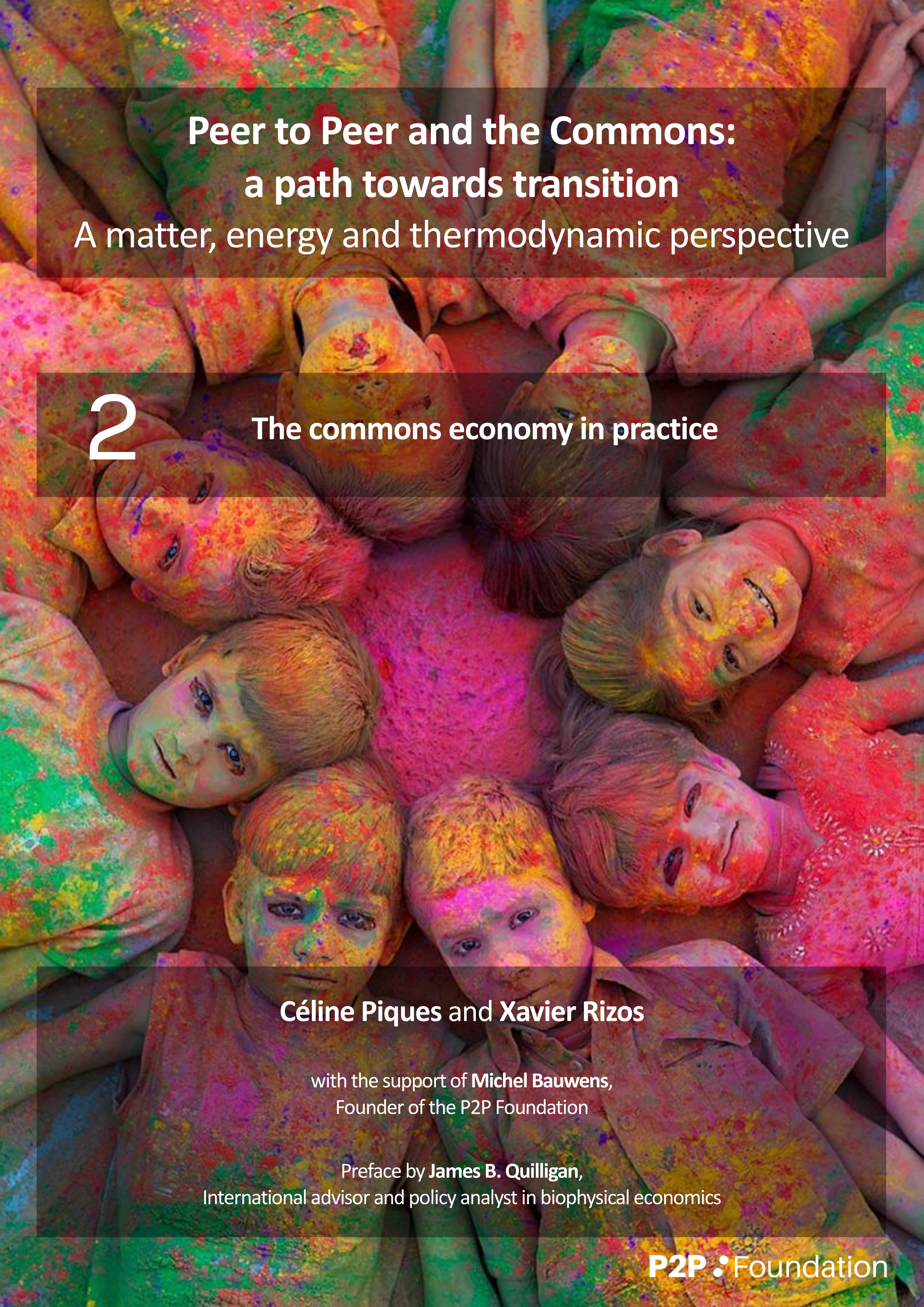

Peer to Peer and the Commons: a path towards transition

A matter, energy and thermodynamic perspective

2 The commons economy in practice

Céline Piques and **Xavier Rizos**

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

Preface by **James B. Quilligan**,
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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.

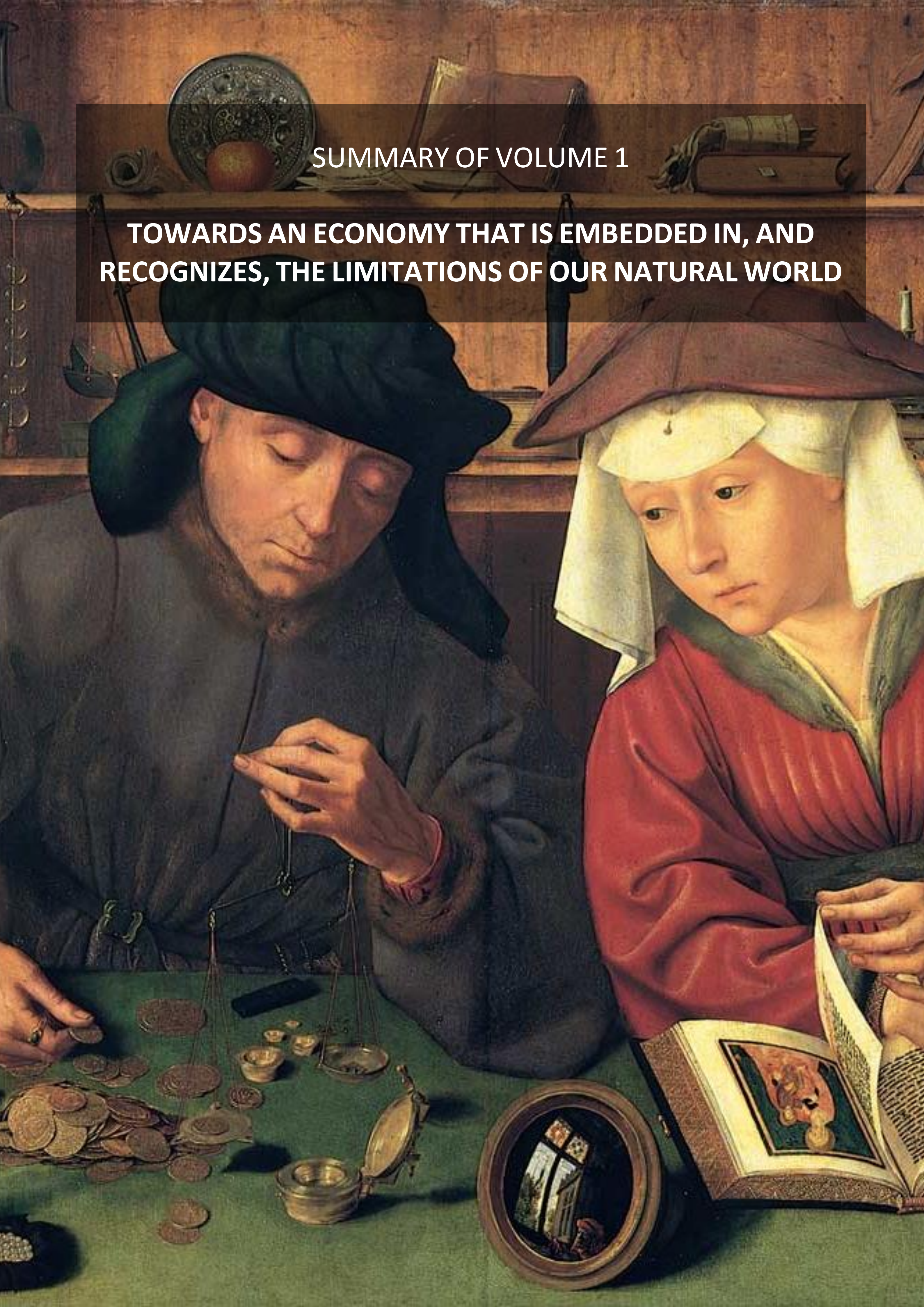
It's sobering to realize how very recent the concept of sustainability actually is. It's also dismaying to see how blurred this idea has become since the Brundtland Commission popularized the idea in 1987. Now, Céline Piques and Xavier Rizos have accomplished **what countless other writers on sustainability 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 Laws 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.

SUMMARY OF 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 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.

*

In the **first volume**[1] we started with the recognition that our system is stretched ecologically, socially, financially, and politically. It has been written, commented upon: our current capitalist paradigm face 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[2] started in the regions most affected by severe drought in decades.

- The financial and economic instability blamed for the Global Financial Crisis has not been resolved[3]: as illustrated by various examples from Europe's ongoing austerity crisis, to the more anecdotal but nonetheless dangerous 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[4] who illustrated the exploding disparity of the top 1% share of income with a graph that has become a reference:

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[1] 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**.

[2] 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

[3] 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

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

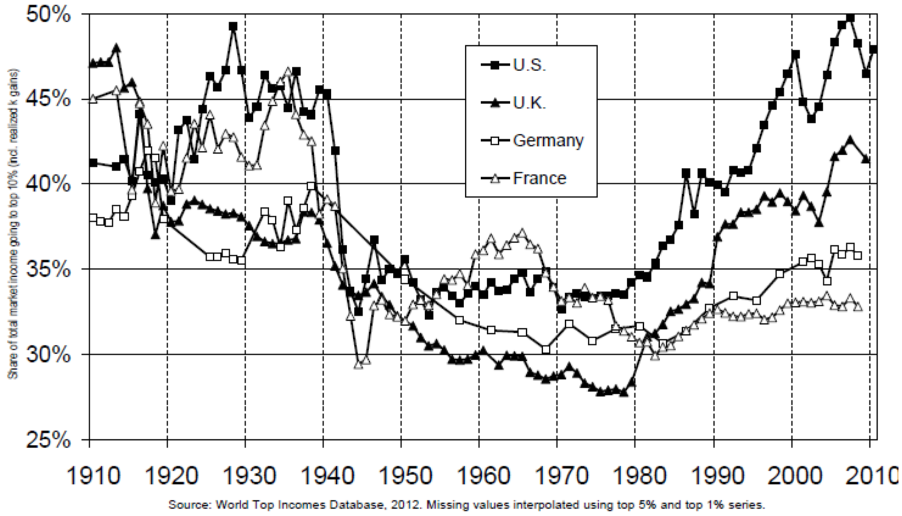

Figure 1- Top Decile Income Shares 1910-2010 (Piketty)

- 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[5].

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.

In volume 1 of this research[1] we have shown 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 have analyzed the imperative to create so-called **negentropic cycles**[6] 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.

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[5] 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/

[6] 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'[7]:

> 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[8], 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.

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[7] 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

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

VOLUME 2

THE COMMONS ECONOMY IN PRACTICE

This volume is divided in 3 main sections:

1 - **Renewable material resources**, which relate to agriculture for the production of food and fibers.

2 - **Non-renewable material resources**, which relate to manufacturing.

3 – **Energy**, which deserves a chapter of its own.

P2P AND COMMONS SOLUTIONS FOR FOOD AND FIBERS

***Key point**: This section shows that a model based on permaculture, organic farming, agro-ecology, agro-forestry, and even urban farming creates negentropic processes to match the regenerative capacity of the biosphere.*

Various studies concur: average organic yields are equivalent to conventional agriculture, and 30% higher in drought years. Total outputs in diversified grassland systems are 15% to 79% higher than in monocultures. Resource efficiency is 2 to 4 times higher on small-scale agroecological farms. There are 30% more species and 50% higher abundance of biodiversity on organic farms.

There are more than 570 million farms in the world[9]. More than 90% of them are run by an either a single individual or a family, and rely primarily on family labour. Family farms occupy a large share of the world's agricultural land and produce about 80% of the world's food[10]. **These farmers really are the 'first' commoners**.

In the past decades, there has been a global concerted push from agro-industrial lobbies to transform farming into an intensive industry, which consumes high volumes of inputs like pesticides and fertilizers, and which has imposed enclosures of seeds and species to control the value chain. This has triggered significant **negative externalities[11]**: pollution, water scarcity, production of low-nutritional value food, and it has pushed farmers into precarious conditions due to a vicious cycle of debt to purchase those inputs.

To be clear, a P2P and Commons approach is not to go back to the harsh conditions faced by farmers centuries ago, before agricultural progress. It is to promote food sovereignty through the struggle against agro-industrial oligopolies by developing **small scale farms which work as a resilient network** to exchange seeds and knowledge in order to practice a sustainable agriculture.

All empirical and conceptual evidence collected by our research shows that there is no thermodynamics barrier to this. All research in this field, from the Food and Agriculture Organization of the United Nations at the global level, to **Vandana Shiva[12]**'s local work in India concurs: the barrier is strictly cultural and political, mainly coming from industrial lobbies.

Vandana Shiva

In fact, knowledge and practices are so proven, that this shift in food production would be

[9] Agriculture's statistics: http://www.globalagriculture.org/report-topics/industrial-agriculture-and-small-scale-farming.html

[10] Source: FAO http://www.fao.org

[11] Negative externalities: https://en.wikipedia.org/wiki/Externality

[12] Vandana Shiva: https://en.wikipedia.org/wiki/Vandana_Shiva

feasible with just political and cultural will (i.e. the challenge is not technical nor biological).

Two modes would co-exist:

- **Farming for low footprint areas** (mainly in developing countries) would focus on preserving and improving their current negentropic practices, **preserving their cosmo-localised modes of production**, sharing infrastructure, and preserving their existing open knowledge and bio-diversity (such as the seed banks promoted by **Vandana Shiva**) from the enclosures imposed by industrial food processors (such as Monsanto).
- **Farming in high footprint area** (mainly in developed countries dominated by intensive farming and retailers) would focus on shifting their current intensive practices to cosmo-localised production. They would do this by opting for short circuits between producers and consumers when it makes sense, and would promote alternative economic models based on more open supply chains and more open book accounting: think of the predetermined basket price of several '**Open Food Networks**[13]' in Australia, and the **AMAP**[14] in France that share the risk of low production between farmers and consumers in a way underpinned by cooperation.

The physical indicators include:

- Metrics showing the **regeneration of soils** and the increase of biomass as a consequence of regenerative agriculture and agro-ecology.
- **Sequestration of CO2** instead of the current emission of CO2 by modern farming.
- **Fixation of nitrogen**, especially by leguminous plants that feed the soil with the required amount of nitrates, instead of flooding soils with external Nitrogen via industrial fertilizers and thus destroying the ecological balance.
- And the **general phasing out of chemical inputs and of industrial processing**, hence resulting in matter and energy efficiencies.

With the dichotomy 'matter-energy' that we are applying throughout this study, the primary 'matter' pertinent to agriculture is the biomass. It is by essence highly regenerative so it not a barrier to the ecological transition of farming. The focus will really be on 'energy' efficiencies, which will come from savings in transportation and chemicals, from the regeneration of soils, the preservation of wildlife (mainly fishery), the decrease in meat consumption and its associated battery farming, the diminution of food wastes, etc.

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13 Open Food Networks: https://openfoodnetwork.org

14 The AMAP in France: http://www.reseau-amap.org

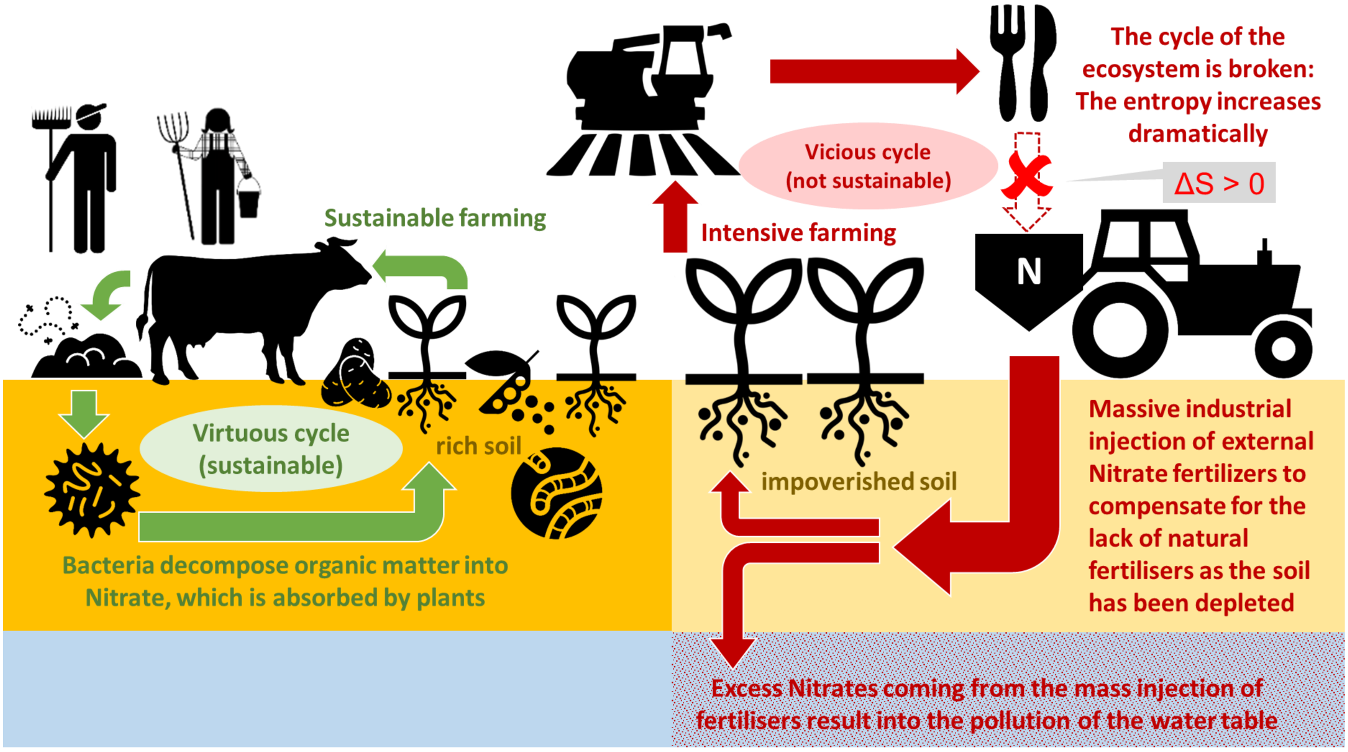


Figure 2- Virtuous cycle of agroecology vs vicious cycles of agri-business

Conclusion of the main studies and experimentations

There is an enduring misconception that fields farmed in an agro-ecological manner will always produce lower yields than their intensively farmed counterparts. It is essential to understand that the transition of a field impoverished by intensive farming and washed-out by chemicals, into organic practices will inevitably lead to lower yields *in the very first years*. However, as the soil regenerates in the following years, it then leads to higher yields, better resilience of the cultures, lesser consumption of pesticides and fertilizers, higher economic margins for farmers, and even less directly quantifiable benefits such as improvements in public health due to the consumption of better quality products.

