Utratel. Commons Transition and P2P: a Primer: http://commonstransition.org/commons-transition-p2p-primer

David Bollier: http://www.bollier.org

Pierre DARDOT, Christian LAVAL. COMMUN, Essai sur la révolution au XXIe siècle: http://www.editionsladecouverte.fr/catalogue/index-Commun-9782707169389.html

Frédéric Lordon: https://scinfolex.com/2016/06/28/ce-que-lon-apprend-sur-les-communs-en-lisant-frederic-lordon/ (article in French)

Wolfgang Streeck. How Will Capitalism End: https://www.theguardian.com/books/2016/dec/09/wolfgang-streeck-the-german-economist-calling-time-on-capitalism https://newleftreview.org/II/87/wolfgang-streeck-how-will-capitalism-end

Thomas Piketty. Capital in the 21st century: http://piketty.pse.ens.fr/en/capital21c2

With special thanks to:
Ann Marie Utratel (http://wiki.p2pfoundation.net/Ann_Marie_Utratel)
Alekos Pantazis (http://wiki.p2pfoundation.net/Alekos_Pantazis)
Jose Ramos (http://wiki.p2pfoundation.net/Jose_Ramos)
from the P2P Foundation for their inputs and support.