The transition is about treating soil as a convalescent sick organism (which it is) and spreading the knowledge in a P2P manner to heal it. The scientific rationale behind this metaphor of a 'convalescent organism' is like that of an athlete who would take high levels of drugs and would win many sports events, but then eventually faces severe health complications. When getting off drugs, this athlete will start losing (the drop of yield for eco-farming) but will eventually go back to previous performance levels after a few years of healthy training (the same with soils).

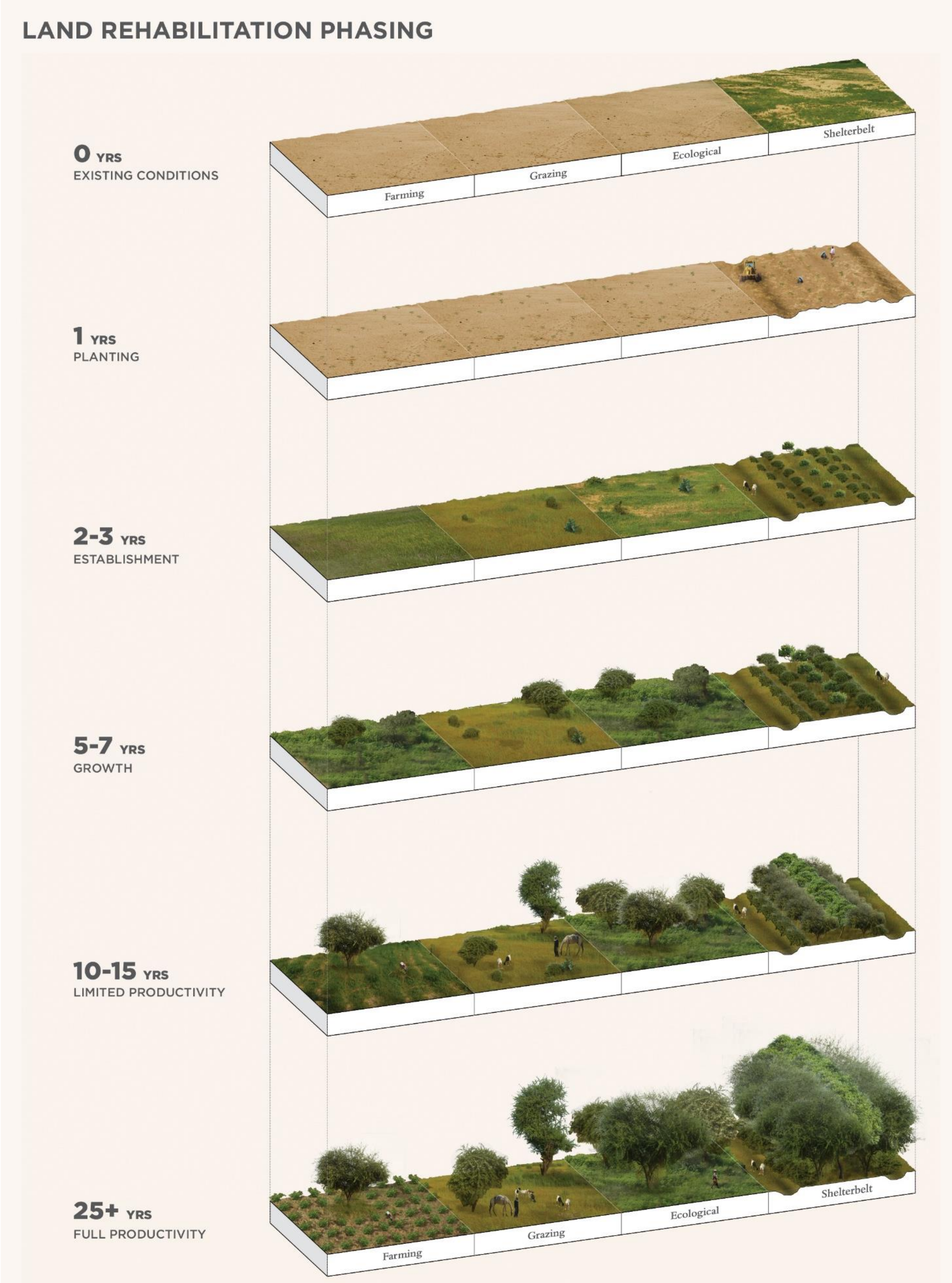


Figure 3 - Land Rehabilitation Phasing. Four types of land rehabilitation strategies — farming, grazing, ecological, and shelterbelts — are shown developing over time[15]

[15] Illustrative image from the 2011 ASLA Student Awards: https://www.asla.org/2011studentawards/238.html

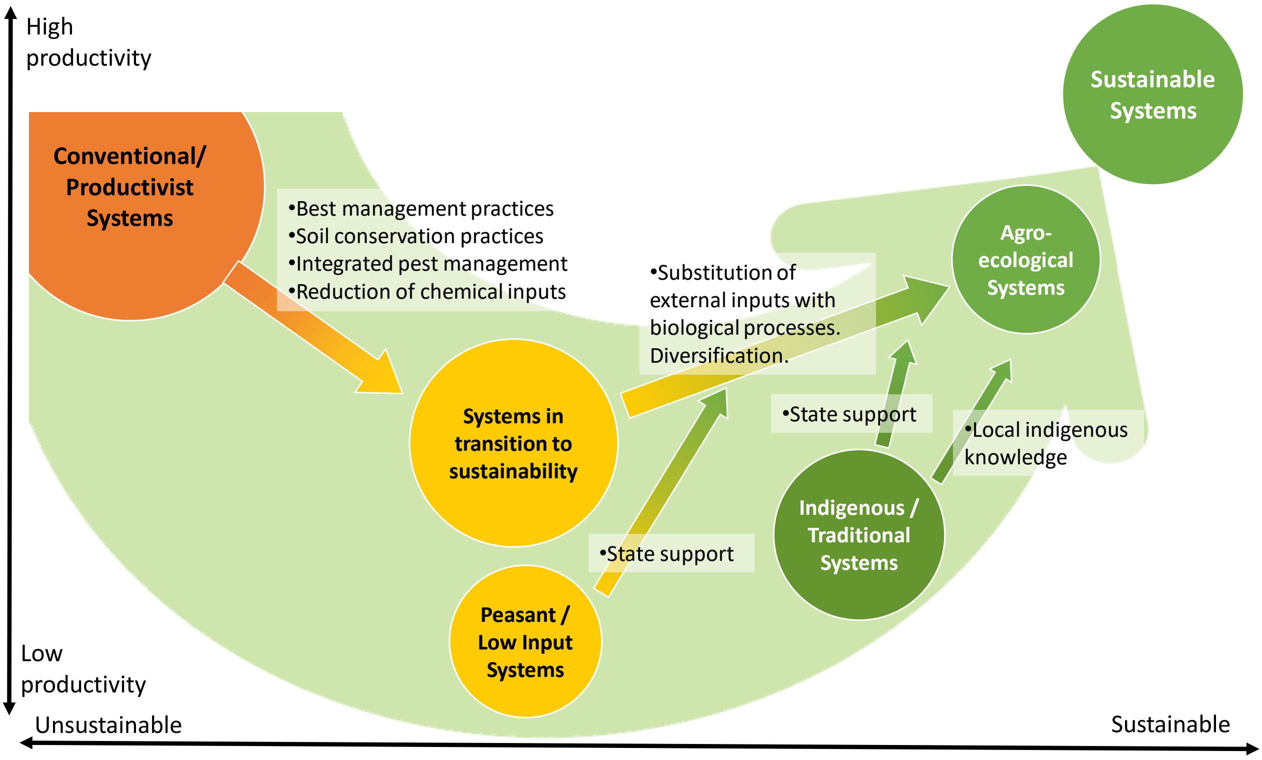


Figure 4 - Conceptual illustration of soil regeneration after years of conventional farming

So contrary to what most studies sponsored by agricultural lobbies assert, it is definitely possible to "feed the world[16]" with agro-ecology.

Why is the logic of the Commons working so well in agro-ecology?

A good example is the way to control undesired weeds. Instead of blindly using the same toxic chemical such as "Roundup[17]" everywhere in the world, a more pertinent approach is to remember that agroecological knowledge is a commons built over time and shared by the practitioners at their local levels. It is highly tailored to local ecosystems' conditions, therefore diametrically opposed to the one-size-fits-all processes pushed by the agroindustry.

Indeed, if **the principles of agroecology are the same at a global level,** and if indeed this **knowledge** must be shared around the world, **there is also a local dimension to these practices which comes from local experiences, local choices about what works and what doesn't.** It translates into the local selection of seeds, the local selection of species to be farmed, and local ways of operating the farm. These must adapt to the terrain and the climate – what the French call "terroir". Or what researcher John Boik calls "engage global,

[16] How to Feed the World in 2050: http://www.fao.org/wsfs/forum2050/wsfs-forum/en/ http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

[17] Roundup: Glyphosate is a broad-spectrum systemic herbicide and crop desiccant. Monsanto brought it to market in 1974 under the trade name Roundup: https://en.wikipedia.org/wiki/Glyphosate

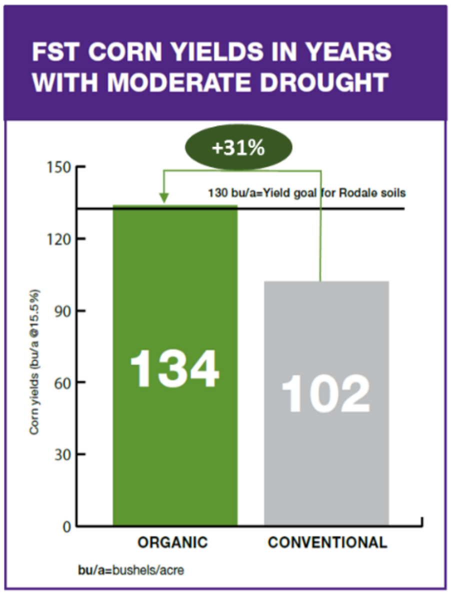
test local, spread viral”[18].

This where a P2P approach is essential because it is precisely built around favouring, sharing and mutualising material resources and knowledge in a way that is highly tuned to local environments, such as seeds and species, water management, and farming practices. It has been proven effective by a number of practitioners and analysts.

The Rodale Institute 30 Year Farming Systems Trial

The **Rodale Institute 30 Year Farming Systems Trial**[19] is a flagship study conducted in America which highlights key conclusions applicable to the entire **agro-ecological paradigm**. Below are some of its key insights on yields, energy consumption, soil health.

Organic farming yields can increase by around 30%



- **Organic corn yields were 31% higher than conventional in years of drought.** These drought yields are remarkable when compared to genetically engineered “drought tolerant” varieties which saw increases of only 6.7% to 13.3% over conventional (non-drought resistant) varieties.
- **Corn and soybean crops in the organic systems tolerated much higher levels of weed competition than their conventional counterparts, while producing equivalent yields.** This is especially significant given the rise of herbicide-resistant weeds in conventional systems, and speaks to the increased health and productivity of the organic soil (supporting both weeds and crop yields).

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[18] The Triarchy of Cosmo-Localization: Engage Global, Test Local, Spread Viral: https://blog.p2pfoundation.net/triarchy-cosmo-localization-engage-global-test-local-spread-viral/2017/02/07

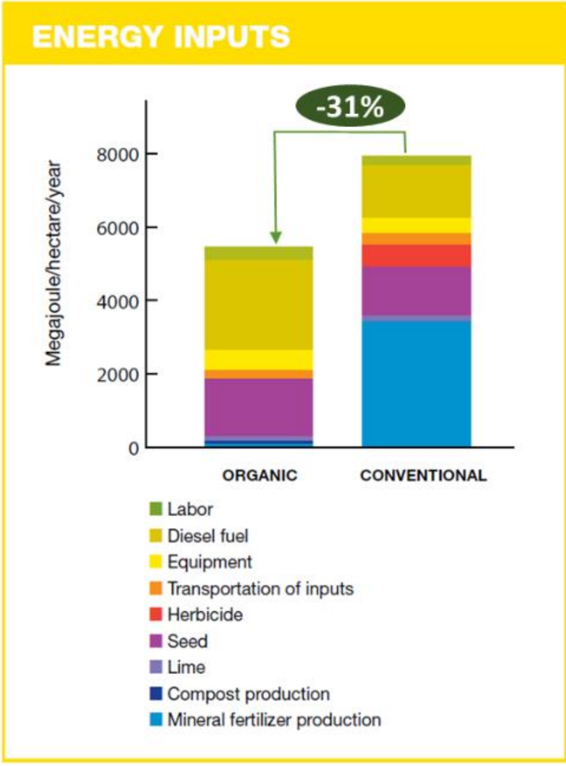
[19] Rodale Institute: Farming Systems Trial, 30-year Report: http://rodaleinstitute.org/assets/FSTbooklet.pdf

Organic farming energy inputs can drop around by 30%, resulting into savings

INPUTS

Our data from FST shows that the organic systems use less energy and are more efficient than conventional systems:

- **The organic systems used 45% less energy than the conventional systems.**
- **Diesel fuel was the single greatest energy input in the organic systems.**
- **Nitrogen fertilizer was the single greatest energy input in the conventional systems representing 41% of the total energy.**
- **Production efficiency was 28% higher in the organic systems than in the conventional systems, with the conventional no-till system being the least efficient in terms of energy usage.**

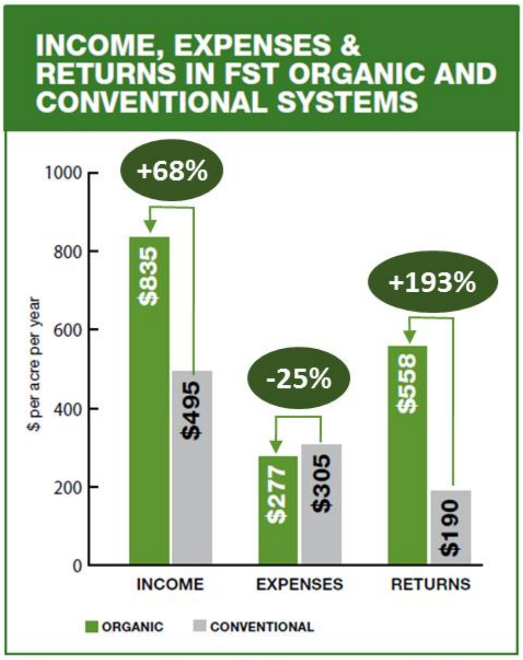


The energy analysis covers only the time period 2008-2010 to reflect data collected for the most recent cropping system comparisons.

This results in overall returns multiplied by a factor of 2 to 3

FROM FST, we have found that:

- **The organic systems were nearly three times more profitable than the conventional systems.** The average net return for the organic systems was $558/acre/year versus just $190/acre/year for the conventional systems.
- **Even without a price premium, the organic systems are competitive with the conventional systems.** Marginally lower input costs make the organic systems economically competitive with the conventional system, even at conventional pricing.
- The most profitable grain crop was the organically grown wheat netting $835/acre/year.
- No-till conventional corn was the least profitable crop netting just $27/acre/year.



The economic analysis covers only the time period 2008-2010 to reflect data collected for the most recent cropping system comparisons.

Energy use can drop from 30% to nearly 50%

Gains in energy, which drive overall costs and extraction of resources were also studied by **Christian Schader** in his thesis on 'Cost-effectiveness of organic farming for achieving environmental policy targets in Switzerland' (2009)[20]. He showed that **energy use in organic farms can drop by 30% to nearly 50%.**

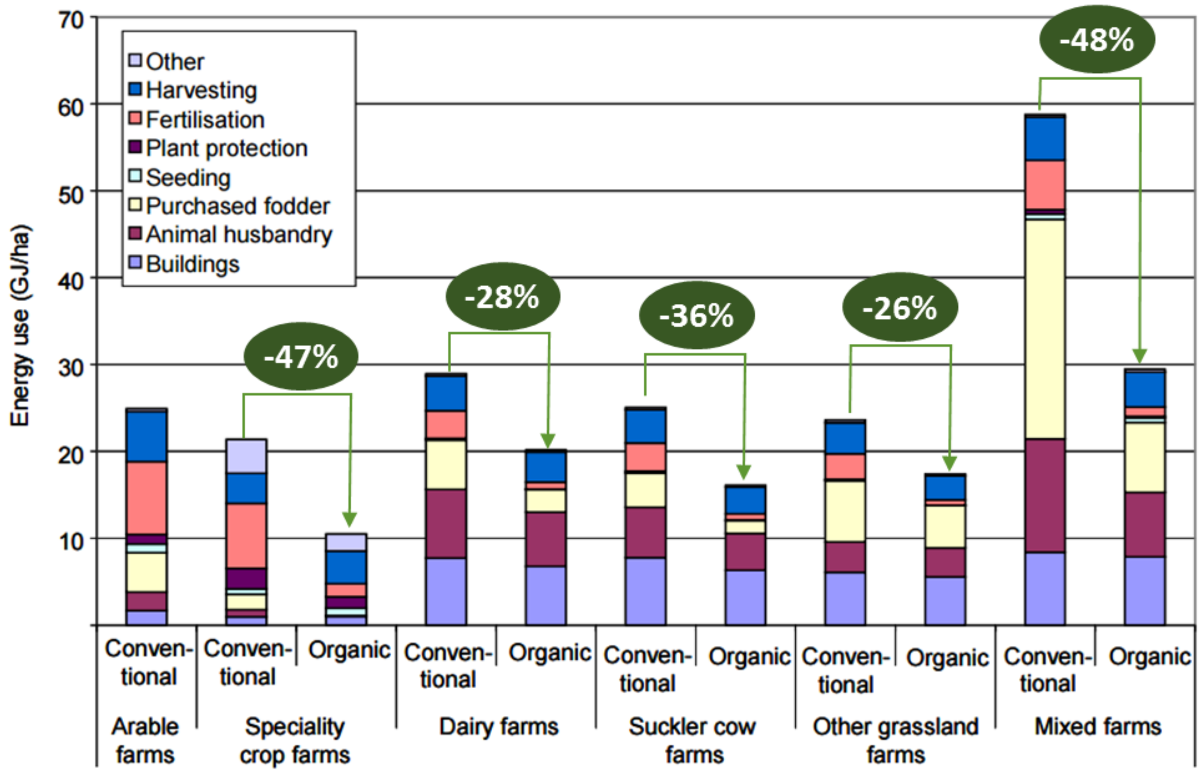


Figure 5 - Energy use on organic and conventional farms in Switzerland, by type. Schader (2009)

Soil and seeds are a commons

Vandana Shiva[21] adds to those considerations by promoting **seeds diversity and commons principles in India**. She points out that Monsanto - the flagship of today's agri-chemical industry – was born from the chemical warfare industry especially famous for manufacturing 'Agent Orange', the toxic defoliant containing the highly toxic substance dioxin used by the US during the Vietnam War from 1961 to 1971. Vadana Shiva argues that **the depredatory nature of the chemical warfare industry has survived in today's agri-chemical industry through its aggressive restriction of seeds supply**. The chemical industry has taken over the seed supply through genetic engineering and patents. Monsanto's strategy is to aim for every farmer in every season everywhere in the world to buy their seeds so they can collect royalties and super profits. It is corporations like Monsanto who even wrote the Intellectual 'Property Rights Treaty' of the World Trade

[20] Christian Schader, 'Cost-effectiveness of organic farming for achieving environmental policy targets in Switzerland' (2009) https://shop.fibl.org/CHen/mwdownloads/download/link/id/493/?ref=1

[21] Vandana Shiva, Pour une désobéissance créatrice, Entretiens avec LIONEL ASTRUC. OLIVIER DE SCHUTTER, PRÉFACIER: http://www.actes-sud.fr/catalogue/societe/vandana-shiva

Organization. As a Monsanto representative said: "In writing this treaty, we were the patient, the diagnostician, the physician all in one."[22] They defined seed saving as a crime to establish "seed slavery" and force farmers to buy their seed and pay them royalties.

Vandana Shiva's conclusion is that **soil and seeds must be considered as commons**. She believes that seed sovereignty includes the farmer's rights to save, breed and exchange seeds, to have access to diverse open source seeds which can be saved; and which are not patented, genetically modified, owned or controlled by emerging seed giants. It is based on **reclaiming seeds and biodiversity as commons and public good**.

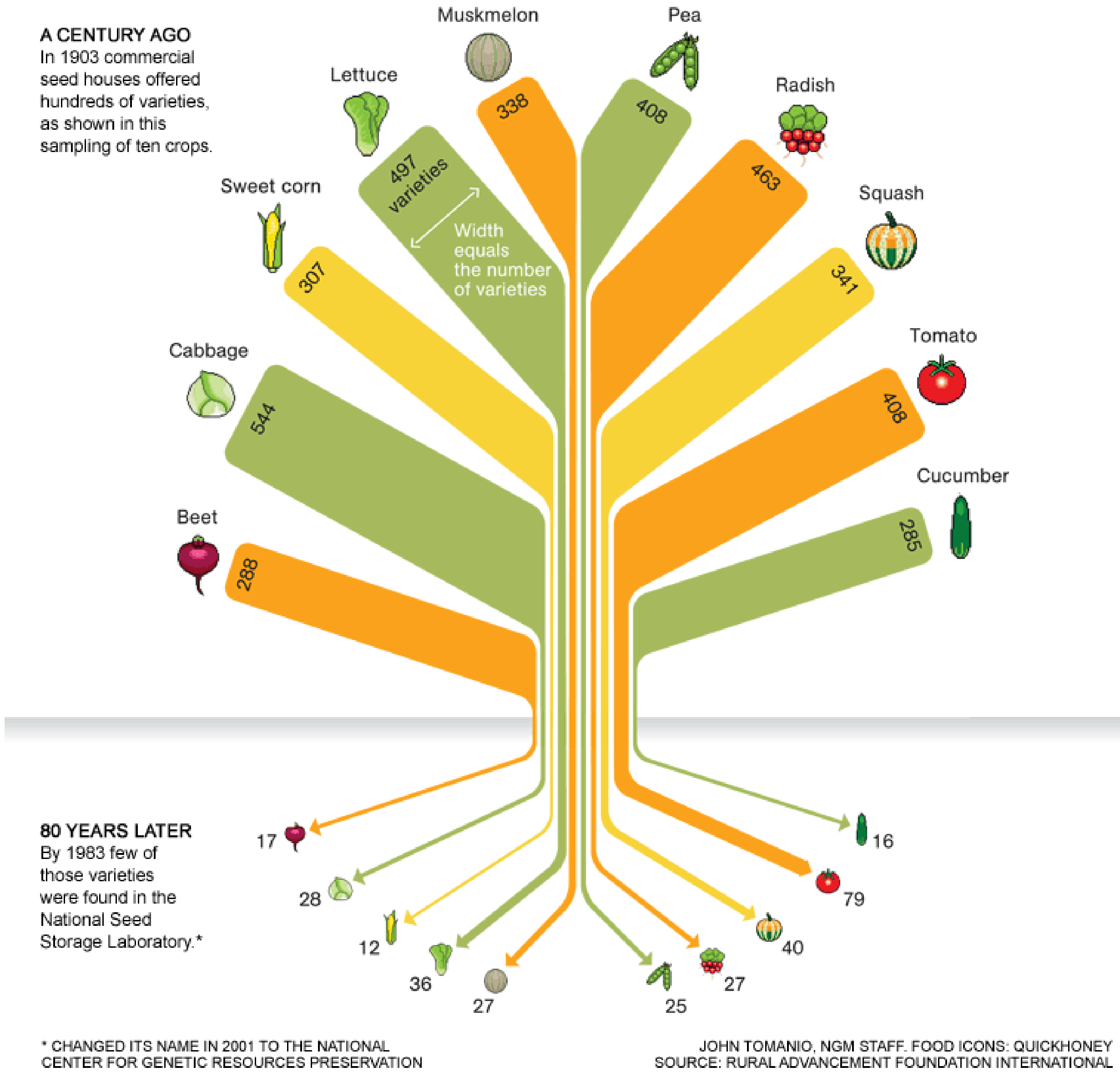


Figure 6 - Illustration of the loss of seed diversity highlighted by Vandana Shiva

Finally, one of the strategic objectives of the p2p and commons-based approach is to **revert the dominance of the bottlenecks between farmers and consumers** as illustrated by the

[22] Vandana Shiva: 'Seeds must be in the hands of farmers' https://www.theguardian.com/global-development/2013/feb/25/vandana-shiva-seeds-farmers

following diagram representing the **Global Food System**[23] when it comes to seeds:

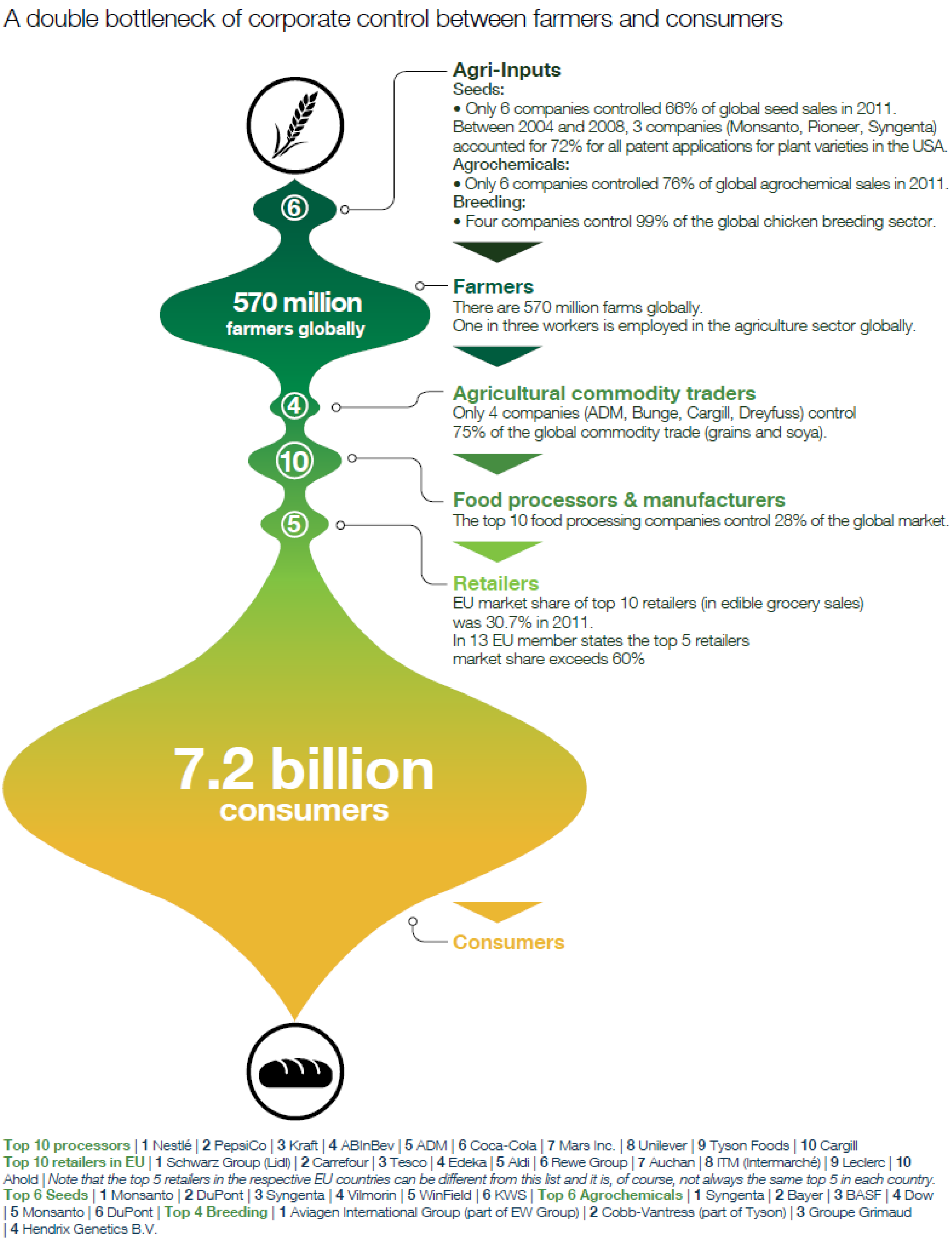
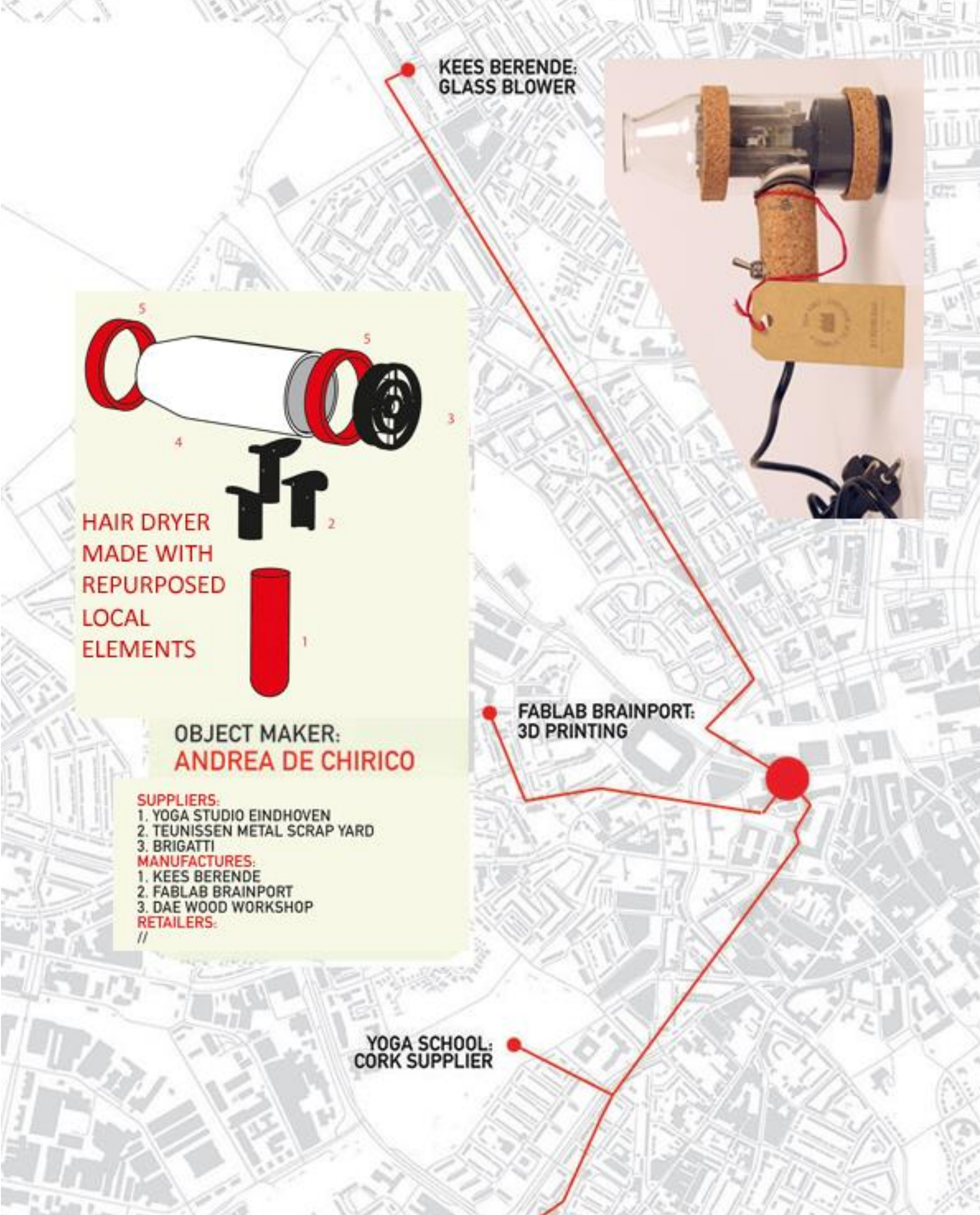


Figure 7 – The Global Food System. A double bottleneck of corporate control between farmers and consumers (source: Greenpeace)

[23] The Global Food System: https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/eco-farming-grundsaetze-oekologischer-landwirtschaft-20150519.pdf

In conclusion, all the studies we surveyed in writing this report show that the feasibility of agro-ecology is unequivocal and the thermodynamics efficiencies are proven. All those studies and multiyear live experiments show that agro-ecology not only delivers the required regeneration of the ecosystems, but can also *at least* deliver equivalent levels of yields to conventional farming, and up to 30% of energy and cost savings, while increasing farmers' financial returns by factors of 2 to 3.

MUTUALIZATION AND RE-LOCALIZATION AS ANSWERS TO THE PROBLEM OF NON-RENEWABLE MATERIALS



***Key point**: This section focuses on non-renewable 'matter' - as opposed to renewable food or energy dealt with in other sections. We articulate the mathematical impossibility of the various schools of thought promoting approaches such as "sustainable development", "sustainable growth" or "recycling" without radical social transformation, when it comes to delaying complete depletion of non-renewable material resources.*

A close look into the dynamics of growth shows its inexorable exponential nature

Looking into this "exponential nature of growth" explains the absolute necessity of limiting the growth rate of raw material consumption to very low levels.

We start by plotting the traditional 'hockey stick' chart representing a growth phenomenon at different 'rates of growth':

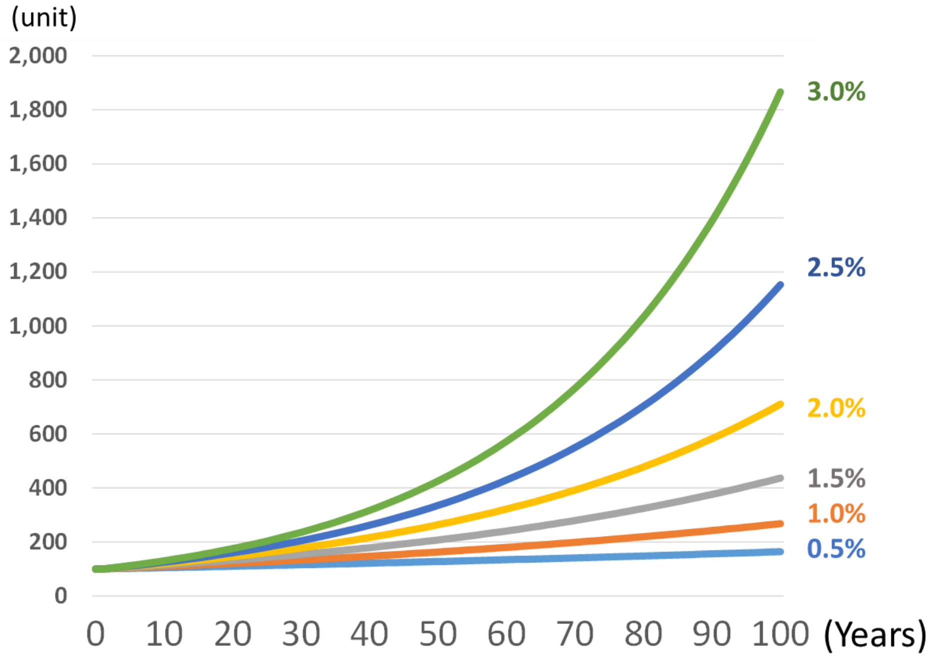


Figure 8 - Notional Growth from a value of 100, following growth rates ranging from 0.5% to 3%

The accumulated effects of an **exponential progression are inherent to the growth phenomenon**. There is no escaping it. Even when the shape looks really flat in the early years, it is just a value building up and looking to explode – literally.

Even more striking is the influence of small variations in the growth rate. Whilst the difference between 1% and 3% doesn't seem that big on the present day (think of the difference between a \$100 and a \$103 item in a shop: not much you would think) it ends up creating a significant material difference after a few years.

Modeling the limits of recycling in a paradigm where extraction keeps growing

The work of sustainability expert **François Grosse**[24] is very useful to dissect the dynamics of growth. **Using the production of steel as a proxy for any type of system growth**:

- He basically shows that **the impacts of recycling are very limited if the growth of total consumption of raw material exceed 1%** per year.
- It is **only if the annual growth rate of raw material consumption is below 1% that recycling has a significant positive impact**. It can then provide over one hundred years of respite.
- Finally, François Grosse shows that **it is only with a negative 'growth rate of material consumption' that we can reach a truly sustainable paradigm**.

The reason of this **impasse is embedded in the exponential mathematical nature of growth**. To understand it, we can start by representing the link between the various parameters driving consumption, growth and recycling.

The physical model representing the extraction and recycling of resources is as follow:

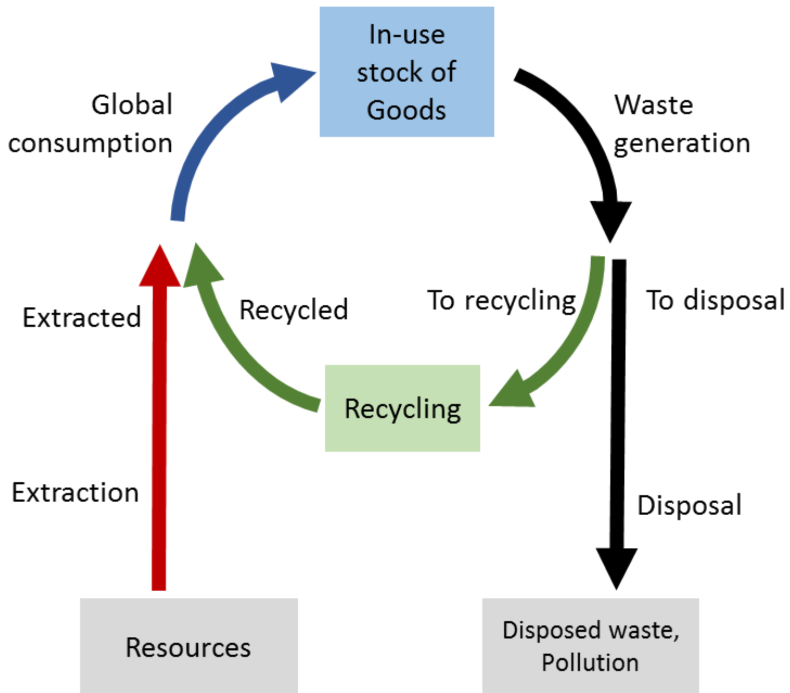


Figure 9 - Illustration of the elements used in François Grosse's model

Translated into a more mathematical formalism, the ecosystem stakes are represented by the following parameters:

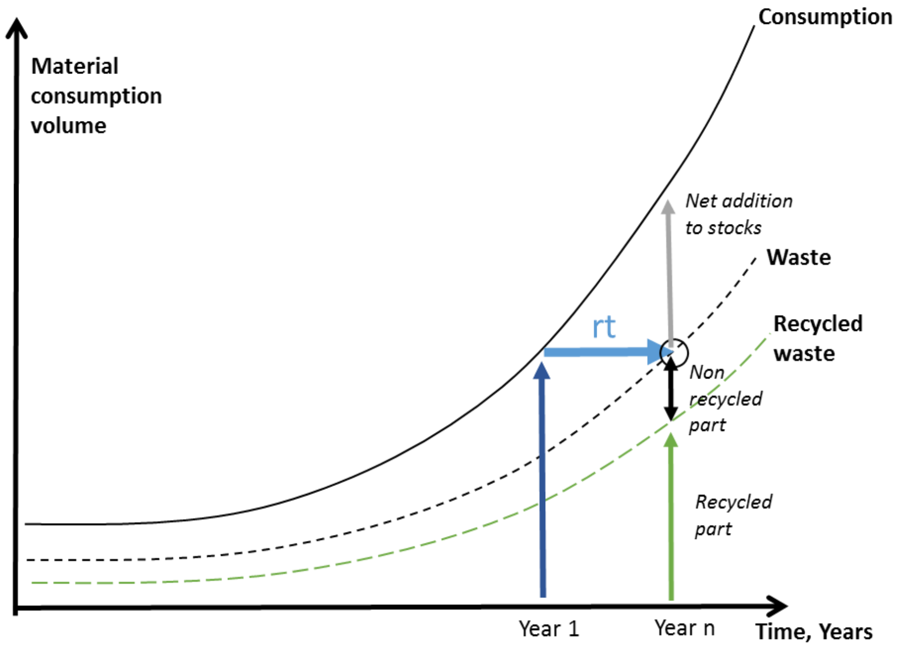
- **'rt' the residence time** (in years): **which is really the mathematical quantification of planned obsolescence** (the shorter the rt, the quicker something breaks or is disposed). A given level of consumed resources on Year 1 will "stay in residence" for

[24] François Grosse: Is recycling "part of the solution"? The role of recycling in an expanding society and a world of finite resources https://sapiens.revues.org/906 - Quasi-Circular Growth: a Pragmatic Approach to Sustainability for Non-Renewable Material Resources: https://sapiens.revues.org/1242

a certain time rt. Average residence time (rt) is the average time separating production of a raw material in a form usable by industry and its discharge as waste after manufacture, distribution and use; therefore it is the time interval *for a given quantity of raw material* between 'extraction-consumption' and 'transformation into waste'.

- Of that waste, a **ratio 'R' is recycled**, the rest is disposed as non-recycled waste into the environment.
- **'g' is the annual growth rate of raw material needs**. When the growth rate is positive, for instance g=3%, it means that raw material needs grow 3% from one year to the next. When growth is flat g=0%; and when we are in a degrowth paradigm g becomes negative.

Below is the graph illustrating this cycle: it clearly shows that the amount we consume on a given year 'n' is a mix of what was already extracted in prior years and still resident in the economy, plus a net addition to stocks coming from newly extracted material. It also shows the obvious binary destination of materials: that once the amount of materials gets to the end of its resident time in the economy, it ends up either as recycled waste, or non-recycled waste.



Material consumption = Waste discharge + Net addition to stocks

Net addition to stocks is defined as the difference between material added to stocks and material removed from the stock to be discharged as waste.

Figure 10 – illustration of François Grosse's model

The question we are trying to solve is the quantification of the effective depletion of resources. To measure it **we calculate the number of years 'd' that recycling 'buys us'**. More precisely, 'd' is defined as the number of years such as the aggregate consumption of **raw virgin materials (i.e. extracted)** at year 'n+d' with recycling is equal to the aggregate consumption of raw materials at year 'n' without recycling. 'd' is also defined as the 'Time

Lag of aggregate consumption' (in years).

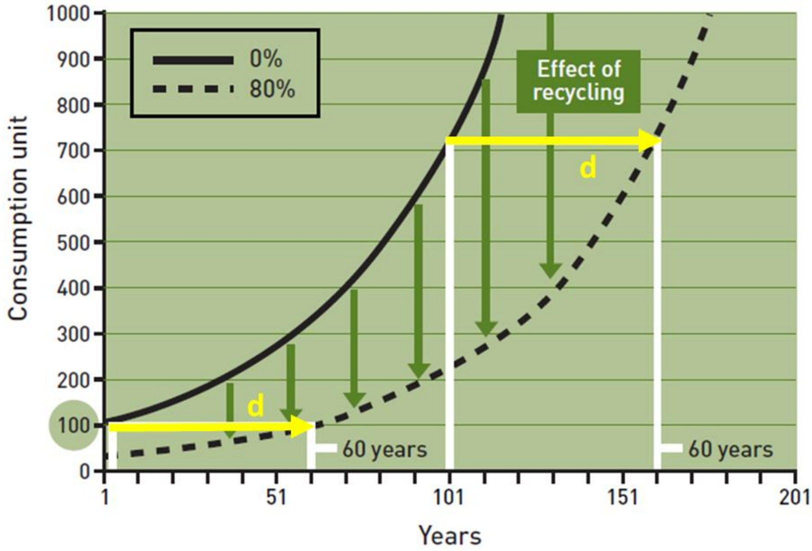


Figure 3: Effect of recycling if annual growth rate of raw material consumption is constant. The annual consumption curve of virgin material is flattened by the effect of recycling. But when, after 60 years, consumption with recycling also overtakes the 100 value point, the dashed curve becomes identical to the other curve, except for a shift of 60 years. In this example, after 100 years, only 200 will be drawn from the natural resources with recycling at 80%, whereas it would already be 700 without recycling. But the 700 mark will be reached only 60 years later with recycling and we will never gain more than 60 years with recycling if the progression of total consumption remains unchanged.

In this example: the annual growth is 2% and the average residence time in the economy for the material under consideration is 7 years.

Figure 11 - Example of Steel consumption and how high levels of recycling only delay current levels of depletion by only 60 years

Grosse's calculations deliver the following insights:

- **The exponential nature of growth** makes recycling ineffective when the growth rate is above 2%.
- It is **only when the rate of growth is lower than 1.5% that recycling makes a significant difference**.
- Differences in the **time in residence** for a given 'recycling rate' and 'rate of growth' have little effect on the time lag for aggregate consumptions, except if there is the combined effect of a really low rate of growth and a really high recycling ratio – which is really a 3rd order effect.

The conclusions are unequivocal:

- The time lag for aggregate consumption highly depends on the total growth rate of consumption of a material. The slower the growth, the more recycling contributes to "a time gain" before the resource becomes scarce.
- **It is almost impossible to attain by recycling alone (i.e. "alone" ~ around 80%) a time lag greater than 100 years if the growth rate is higher than 1.5% per annum**.
- For a growth rate higher than 3% - as in the last 100 hundred years of steel production - recycling only has a minor, if not marginal, effect on the conservation of the

resource.

Using Iron as a proxy to model and analyse the extraction, consumption, recycling and ultimately depletion of non-renewable natural resources

Looking at the steel example (which is made of Fe extracted from natural crude Iron Ore), at the current annual growth rate of 2%, which seems reasonable, in one century (i.e. in 2110) annual production would have to be multiplied by 7. Aggregate consumption of material will be 320 times our current consumption. Assuming this will happen with a 'recycling ratio' of 62%, which is a very high level by any standard, the aggregate extraction of virgin material will still be 147 times our current consumption.

To get a sense of the order of magnitude, steel is far and away the material which is subjected to the most recycling worldwide**. And yet the present recycling rate of 62% is only saving humanity less than 100 years before iron becomes scarce**.

When studying such a stock we must understand the notions of Reserves and Resources and be equipped to respond to the type of "industrialist" argument illustrated below and extracted from an industry report[25]:

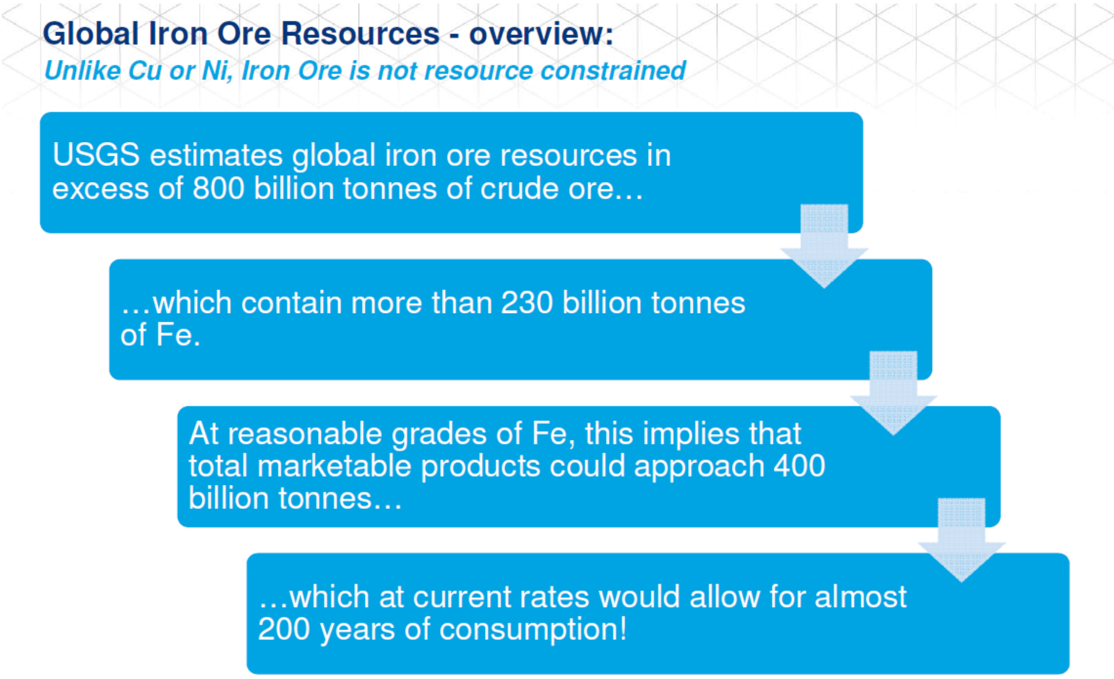


Figure 12 - Example of industrialist argument downplaying the depletion of non-renewable resources

- '**Reserves**' which is the known Iron Ore deemed *economically viable*: 85 billion tons have been permanently identified. This quantity has remained relatively constant over the past decade because prospection to open new mines has kept going as extraction has progressed.
- '**Resources**' which is the ultimate quantity of Iron available for extraction on Earth: it is currently estimated at around 230 billion tons. It is the 'resources' that

[25] Wood Mackenzie, 2016: Global Iron Ore Resources – Current Status & Market Outlook

physically limit how much Iron we will ultimately be able to extract: we cannot extract more than the amount of available resources.

Once understood those notions, it becomes obvious that while the resources are higher than the identified reserves, those resources diminish as extraction progresses until the system reaches the point where new prospection cannot uncover new reserves and further extraction eats into the final resources, to the point of total depletion.

To get a sense of the magnitude, taking the example of Oil, Shell estimates that it is the equivalent of 4 Saudi Arabia we must find in just 10 years to keep the reserves at expected levels. That is nothing less than half of the current global production.

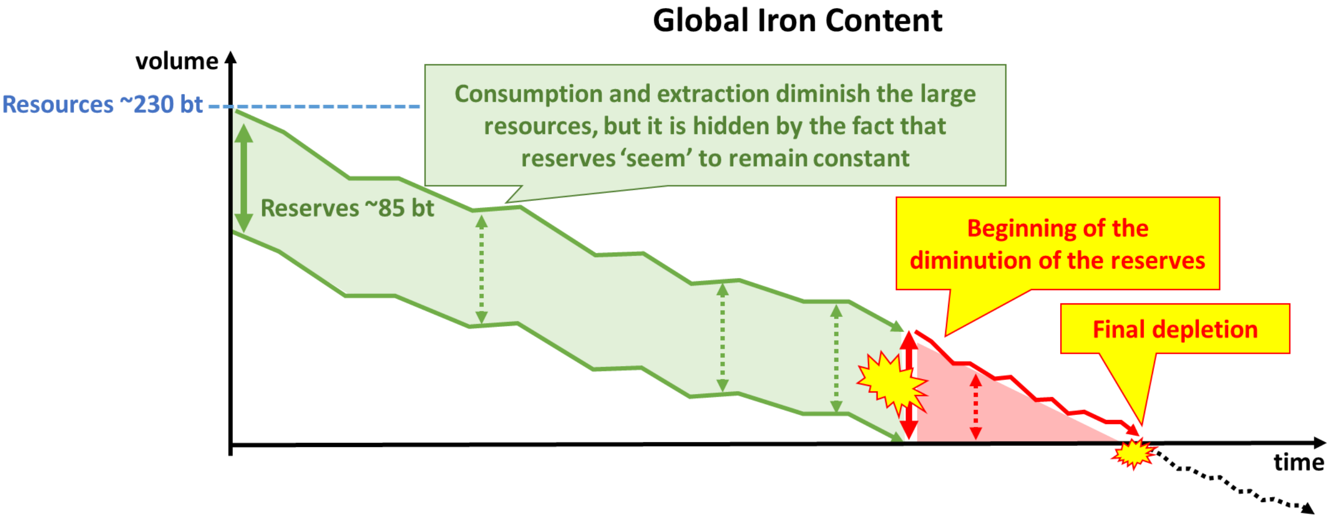


Figure 13 – Schematics illustrating the combined depletion of reserves and resources

Using our model to estimate how much time we have before the current resources of Iron get totally depleted

Francois Grosse's model can be pushed further to **estimate how many years we have before the current resources of Iron get depleted**.

To do so, we need to use some formalism to distinguish the mass of *virgin* material *extracted* every year, from the mass of material *consumed* every year - the difference between those two value being equal to the recycled material:

- **u_n**: mass annual consumption of material on year 'n'. The material can either be recycled or virgin (i.e. recently extracted). This represents how much iron we consume to build stuff on a given year 'n'.
- **U_n**: mass *aggregate* annual consumption of material on year 'n'. This is the *accumulation year after year* of the iron consumed as per the previous measure. It is either virgin or recycled. In other words, it is much iron we have been consuming in 'n' years from year '0' to year 'n'.
- **v_n**: mass annual consumption of virgin material *extracted* on year 'n'. Because it measures the extraction, the v_n quantity is independent of whether the iron is recycled or not: it simply measures how much iron we dig from the ground on a

given year ‘n’.

- $\mathbf{V_n}$: mass *aggregate* consumptions of virgin material *extracted* on year ‘n’. This is the *accumulation year after year* of the iron extracted as per the previous measure. It is either virgin or recycled. In other words, it is much iron in total we have been digging from the ground in ‘n’ years from year ‘0’ to year ‘n’.

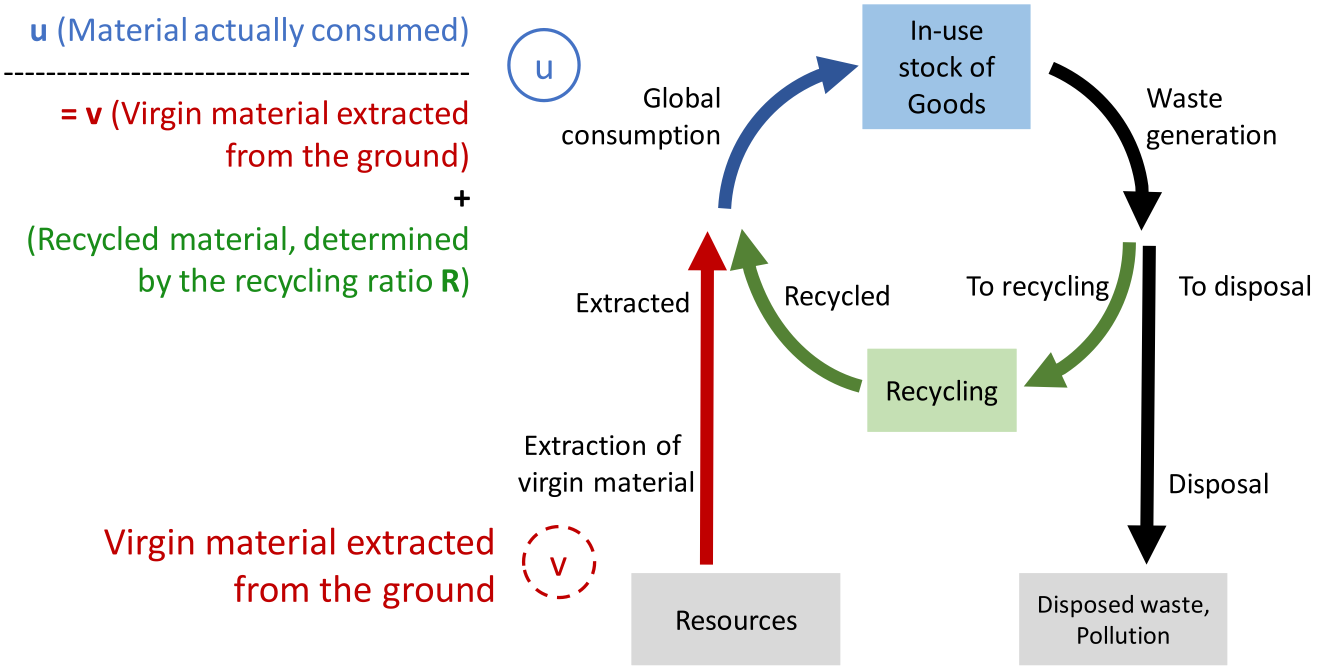


Figure 14 – Formalisation of the recycling model

With this formalism, **if the ultimate amount of available virgin iron resources available in the ground is VR (Virgin Resources = 230 Bt for Iron), it is also the “thermodynamic” limit on matter set by the ecosystem**: i.e. we cannot extract more virgin material than $\mathbf{V_R}$.

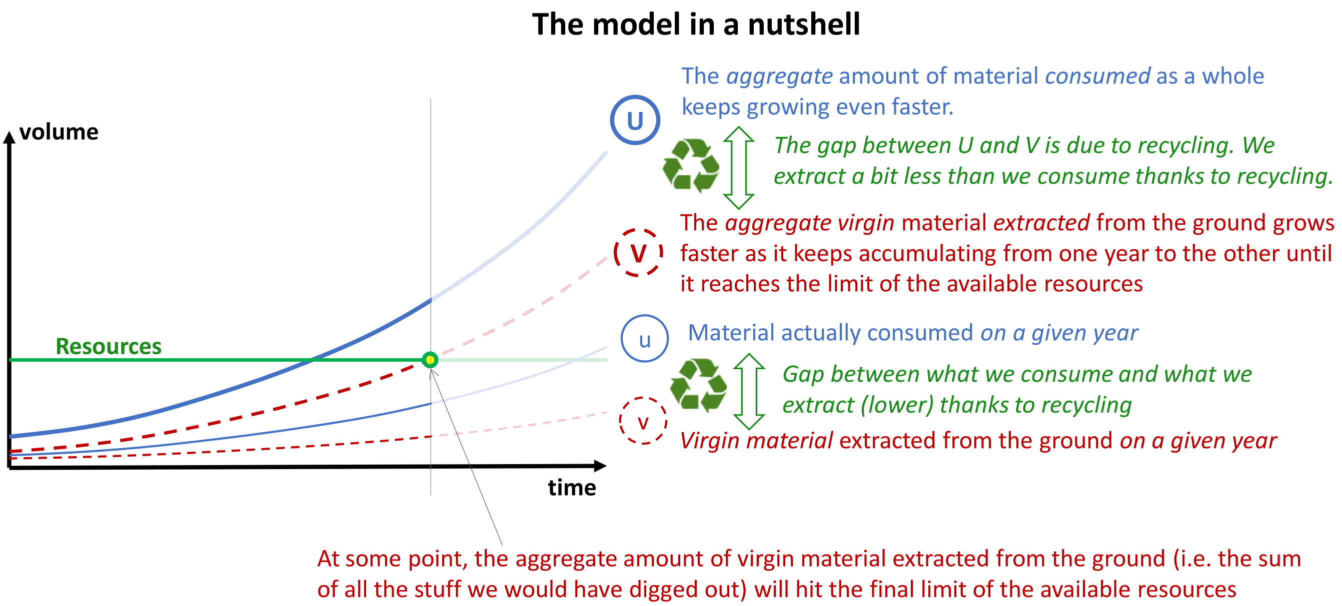


Figure 15 – Illustration of the growth in consumption and extraction of virgin material despite recycling

This model allows draw **several hypothetical scenarios to help us understand the patterns of growth, degrowth, depletion and stabilisation.**

For a given recycling ratio **R**, and a given time in residence **rt**, we can model how the ultimate amount of virgin material extracted from the ground $\mathbf{v_n}$ on year n varies and how long it will take to reach the final limit of **VR = 230 Bt of Iron.**

The current situation in the Iron Ore industry provides the initial parameters that we can then extrapolate and simulate: current global extraction of Iron (v_0) was 3.3 Bt in 2016, our current Recycling Rate of Iron is R=62%, and we can estimate of global consumption of Iron in 2016 (u_0) at 8.6 Bt.

We can therefore use this model to draw 4 main scenarios leading to either growth or degrowth

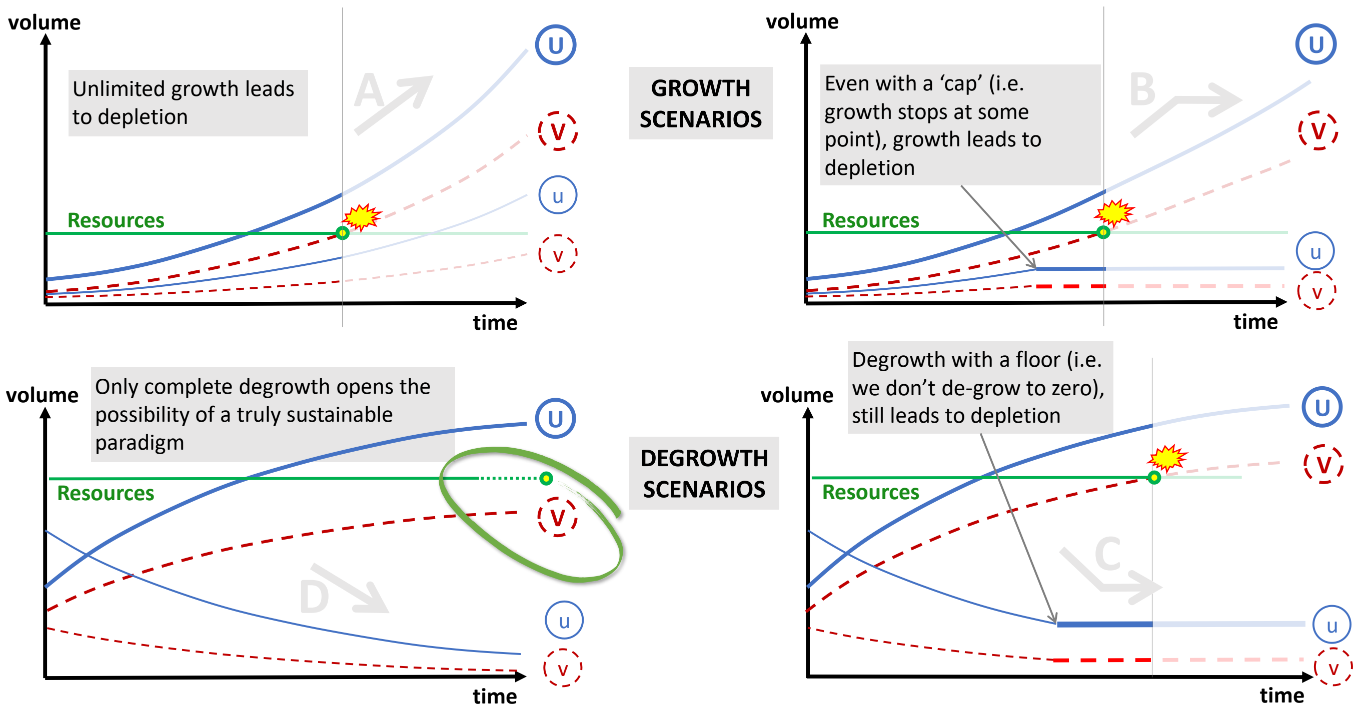


Figure 16 - Summary of the scenarios in 4 main cases (graphs are not to scale)

Scenario A: We can assume current levels of recycling (R=62%), the same level of residence time of 7 years, and a growth rate of 1% and 3% respectively (in line with the current situation): it will take between 48 years (at 1% growth) and 31 years (at 3% growth) to exhaust all iron resources.

Scenario B: We assume that we grow at 1%, and then we maintain a plateau of consumption once we have reached 150% of the current levels experienced in 2016. In practice, it would mean giving us a few more years to curb growth, and then staying at the levels of consumption we will have reached. In that case, it will take 44 years to deplete iron resources (in this scenario we still consider the same level of residence time of 7 years).

Scenario C: We show that with a -1% degrowth in consumption of material, with the current level of recycling (R=62%) we can delay depletion by 152 years.

Scenario C: This scenario is based on a -1% degrowth in consumption of material and the current level of recycling (R=62%). However, we moderate it with the assumption that we do not believe in a complete degrowth path: iron consumption drops from the current level (8.6 Bt per year) to 50% of this level, and then stays stagnant. In doing so, we delay depletion by 120 years but can never reach a sustainable paradigm: the aggregate amount of extracted virgin material ends up hitting the threshold imposed by limited resources. The reason is that resources being finite, even with a relatively low level of extraction, the 'aggregate consumption' will always end-up eating up all those available resources.

Scenario D: We show that by pushing recycling just a little from R=62% to R=69%, still with a residence time of 7 years, and with a **continued degrowth of -1%** we now never reach depletion. In that case **the ultimate aggregate amount of extracted virgin material is V = VR = 230 Bt of Iron**, just the resources available on Earth. **This is the break-even point.**

Only a degrowth in extraction can lead to a sustainable scenario

- It is **only if the growth rate of extraction is lower than 1% AND we have very high levels of recycling (more than 60 to 80%) that we can delay significantly the depletion rate of natural resources**. "Significantly" means that we push the resolution of the problem to the next century and future generations.

- **It is only if growth becomes negative (i.e. we effectively switch to degrowth) that we can reach a truly sustainable paradigm**.

Our modelling shows that we can deliver a paradigm that is truly sustainable in the long run if the growth rate is negative - even slightly - to reach a limit V of aggregate extraction that is below the available reserves V_R = 230 Bt of Iron.

The special case where total raw material needs are entirely met by recycling

This special case worth highlighting is when the **Recycling Rate 'R' is such that there is exact equality between recycled products and total raw material needs**. It corresponds to a scenario where we consume less and less year-on-year, to reach a state where what is consumed is entirely satisfied by the recycling of already extracted stock.

It is illustrated by the following simulations:

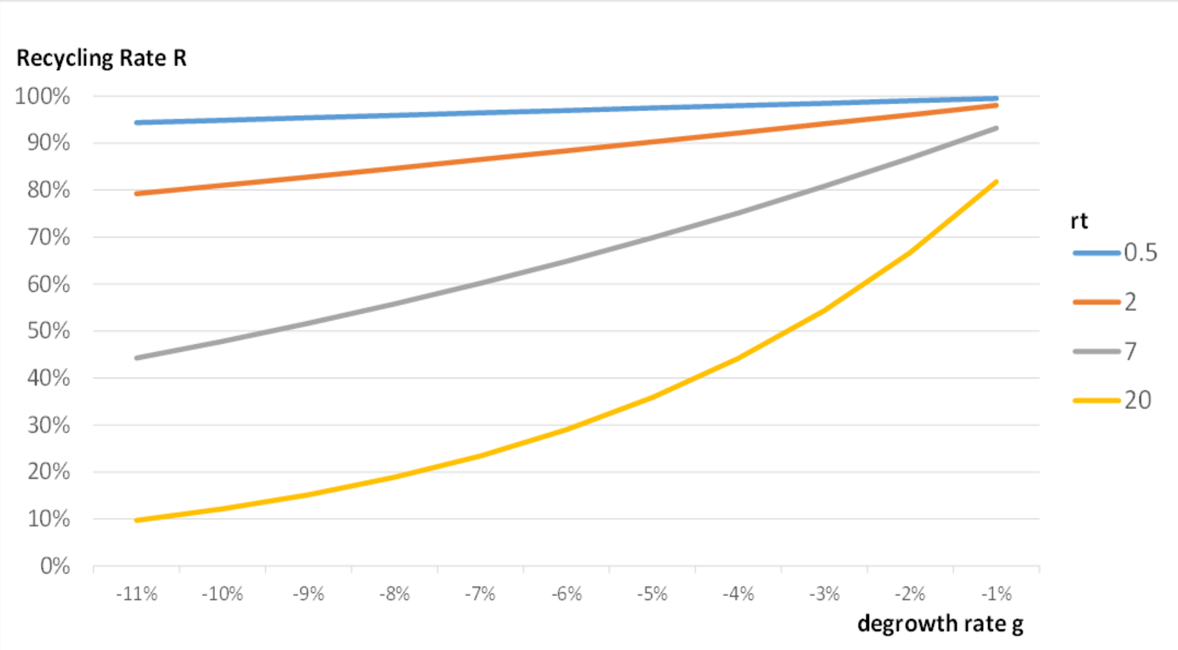


Figure 17 – Link between degrowth and recycling rate when there is exact equality between recycled products and total raw material needs

- Taking the example of a residence time of 7 years (which is typically the case for common metals like steel), a degrowth rate of -1% requires 93% recycling, while -5% requires a recycling ratio above 70%.

- It confirms the extreme sensitivity of the pace of raw material needs. In particular, it really makes the link with the positive effect of a **freeze of planned obsolescence** (i.e. a higher **rt**) in a degrowth paradigm

Finally, we must really remember that the "**growth**" and "**degrowth**" terms are about material growth, i.e. about extraction of raw material resources. We are not talking about GDP degrowth, or degrowth in the standard of living. **We are talking about the degrowth of the extractive nature of our system, while maintaining a comfortable standard of living**.

The malign confusion about 'degrowth'

The term "de-growth" is of fairly recent origin and most widely discussed in France ("**décroissance**") over the past decade, though the concept has been around in various forms since the industrial revolution.

To be clear, the need for 'degrowth in material consumption' highlighted by the above model is absolutely not about advocating a return to the stone age. **It is about replacing the current techno-industrial logic that creates dependency and vulnerability, by autonomy**.

Once again Nicholas Georgescu-Roegen provides us with the right words to frame the argument:

> "The problem of the economic use of the terrestrial stock of low entropy is the main problem for the fate of the human species. To see this, let **S** denote the present stock of terrestrial low entropy and let **r** be some average annual amount of depletion. If we abstract (as we can safely do here) from the slow degradation of **S**, the theoretical maximum number of years until the complete exhaustion of that stock is **S/r**. This is also the number of years until the industrial phase in the evolution of mankind will forcibly come to its end. Give the fantastic disproportion between **S** and the flow of solar energy that reaches the globe annually, it is beyond question that, even with a very parsimonious use of **S**, the industrial phase of man's evolution will end long before the sun will cease to shine. What will happen then (if the extinction of the human species is not brought about earlier by some totally resistant bug or some insidious chemical) is hard to say. Man could continue to live by reverting to the stage of a berry picking species as he once was. But, in the light of what we know about evolution, such an evolutionary reversal does not seem probable. Be that as it may, the fact remains that the higher the degree of economic development, the greater must be the annual depletion r and, hence, the shorter becomes the expected life of the human species.
>
> The upshot is clear. Every time we produce a Cadillac, we irrevocably destroy an amount of low entropy that could otherwise be used for producing a plow or a spade. In other words, every time we produce a Cadillac, we do it at the cost of decreasing the number of human lives in the future. Economic development through industrial abundance may be a blessing for us now and for those who will be able to enjoy it in the near future, but it is definitely against the interest of the human species as a whole, if its interest is to have a lifespan as long as is compatible with its dowry of low entropy. In this paradox of economic development we can see the price man has to pay for the unique privilege of being able to go beyond the biological limits in his struggle for life."

So, 'de-growth' is really about prioritizing the way we chose to degrade entropy. To reduce it to the degrowth of GDP or of our standard of living is a mistaken caricature. Instead, what is enunciated in this section is the **second pillar for the Peer Paradigm argument** (after the first pillar about agro-ecology): it might seem like a tautology but **the only way to materially curb the effect of exponential growth rates on non-renewable resources, is… to seriously limit the growth of their extraction**. What might have sounded like a flippant or radical political remark for years is actually pure science and maths. And because "seriously limiting growth" by using draconian rationing measures is not an appetizing political or social prospect, Peer Collaboration around managing the Commons is the way to make it happen in a palatable manner.

A SHIFT TO 100% RENEWABLE ENERGY GLOBALLY IS FEASIBLE TODAY

A third important category after **renewable** and **non-renewable matter** detailed in the previous sections, is the **energy** domain. It is important to highlight that energy is subordinated to those previous sections: the amount of energy we use is predicated on our life styles and how we consume materials.

***Key point**: This section which would have still been seen as a challenge just a few years ago, has now turned very straight forward: the number we are after is simple. It's 100% of renewable energy which we know is now possible. Of course, 100% of renewable energy needs to be put in context, in terms of the type of society we aspire to: i.e. its level of industrialization. If there is one thing of which we can be very confident, it is that a renewable energy transition will test humanity's collaboration capacities like never before. This is a situation that, in one way or another, will affect and involve every facet of society and is highly political in nature.*

It is of course absolutely established that 100% renewably powered societies are feasible, by the simple fact that viable non-industrial societies existed over the vast majority of our species' existence. The present challenge is whether renewable energy technologies can support societies and economies functionally equivalent to those in place today.

Whist feasibility assessments need to be subjected to careful critical scrutiny - including those listed in this report - the positive answer is given by the plethora of studies outlining both the feasibility of using 100% renewable energy to power the modern world, as well as roadmaps to reach that target. It has even become reality in certain geographies. To cite a few:

Denmark's wind turbines produce 40% of its energy needs. On some windy days in 2015 Denmark produced as much as 140% of its domestic needs and the excess was exported.

Lower Austria, Austria's largest state announced this year that it had achieved a goal of 100% renewable power by harnessing the power of the Danube, and supplementing that hydropower with solar and biomass. It now runs carbon free.

Costa Rica ran on 100% renewable energy for 300 out of 365 days in 2015. Almost all of the country's infrastructure and utility energy is provided by hydroelectric and geothermal power, although the country still has about two million cars driving around using gas.

So instead of repeating arguments that have now made it to the mainstream, the following section highlights a few handpicked studies that stand-out in their analyses of our energy balance sheet, and show that we can live on renewable sources to produce the energy our societies need.

The renewable energy vision in a nutshell

On top of **shifting the nature of the energy production** from non-renewable to renewable sources, the idea is also to **reduce the amount of energy consumed** globally. To appreciate the order of magnitude of what is targeted, it can be useful to refer to the **'2000-watt**

society' vision[26] and understand that our goal is to shift from a 17,000-watt society to a 2,000-watt society.

The '2000-watt society' is an environmental vision, first introduced in 1998 by the Swiss Federal Institute of Technology in Zürich (ETH Zurich), which pictures the average First World citizen reducing their overall average primary energy usage to no more than 2,000 watts (48 kilowatt-hours per day) by the year 2050 – and without lowering their standard of living. 2000 watts is approximately the current world average rate of total primary energy use. This compares to averages of around 6,000 watts in western Europe, 12,000 watts in the United States, 1,500 watts in China, 1,000 watts in India, 500 watts in South Africa and only 300 watts in Bangladesh. Switzerland itself, currently using an average of around 5,000 watts, was last a 2000-watt society in the 1960s.

Stanford Professor Mark Jacobson's energy roadmap

The latest of such energy research comes from Stanford University where Mark Jacobson [27]outlined roadmaps for 139 countries, including the world's major greenhouse gas emitters, to switch to 100% clean, renewable energy generated from wind, water and sunlight for all purposes by 2050. 'All purposes' means that their plan not only looks at residential electricity as most studies do but also encompasses transport, commercial and industrial sectors.

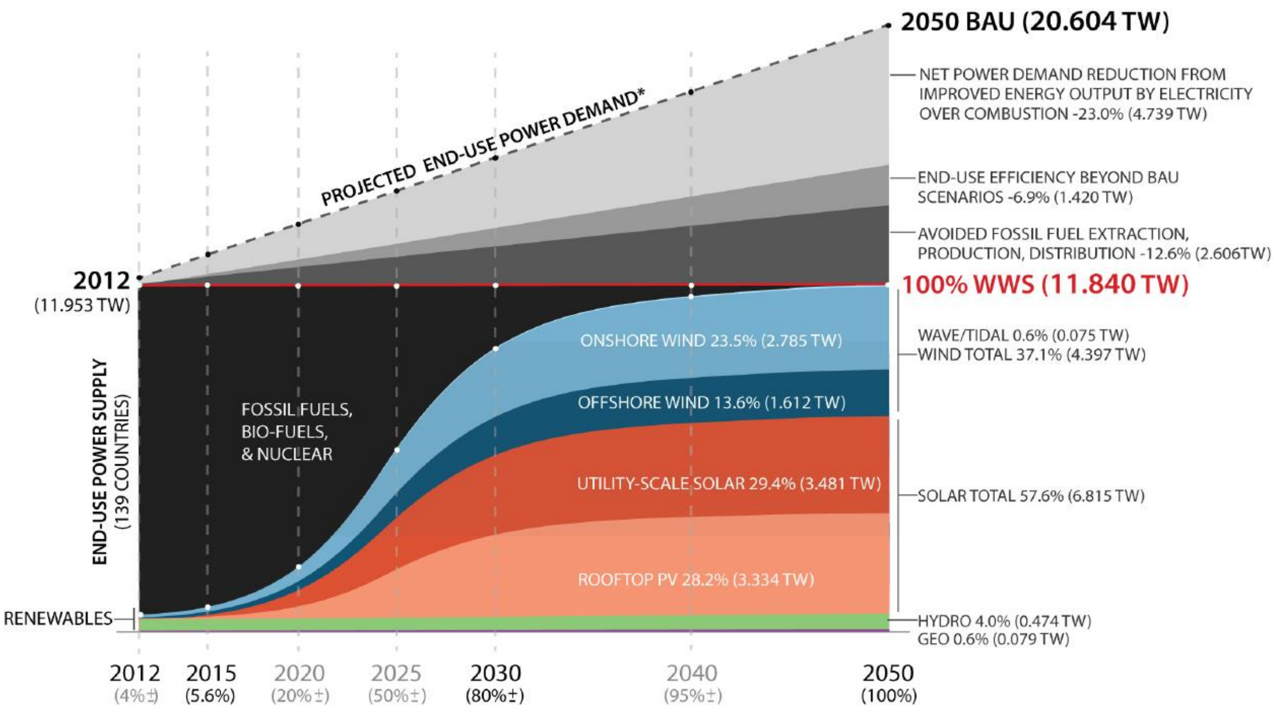


Figure 18 – Projected global power demand as a result of Mark Jacobson's scenario

[26] The 2000-watt society: https://en.wikipedia.org/wiki/2000-watt_society

[27] Mark Jacobson's study: 100% Clean and Renewable Wind, Water, and Sunlight (WWS) All-Sector Energy Roadmaps for 139 Countries of the World: http://web.stanford.edu/group/efmh/jacobson/Articles/I/CountriesWWS.pdf

Not only would 100% of the world energy be renewable, but their plan would reduce global energy consumption by 42%, mainly because of the cosmo-localisation of energy production which will eliminate the need to extract, transform and transport it.

Jacobson and his colleagues found that future costs for producing clean energy are similar to a business-as-usual scenario of about 11 cents per kilowatt hour, similar to the average cost in America today. The air pollution and climate costs due to fossil fuels, however, are virtually eliminated by clean-energy technologies. The benefits range from business (job creations) to public health (a significant drop in disease created by pollution). It would also stabilise energy costs, thanks to free fuels such as wind, water and the sun; reduce geopolitical/terrorism risk by distributing energy/electricity generation; and eliminate the overwhelming majority of heat-trapping emissions that contribute to climate change.

The researchers also calculated that just 0.3% of the world's land footprint would have to be devoted to energy production under a 100% clean energy scenario. That land footprint would less than the size of Madagascar.

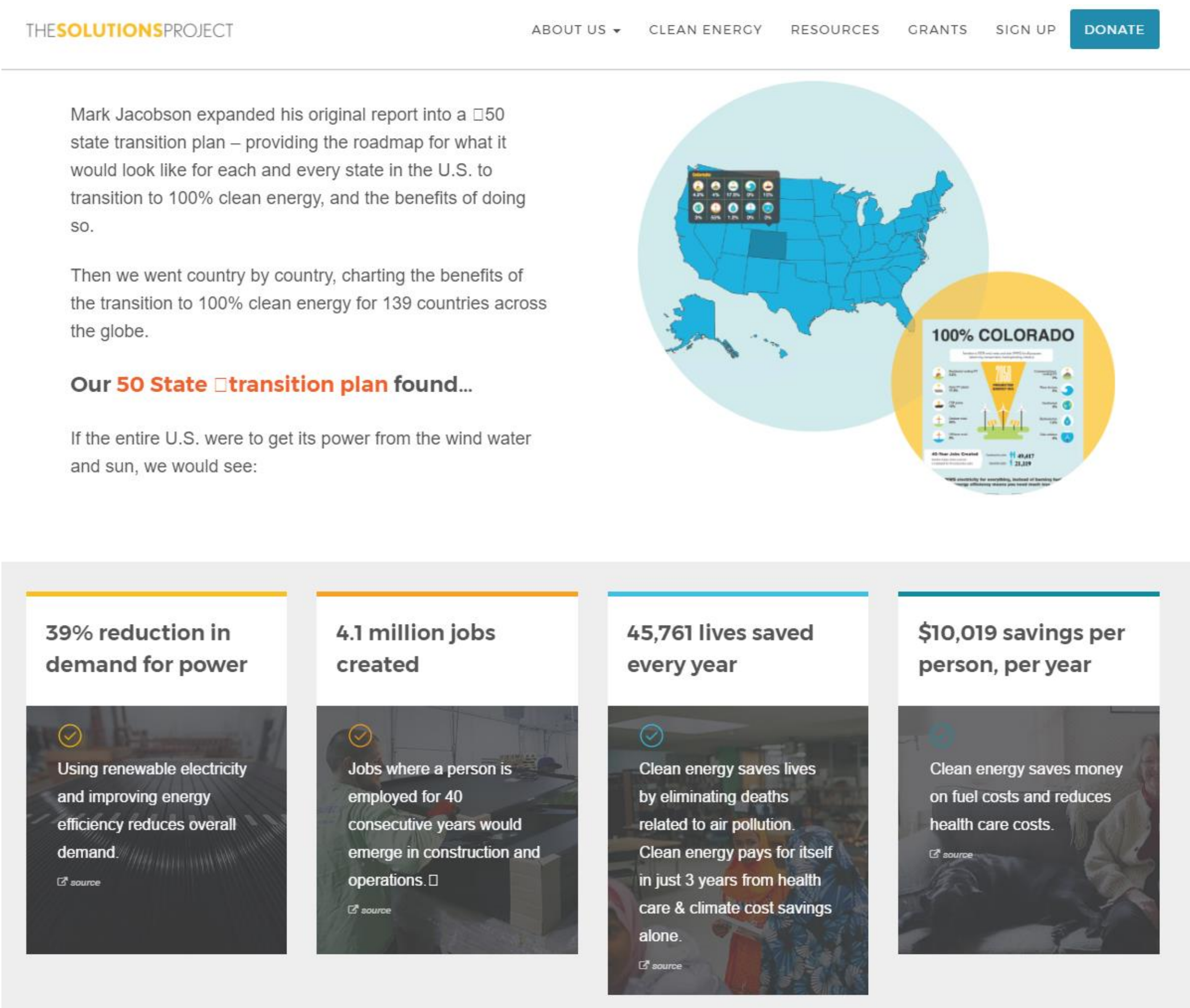


Figure 19 – thesolutionsproject.org

'**The Solutions Project**[28]'was conceived as an organization in 2011 to promote the result of this academic research and to push the "50 States 50 Plans" initiative: plans developed for each of the 50 United States specifying the precise mix of renewable energy types that, given factors such as geography and climate, would allow that particular state to receive all of its energy from renewable sources by 2050. The organization defines renewable energy as solar power, wind power, hydroelectric power, geothermal energy and wave/tidal power.

The NEGAWATT manifesto published[29] in France

The 'négaWatt 2050 scenario' is an energy scenario for France based on proactive energy sufficiency and efficiency efforts, leading to a 65% cut in primary energy consumption by 2050 compared to 2010. It is about making 2/3 of the way towards a truly sustainable society while still maintaining a high level of energy services for heating, transports, and specific electricity needs.

The 'négaWatt collective' has been building up a body of work modeling energy transition scenarios for France. Their goal is to address environmental risks (climate change, biodiversity loss…), technological risks (e.g. nuclear accidents), and dependency on foreign resources, and are based on three main pillars:

[28] The Solutions Project: http://thesolutionsproject.org - https://en.wikipedia.org/wiki/The_Solutions_Project

[29] NEGAWATT manifesto: https://negawatt.org/Manifeste-negawatt

Pillar 1 - Sufficiency: reducing the overall need for energy-using services, through better sizing, using, and sharing equipment, better organising land and society, etc.

Pillar 2 - Efficiency: avoiding as much energy losses as possible all along the chain in the way energy services are provided, through improved equipment, buildings, and vehicles.

Pillar 3- Renewables: prioritising green energies for supplying the remaining energy demand.

The négaWatt 2050 scenario is underpinned by key points pertinent well beyond France:

Point #1. The energy consumption trend has already reversed in the western world: Energy consumption has diminished in OECD countries for several years[30]. In France, the demand curve is now close to the one already envisaged by négaWatt in 2003. The country's greenhouse gas emissions have declined, not only nationally but also considering those emissions embedded in imported goods: the trend is not just due to the economic crisis or offshoring, it is structural and not just temporary.

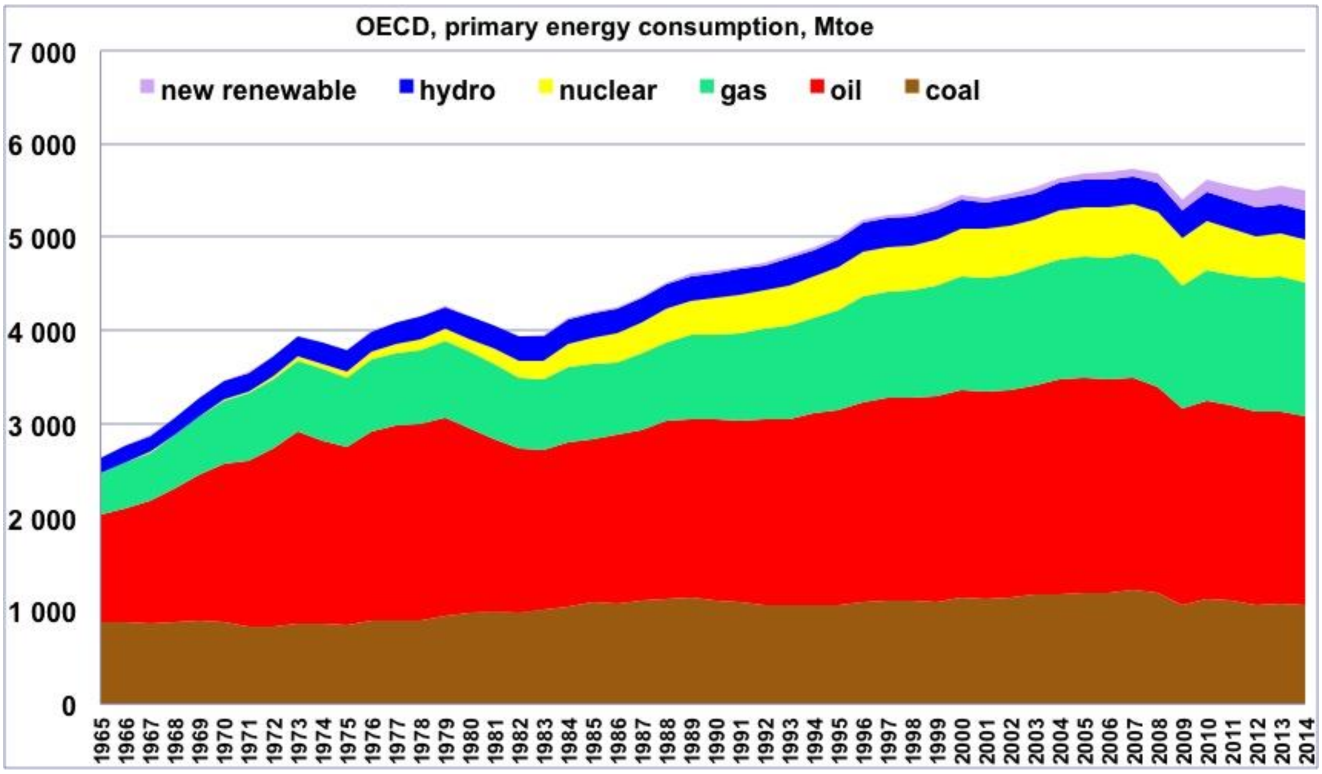


Figure 20 – OECD primary energy consumption (1965-2014)

Trends confirm the well-known **dichotomy between the OECD countries that have been changing their industrial paradigm now that their industrial revolution is well over**, and

[30] The decrease in energy consumption is incured – for instance in Europe – but not chosen nor managed (« la baisse de la consommation d'énergie est subie – ce qui est désormais le cas de l'Europe – et non gérée ») https://jancovici.com/transition-energetique/choix-de-societe/peut-on-concilier-energie-en-baisse-chomage-en-baisse-et-fiche-de-paie-en-hausse/

developing countries that must find ways to do their industrial revolution without repeating the mistakes made in the OECD world in the past century.

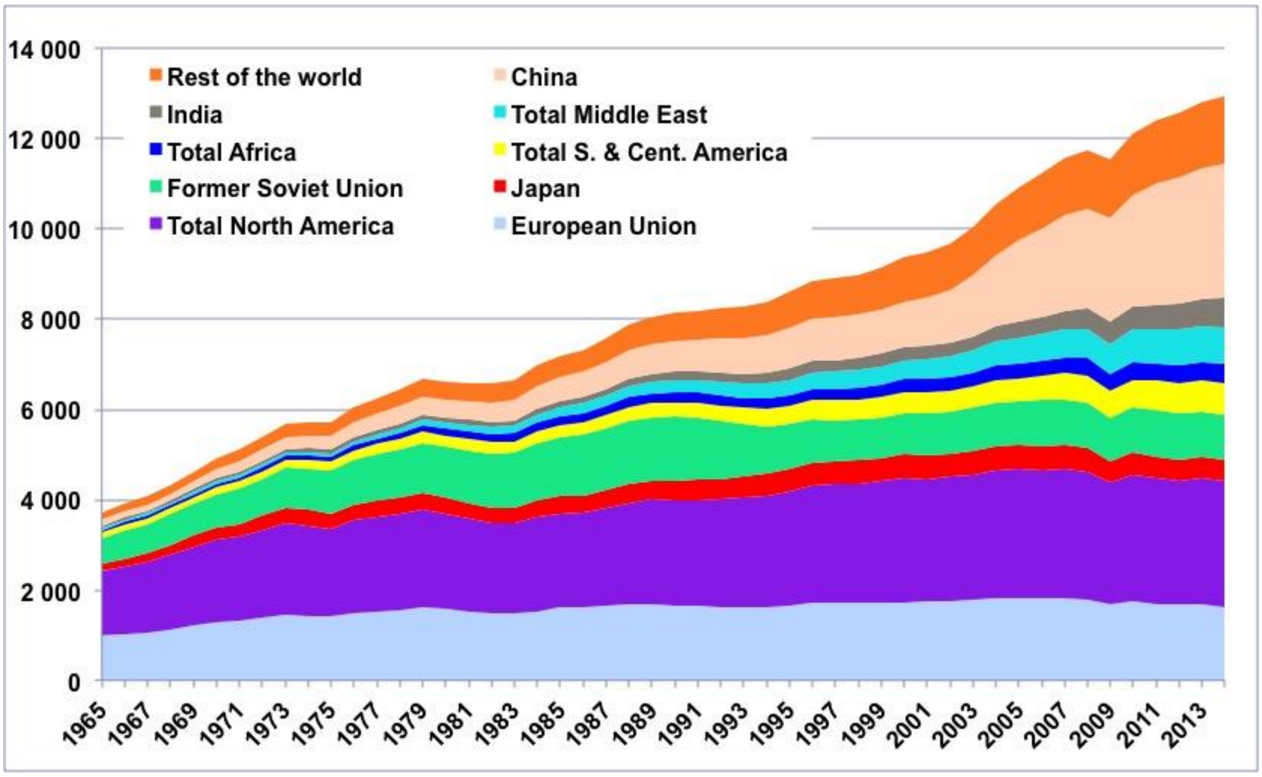


Figure 21 – OECD vs developing countries: Global primary energy consumption – wood excluded (1965-2014)

Point #2. Sufficiency and efficiency play a key role for the energy transition: The négaWatt scenario models the implementation of energy sufficiency and efficiency actions in all sectors (buildings, transports, industry). It leads to a potential halving of the final energy consumption by 2050, while still ensuring a high level of energy services.

Point #3. The possibility to reach a 100% renewable future is confirmed: All remaining energy needs can be supplied by renewable energy sources by 2050. Solid biomass is the top contributor, closely followed by wind, then solar and biogas. This allows to progressively shut down the country's nuclear reactors with no life extension over 40 years. The last one would terminate in 2035.

Point #4. Net zero emission in 2050 ensuring a carbon-neutral France: Combined with the 'Afterres2050' scenario developed by the 'Solagro association'[31] on agriculture, food and land use, the négaWatt scenario reaches a level where remaining greenhouse gas emissions (mostly from agriculture) are fully offset by national carbon sinks. With this scenario, the amount of carbon in soils would flatten, and carbon sink potentials would finally diminish over 2050-2100, leaving open the issue of further action.

Point #5. The complementarity between gas and electricity is essential: By 2050, they may represent more than 70% of the final energy consumption as liquid fuels go down.

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[31] Scénario Afterres 2050: http://afterres2050.solagro.org/wp-content/uploads/2015/11/Solagro_afterres2050-v2-web.pdf

They should be seen as complementary rather than competitors. The storage of renewable electricity in the form of synthetic methane (power-to-gas[32]) is one of the pillars of the energy future envisioned by négaWatt.

Point #6. Land use has a significant importance: Agriculture and forest management has a major role to play to provide renewable resources, store carbon, and reduce its own greenhouse gas emissions. It justifies the relevance of the négaWatt approach to the food chain: sufficiency in diets, efficiency in production processes, production and use of renewable energy.

'Our Renewable Future' by David Fridley and Richard Heinberg

Our Renewable Future[33] by David Fridley and Richard Heinberg starts from the two competing depictions of society's energy options.

> On one hand, the fossil fuel industry claims that its products deliver unique economic benefits, and that giving up coal, oil, and natural gas in favor of renewable energy sources like solar and wind will entail sacrifice and suffering. Saving the climate may not be worth the trouble, they say, unless we can find affordable ways to capture and sequester carbon as we continue burning fossil fuels.
>
> On the other hand, at least some renewable energy proponents tell us there is plenty of wind and sun, the fuel is free, and the only thing standing between us and a climate-protected world of plentiful, sustainable, "green" energy, jobs, and economic growth is the political clout of the coal, oil, and gas industries.
>
> Which message is right? Will our energy future be fueled by fossils (with or without carbon capture technology), or powered by abundant, renewable wind and sunlight? Does the truth lie somewhere between these extremes—that is, does an "all of the above" energy future await us?
>
> Or is our energy destiny located in a Terra Incognita that neither fossil fuel promoters nor renewable energy advocates talk much about? As maddening as it may be, the latter conclusion may be the one best supported by the facts.
>
> If that uncharted land had a motto, it might be, "How we use energy is as important as how we get it."

This research stands-out for laying the path for a "100% Clean Energy". The significant value of this work derives from three qualities:

---

[32] "Power to gas" is a key concept when it comes to storing alternative energy. This process converts short-term excess electricity from photovoltaic systems and wind turbines into hydrogen. Combined with the greenhouse gas CO2, renewable hydrogen can be used to produce methane, which can be stored and distributed in the natural gas network. Researchers have now succeeded in further optimizing this process.

[33] Our Renewable Future by David Fridley and Richard Heinberg: http://ourrenewablefuture.org/

- it vividly imagines a positive end-state, skipping over the well-known dangers that could be avoided by achieving this state.
- It realistically reduces the challenges to engineering problems, explained in some detail.
- It forthrightly calls for sacrifice in our life styles with less energy per capita.

Fridley and Heinberg's work is also notable for the explicit consideration for the **need of up-front investment before reaching the break-even point where renewables truly deliver efficiencies**.

The key issue is that it takes energy to get energy: for example, energy is needed to drill an oil well or build a solar panel. Only net energy, what is left over after energy investment is subtracted, is actually useful to us for end-use purposes. Sometimes the relationship between energy investments and yields is expressed as a ratio, **Energy Returned On Energy Invested (EROEI)**. For example, an EROEI of 10:1 indicates ten units of energy returned for every unit invested.

The historic economic bonanza resulting from society's use of fossil fuels partly ensued from the fact that, in the twentieth century, only trivial amounts of energy were required in drilling for oil or mining for coal as compared to the gush of energy yielded. High EROEI ratios (in the range of 100:1 or more) for society's energy-obtaining efforts meant that relatively small amounts of capital and labor were needed in order to supply all the energy that society could use. As a result, many people could be freed from basic energy-producing activities (like farming or forestry), their labor being substituted by fuel-fed machines. Channeled into manufacturing and managerial jobs, these people found ways to use abundant, cheap energy to produce ever more goods and services. So the middle class mushroomed, as did cities and suburbs.

The trouble is that the EROEI ratios for fossil fuels are declining as the best-quality resources are used up; meanwhile, the net energy figures of most renewable energy sources are relatively low compared to fossil fuels in their heyday. A practical result of declining overall societal EROEI is the need to devote proportionally more capital and labor to energy production processes.

Incorporating the dimension of time into EROEI analysis adds a layer of complexity, but doing so is essential if we are to **realistically compare energy from flows (solar and wind) with energy from stocks (fossil fuels)**. The great majority of the energy investment into solar panels comes during their manufacture, while the energy return is delivered slowly over the decades of their projected usefulness.

This front-loading of energy investment creates problems if we wish to push the energy transition very quickly. If solar and wind build-out rates are very high, the net energy available from these sources will be smaller during the transition period.

This is what the figure below illustrates: during at least the early stages of the transition, the kinds of energy being invested in building and deploying renewable energy systems (mostly fossil fuels for high-heat industrial purposes and for transportation) will be different from the higher-quality electrical energy yielded from those systems once they have reached maturity.

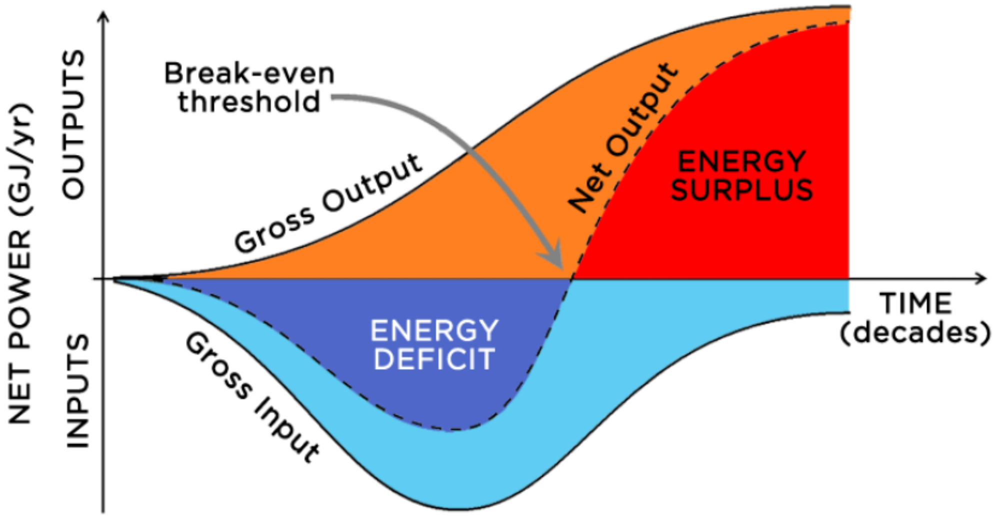


Figure 1.1. Energy input, output, and net power during the build-out of new energy production infrastructure. GJ=gigajoules.
Source: Michael Carbajales-Dale, "Fueling the Energy Transition: The Net Energy Perspective," presentation at Global Climate and Energy Project Workshop on Net Energy Analysis, Stanford University, Stanford, CA, April 1, 2015.

Figure 22 – Illustration of the need for up-front investment before reaching the break-even point where renewables truly deliver efficiencies

Indeed, Fridley and Heinberg explain **how renewable energy technologies currently require fossil fuels for their construction and deployment, so in effect they are functioning as a parasite on the back of the older energy infrastructure. The question is, can they survive the death of their host?**

Fridley and Heinberg detail the transition for 9 selected sectors – in their own words:

> Food: Fossil fuels are currently used at every stage of growing, transporting, processing, packaging, preparing, and storing food. As those inputs are removed from food systems, it will be necessary to bring growers and consumers closer together, and to replace petrochemical-based fertilizers, herbicides, and pesticides with agro-ecological farming methods that rely on crop rotation, intercropping, companion planting, mulching, composting, beneficial insects, and promotion of microbial activity in soils. As mentioned earlier, we will need many more farmers, especially ones with extensive practical, local ecological knowledge.
>
> Water: Enormous amounts of energy are used in extracting, moving, and treating water; conversely, water is used in most energy production processes. We face converging water crises arising from aging infrastructure and climate change-related droughts and floods. All this suggests we must become far more water thrifty, find ways to reduce the

energy used in water management, use intermittent energy sources for pumping water, and use water reservoirs for storing energy.

Resource extraction (mining, forestry, fishing): Currently, extractive industries rely almost entirely on petroleum-based fuels. Since, as we have seen, there are no good and comprehensive substitutes for these fuels, we will have to reduce resource extraction rates, reuse and recycle materials wherever possible, and employ more muscle power where possible in those extractive processes that must continue (such as forestry).

Building construction: Cement, iron, and road-building materials embody substantial amounts of energy, while large construction equipment (cranes, booms, bulldozers) requires concentrated energy for its operation. We must shift to using natural, locally available building materials, and more labor-intensive construction methods, while dramatically reducing the rate of new construction. The amount of enclosed space per person (home, work, shopping) will shrink.

Building operations: We've gotten used to actively heating, cooling, ventilating, and lighting our buildings with cheap, on-demand energy. We will need to maximize our passive capture of ambient, variable, solar energy using south-facing glazing, superinsulation, and thermal mass. Whatever active energy use is still required will employ efficient heat pumps and low-energy LED lighting, powered mostly by solar cells and wind turbines with minimal storage and redundancy.

Manufacturing: Our current system is globalized (relying on oil-based transport systems); consumes natural gas, electricity, and oil in manufacturing processes; and uses materials that embody large amounts of energy and that are often made from fossil fuels (i.e., plastics). Significant energy is used also in dealing with substantial flows of waste in the forms of packaging and discarded products. The economy has been fine-tuned to maximize consumption. We must shift to shortened supply chains, more localized manufacture of goods (shipping information, not products), materials with low embodied energy, and minimal packaging, while increasing our products' reuse and repair potential. This will be, in effect, an economy fine-tuned to minimize consumption.

Health care: The high dollar cost of modern health care is a rough indication of its energy intensity. As the energy transition gains momentum, it will be necessary to identify low-energy sanitation and care options, and prioritize prevention and local disaster response preparedness. Eventually, high-energy diagnostics and extreme end-of-life interventions may simply become unaffordable. Treatment of chronic conditions may rely increasingly on herbs and other traditional therapies (in instances where their efficacy can be verified) as the pharmaceutical industry gradually loses its capability to mobilize billions of dollars to develop new, targeted drugs.

Transportation: The energy transition will require us to prioritize transport modes according to operational and embodied energy efficiency: whereas automobile and truck traffic have been richly subsidized through road building in the last seven decades, governments should instead devote funds toward electrified rail networks for both freight and passenger travel. We must also design economic and urban systems so as to reduce the need for motorized transportation—for example, by planning communities so that most essential services are within walking distance.

Finance: It would appear that comparatively little energy is needed to run financial systems, as a few taps on a computer keyboard can create millions of dollars instantly and move them around the globe. Nevertheless, the energy transition has enormous implications for finance: heightened debt levels imply an increased ability to consume now with the requirement to pay later. In effect, a high-finance society stimulates consumption, whereas we need to reduce consumption. Transition strategies should therefore include goals such as the cancelation of much existing debt and reduction of the size and role of the financial system. Increasingly, we must direct investment capital toward projects that will tangibly benefit communities, rather than leaving capital investment primarily in the hands of profit-seeking individuals and corporations

It is obvious that suggestions in each of these categories are far from new. Organized efforts to reduce **both operational and embodied energy consumption**[34] throughout society started in the 1970s, at the time of the first oil price shocks. Today there are many NGOs and university programs devoted to research on energy efficiency, and to **life cycle analysis** (which seeks to identify and quantify energy consumption and environmental impacts of products and industrial processes, from “cradle to grave”). Industrial ecology, biomimicry, “cradle-to-cradle” manufacturing, local food, voluntary simplicity, permaculture, and green building are just a few of the strategies have emerged in the last few decades to guide us toward a more energy-thrifty future. Most major cities now have bicycle advocacy groups, farmers markets, and energy efficiency programs. These all represent steps in the right direction.

Yet what is being done so far barely scratches the surface of what is needed. There could be only one meaningful indication of success in all these efforts, and that would be a decline in society’s overall energy use. **So far, we have seen energy declines primarily in times of severe economic recession** - hardly ever purely as a result efficiency programs (as shown on figure 20 where we see declines in primary energy consumption after 1973, 1979 and 2007). What we need is not just to trim energy use here and there so as to save money, but to reconfigure entire systems to dramatically slash consumption while making much of the remaining energy consumption amenable to intermittent inputs.

British physicist’s David JC MacKay’s ‘Sustainable Energy without the hot air’[35]

MacKay’s book was published in 2008 and was described as the "Freakonomics of energy and climate". A review by the Economist called it a "tour de force" and an "exemplary"

[34] Embodied energy is the energy consumed by all of the processes associated with the production of a product, from the mining and processing of natural resources to manufacturing, transport and product delivery. Embodied energy does not include the operation and disposal of the material, which would be considered in a life cycle approach. Embodied energy is the ‘upstream’ or ‘front-end’ component of the life cycle impact of a product.

[35] Sustainable Energy — without the hot air: http://www.inference.eng.cam.ac.uk/sustainable/book/tex/sewtha.pdf

work of popular science - and the initial print run of 5,000 evaporated in days before it it broke into the Top 60 bestsellers list on Amazon.co.uk in 2009.

The book's masterstroke is to express all forms of power consumption and production - the car, the washing machine, the wind turbine, the mobile phone charger, the nuclear power station - in a single unit of measurement. So rather than drown readers in a swamp of gigahertz, megawatts, joules, tons of oil equivalent and the like, he describes everything in terms of kilowatt hours per day (kWh/d).

He also anchors his thesis in very practical and tangible examples: starting with a one 40-watt lightbulb, kept switched on all the time, that uses one kilowatt-hour a day. Once we learn that driving the average car 50km a day consumes 40kWh/d, we can see that this is equal to the power needed to keep 40 40W lightbulbs constantly lit for a day. This, MacKay argues, sharpens the debate by helping us to focus on the big things - such as how hopelessly undercooked our current plans for renewable energy are - rather than get distracted by "eco-gestures", such as believing you have done your bit by remembering to switch off the mobile phone charger.

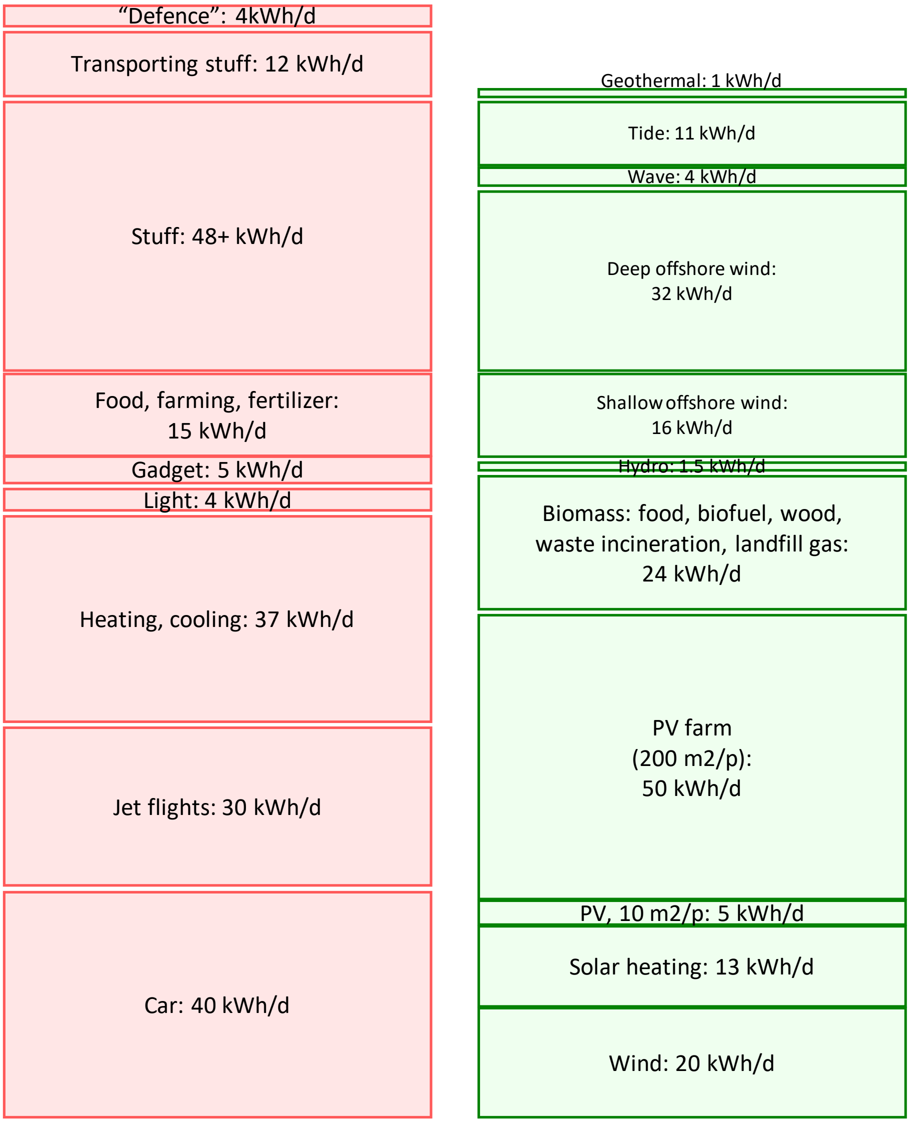
> "The amount of energy saved by switching off the phone charger is exactly the same as the energy used by driving an average car for one second."

David JC MacKay's unique original contribution has been to model a balance sheet of the energy consumption per capita in the UK. To do so he built this balance sheet "bottom up" by estimating and adding up each module on the consumption and renewable production sides.

On the right-hand, green stack, represents the sustainable production estimates for the UK. It adds up to about 180 kWh per day per person. On the left hand, the red stack represents the energy consumption of a "typical moderately-affluent person" in the UK: it adds up to 195 kWh per day per person. A close race.

David JC MacKay's work allows to answer the question "Can the UK conceivably live on its own renewables?"

MacKay estimates that a typical affluent British person consumes 195 kWh per day. The average American consumes about 250kWh per day. So if all UK residents raised their standard of consumption to an average American level, the green production stack would definitely be dwarfed by the red consumption stack.



The state of play after we added up all the traditional renewables

Figure 23 - David JC MacKay's balance sheet of the energy consumption per capita in the UK

However, in the current state, the answer is that the UK can conceivably technically live on its own renewables. While his study is centered on the UK, his conclusions are relevant globally: the really challenge will be the tradeoffs and choices we need to understand and make.

MacKay famously declared that he is neither anti-wind nor pro-nuclear - as some commenters concluded at the time - but, rather, "pro-arithmetic". He admitted, though, that his pragmatic talk of needing to cover an area "the size of Wales" in wind turbines, build 100 nuclear power stations and construct country-sized solar parks in the Sahara, if we are to maintain our "European lifestyles", was going to raise hackles.

> "One coal-fired power station equals 2,000 wind turbines. When we retire a technology, we must know we have made the right choice."

MacKay's legacy is the clear message that we cannot address our energy needs in a sustainable manner, through "half measures" such as "slightly more efficient fossil-fuel power stations".

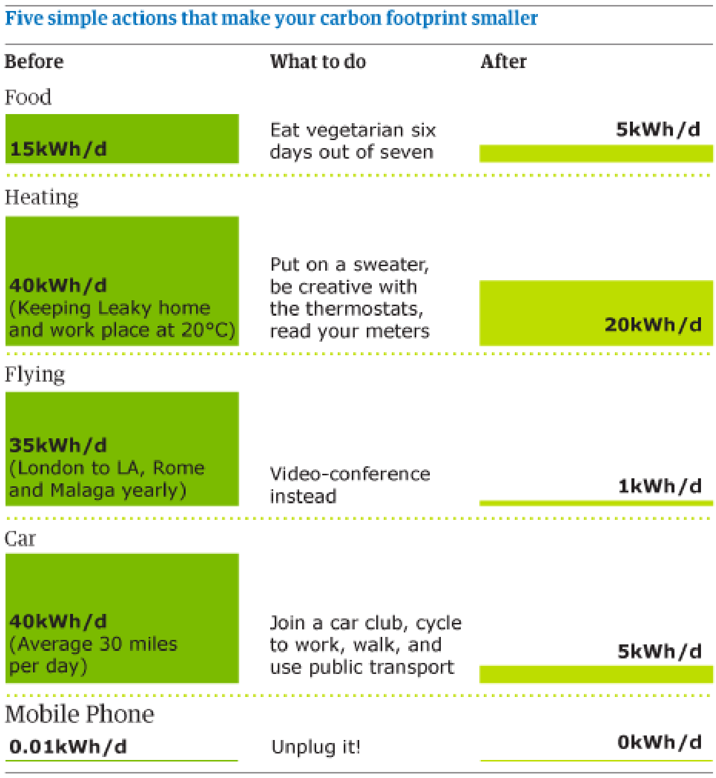


Figure 24 – Illustration of putting energy consumption and corresponding measures into perspective - Source: The Guardian[36]

His work clearly connects the serious problems of **resource shortages**, **climate change** and **economic recession** and demonstrates how the problems are best addressed with corresponding solutions.

Professor Sir David J C MacKay (1967-2016)

[36] David MacKay, Think big on renewables scale https://www.theguardian.com/environment/cif-green/2009/apr/29/renewable-energy-david-mackay

FACED WITH THIS ‘LIMIT OF GROWTH’ IMPOSED BY NON-RENEWABLE MATERIALS, A P2P AND COMMONS PARADIGM PROVIDES A WAY TOWARDS SUSTAINABILITY

Two ecological principles emerge from the previous sections: substitution and reduction

The previous sections show that a necessary condition to envisage a transition towards a commons-based paradigm is to design and follow measures that will deliver substitution as well as reduction of our current extractive practices.

The substitution of non-renewables by renewables

This is made possible with a **cosmo-localised production**, which in practice must belong to the agricultural domain: i.e. unless we all become local miners (which we won't), non-renewable materials must be replaced as much as possible by wood and fibres. Those renewables must also be sustainably regenerated: i.e. their consumption must be compensated by their production. In other words, we're obviously not talking about chopping the Amazon forest just because using wood is good!

With the principle of **cosmo-localisation**, we always **privilege local businesses** who care more about the local environment and trade traceable items, because the success of local businesses depend on the health of the local environment and will favour short-circuits. A trivial example would be that instead of buying a plastic piece of furniture at a multinational chain, we should favour buying locally made furniture out of renewable wood.

The difference with capitalism and this proposed paradigm is to introduce non-economic goals carried out by communities and cooperatives of commoners, supported by institutions like cities: hence the notion of 'partnering State' and the often quoted example of 'cities in transition' movement.

The difference with pure-localists and this proposed paradigm is to rely on open design and global knowledge. Contrary to ancestral tribes that also functioned in sharing-mode, those contemporary communities are not restricted by geographies. Because they leverage a global system, the diffusion of knowledge is made possible by global networks and communities. **Belonging to communities is polymorphic**, which means that one can belong to several communities at the same time.

The effective diminution of extraction through the mutualisation of infrastructures and circular economy

It is this objective of '**mutualisation of infrastructures**' that gave the initial impetus to the mainstream 'collaborative and sharing economy' and the **Circular Economy** analyzed by the **Ellen MacArthur Foundation**[37], even if the majority of current models like Uber and AirBnb hijacked the original principles of the 'sharing economy' and have become hyper-capitalist caricatures of the 'selling economy'. Largely because large platforms used free

[37] The Circular Economy analysed by the Ellen MacArthur Foundation: https://www.ellenmacarthurfoundation.org

labour to their benefit under the pretense of 'collaboration'.

This simply reinforces the lessons highlighted by Ostrom: the need for rules and for a systemic political project. The initial principle of mutualizing to lower collective consumption is more relevant than ever, but only when put in practice with a '**Commons**' approach and '**praxis**'[38].

However, do those principles applied to agriculture, non-renewable materials and energy make a system? Are they sufficient?

The short answer is "Yes, but… it will require a significant material change".

The notable work of French PhD François Briens[39] shows how shifts in our modes of consumption can achieve truly sustainable goals, and also emphasizes how radical they must be to succeed.

***Key point**: French PhD at the prominent 'Ecole des Mines[40]', **François Briens** proposes a ground-breaking macro-economic model of a degrowth paradigm for France. His work stands-out because he focuses on what we want to achieve, and why.*

"*La Décroissance au prisme de la modélisation prospective: exploration macroéconomique d'une alternative paradigmatique - Degrowth through the prism of prospective modelling: a macroeconomic exploration of a paradigmatic alternative*"[41] uses the French National Accounts to model bottom-up what a radical shift in our modes of consumption would look like at horizon 2060.

Donella Meadows, lead author of the Limits of Growth

The merit of his original and extremely granular work is to starts by positioning his argument in the context of the political ecology and the theoricians of the degrowth movement (i.e. Herbert Marcuse, Donella and Dennis Meadows, Ivan Illich,

[38] Praxis: established custom and practice. See Dardot et Laval, COMMUN: http://www.editionsladecouverte.fr/catalogue/index-Commun-9782707169389.html

[39] La Décroissance au prisme de la modélisation prospective : Exploration macroéconomique d'une alternative paradigmatique: https://pastel.archives-ouvertes.fr/tel-01305956

[40] École des mines de Paris, also known as MINES ParisTech: https://en.wikipedia.org/wiki/Mines_ParisTech

[41] *Idem*

etal[42]). In fact Briens' work is underpinned by a very detailed and rigorous mathematical model which echoes the minutiae of the **World3 model**[43] used by the authors of the Meadows Report to simulate the consequence of interactions between the Earth's and human systems.

Briens proposed a projection to illustrate and quantify through economic and environmental indicators what a "degrowth" society would look like. To do so he interviewed various experts advocates of a more sustainable system, and translated their qualitative hypotheses into quantified assumptions about the energy, pollution and extraction impacts.

Taking France as his case study and working at the National Accounts level Briens was able to formulate hypotheses as granular as food consumption, clothing, housing, household goods, furniture, or health spending. He then quantified what those hypotheses mean in terms of lesser energy consumption, lesser wastes, lesser extraction: these are **the outputs**, i.e. the ultimate objectives.

This work led him to paint the picture of radically more frugal modes of consumption. It shows that only a major shift of our life style can be impactful and material on the sustainability and durability of resources. He joins Francois Grosse in the conclusion that we cannot escape a form of material degrowth in order to materially move the dial.

It is important to understand what 'materially moving the dial' entails.

To give a sense of the order of magnitude, we are for instance talking about shifts such as:

- reusing up to 90% of our furniture,
- dividing white goods and house equipment by 10,
- divide plastic packaging by 20,
- transitioning to 100% of renewable electricity,
- reaching zero food waste at consumption level.

What is striking with this work is the apparent enormity of the measures it implies.

One mislead way to respond to it would be to dismiss it as pure fantasy born out of the brain of an eco-warrior.

Another way to appreciate this work is to understand its clear message: if we want to drop energy consumption by around 75%, which is roughly the level required to be

[42] Herbert Marcuse: https://en.wikipedia.org/wiki/Herbert_Marcuse, Donella Meadows: https://en.wikipedia.org/wiki/Donella_Meadows, Dennis Meadows: https://en.wikipedia.org/wiki/Dennis_Meadows, Ivan Illich: https://en.wikipedia.org/wiki/Ivan_Illich

[43] The World3 model is a system dynamics model for computer simulation of interactions between population, industrial growth, food production and limits in the ecosystems of the Earth. It was originally produced and used by a Club of Rome study that produced the model and the book The Limits to Growth. The principal creators of the model were Donella Meadows, Dennis Meadows, and Jørgen Randers. https://en.wikipedia.org/wiki/World3

sustainable, we have no choice but to reinvent our patterns of consumption and the practices governing our society. If we chose not to do so, we will simply not deliver the sustainability we aspire to. It is that straight forward.

To be clear, this is not about a moral judgment on the validity of 'degrowth', or the need or desire to pursue our current industrial and capitalist paradigm; it is a matter of pure objective facts and science.

The means and ways to reach those objectives will be a matter of political willingness and principles

No matter how granular and sophisticated studies are, no matter how socially motivated we are, no macro-economic indicators can tell us *how* to reach this frugal state in practice.

To put it bluntly, we are not going to wake-up one day suddenly all frugal and parsimonious within our current patterns of consumption. It is something that will be built one step after the other through practice. It will happen by trying thousands of options like the various versions of the **Open Food Networks**, or **participatory initiatives at the city level**. To list of those solutions is a task bigger and larger than this study, and one that the P2P Foundation does relentlessly on a daily basis.

Form a heuristic perspective, we know those solutions **must be designed outside of a mass consumption and mass industrial paradigm**; we know they **must be collaborative to prevent confiscation** by a few; and we know **they must favour local action to present a chance of controlling the chain of production** because to trace and control a product in long supply chains is just too complex, as illustrated by the 2013 horse meat scandal in Europe[44].

One avenue is proposed by Michel Bauwens, director and founder of the P2P Foundation[45]. He proposes **four principles** and approaches **to help deliver this desired parsimonious steady state, whilst maintaining palatable levels of comfort**:

1 – The complete freeze of planned obsolescence. Planned obsolescence is defined as "*a policy of planning or designing a product with an artificially limited useful life, so it will become obsolete (that is, unfashionable or no longer functional) after a certain period of time*." The freeze of planned obsolescence is in effect a practical lever to **reduce** our consumption.

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[44] The 2013 horse meat scandal was a scandal in Europe in which foods advertised as containing beef were found to contain undeclared or improperly declared horse meat – as much as 100% of the meat content in some cases. While the presence of undeclared meat was not a health issue, the scandal revealed a major breakdown in the traceability of the food supply chain, and the risk that harmful ingredients could have been included as well.
https://en.wikipedia.org/wiki/2013_horse_meat_scandal

[45] Michel Bauwens: http://wiki.p2pfoundation.net/Michel_Bauwens, P2P Foundation: https://blog.p2pfoundation.net, COMMONS TRANSITION. Policy proposals and ideas to implement a Social Knowledge Economy: http://commonstransition.org/

2 - The sharing of natural resources and physical infrastructures, which was the insights that gave the initial impetus to the mainstream "collaborative and sharing economy" – which as unfortunately been corrupted by capitalist platforms. This is in effect a practical lever to **share** the material goods we consume**.**

3 - The re-localization of production when it makes sense. An approach that has been coined as **'cosmo-localization'** of production, and which is made possible by trends such as the maker movement[46], distributed energy production and storage, resource scarcity, and parsimonious consumption. This principle of **re-localizing** addresses the problem that industrial production spread on a **global scale causes inefficiencies and wastes**, from energy wasted in transportation, to dumping pollution in places that are "Not In My Back Yard"[47].

4 - All of this, supported by the relevant practices to prevent enclosure and appropriation of non-rivalrous and non-exclusive goods by private interests, such as knowledge, information and data. Some of those practices include concepts like "**Open Data**" or "**Open design**", which is defined as "*the development of physical products, machines and systems through use of publicly shared design information. Open design involves the making of both **free and open-source software (FOSS)**[48] as well as open-source hardware. The process is generally facilitated by the Internet and often performed without monetary compensation.*"

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[46] The Maker movement: https://en.wikipedia.org/wiki/Maker_culture

[47] NIMBY (an acronym for the phrase "Not In My Back Yard") is a pejorative characterization of opposition by residents to a proposal for a new development because it involves controversial or potentially dangerous technology often with the connotation that such residents believe that the developments are needed in society but should be further away: https://en.wikipedia.org/wiki/NIMBY

[48] 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

In conclusion, this present research revisits the thermodynamics impasse of unlimited growth, and shows that a new paradigm underpinned by the Commons and P2P principles is possible.

> "Those who see the world as a mechanism, a clock, do not look at the economy in the same way as those who see it as a deteriorating energy system," said French economist René Passet[49].

Whilst the task of shifting our mindset from looking at a mechanism to looking at a deteriorating energy system, as well as designing new practical alternatives is enormous and might feel daunting, there is however "a light on the hill"[50] provided by the various precursor influencers, thinkers and practitioners who have collectively started to write the blueprint of this new paradigm.

[49] René Passet: «Il faut prendre du recul pour voir qu'un autre monde est en train de naître» http://www.bastamag.net/Rene-Passet-Il-faut-prendre-du «Ceux qui voient le monde comme une mécanique, une horloge, ne considèrent pas l'économie de la même façon que ceux qui le voient comme un système énergétique qui se dégrade.»

[50] "The light on the hill" is a phrase used to describe the objective of the Australian Labor Party. The phrase, which was used in a 1949 conference speech by then Prime Minister Ben Chifley: https://en.wikipedia.org/wiki/The_light_on_the_hill

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