COLLISION POINTS AMONG BIOECONOMY WORLDS, TOWARD YEAR 2125

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Abstract

The bioeconomy is proposed as a next phase of development based on renewable biological sources, replacing an age of fossil resource dependency. Because the bioeconomy is comprised of technologies, products and services related to and sourced from lifeforms, its emergence as a socio-technical and socio-economic regime will necessarily entail a reconfiguration of humanity's relationship to nature, thus completely changing dominant values and frameworks for decision-making and policymaking. Meanwhile assumptions and frames of reference used in bioeconomy strategy, vision, and policy discourses largely go unquestioned, leaving future views of its development open to ethical pitfalls. This paper presents preliminary insights generated from a research project called Bioeconomy and Justice linking philosophy of ethics and futures studies. The overall aim of the research project is to identify ethical questions for decision makers concerning the bioeconomy in relation to three-time horizons--the years 2025, 2075, and 2125. A key objective of the futures studies team is to identify high-impact future contexts appearing on these three time horizons which will require difficult ethical choices by elected officials, industry leaders, scientists, entrepreneurs, consumers, and policymakers. To meet this objective, potential blind-spots and unknown futures of the bioeconomy are identified using a mix of futures studies methods, including Horizon Scanning, Evidence-based Narratives, and Worldmaking as Scenarios (see Vervoort et al. 2015). Based on material generated through these methods, a set of 'world archetypes' are produced and used to map 'collision points' among competing interests, worldviews, value systems, as well as relationships among humanity, technology and nature. These collision points are then analysed to determine future contexts of high-uncertainty with troubled ethical groundings. This paper presents some of these seeds for ethical re-evaluation as an entry point for anticipating what types of policy interventions may be required both in the present and in various possible futures. By analysing these seeds for near and 107-year futures of the bioeconomy, this paper contributes new insights into potential impacts on future society and its governance. Bioeconomy and Justice is a project funded by the Academy of Finland.

Keywords: Worldmaking as Scenarios; Future Ethics; Long-term Futures; Bioeconomy.

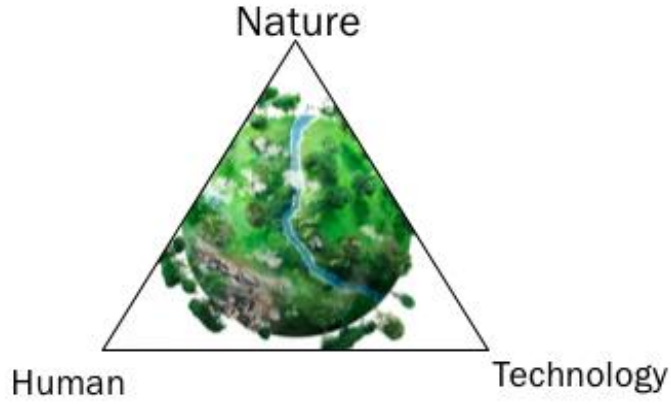
Introduction

Bioeconomy and Justice is a research project linking ethical philosophy and futures studies. Its overall aim is to identify ethical questions for decisionmakers arising from the bioeconomy. The overall project applies multiple methods to develop scenarios on three time horizons--2025, 2075, and 2125. This paper presents preliminary insights from the first stages of the project. These insights set the stage for identifying future situations which will require complicated ethical choices by key bioeconomy actors.

The bioeconomy has many varied interpretations and meanings. Its main role is to meet the challenges of climate change by replacing human dependency on petroleum and minerals with innovative bio-based products and services. In the bioeconomy, sophisticated technologies are applied to nature to serve human needs. This new socio-technical and socio-economic regime

will inevitably change humanity's relationship to nature and technology. The values and frameworks underpinning society and governance will change along with it. As these changes occur, assumptions underpinning bioeconomy strategies, visions, and policy discussions must be questioned in order to reveal ethical pitfalls.

The relationship among humans, nature and technology is a key sensemaking framework for considering long-term futures. This triangular set of relationships has been part of the human condition since at least the ancient Romans and arguably earlier (Heinonen 2000). While the fact of this relationship will likely be constant through time, the characteristics of each edge of the triangle will change as they have through history. It is important not to overemphasize the human's actions when considering the relationships depicted by the edges. Not only is humanity acting on (and through) technology and nature; but so is technology acting on (and through) nature and humans; and nature is acting on (and through) technology and humans (Figure 1).



Human ← **Nature** → Technology
(Technology ←) (→ Human)

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(Nature ←) (→ Technology)

Figure 1. Triangular relationship of Nature-Technology-Humans and detail in of relationship flows along its three edges

Acute pressing global threat sea level rise, warming, unpredictable and dangerous weather, loss of nature, poverty, famine, drought, and population growth all require immediate action and changes, that perhaps distort our understanding of the future in this bio renewable era. These driving forces generate urgency in various actors making decisions that will influence the rise or fall of the bioeoconomy.

Methodological approach

A mix of futures studies methods are applied to identify high-impact future problem contexts that are likely to emerge and would require difficult ethical choices by elected officials, industry leaders, scientists, entrepreneurs, consumers, and policymakers. These ethical trouble spots are identified using Horizon Scanning and Scenarios as Worldmaking.

Through a rigorous and ongoing horizon scanning process, the foresight research team has gathers materials from academic literature, web searches, social media, blogs, team-conducted interviews, conference presentations, and any available sources of potential insights. The materials and information found through horizon scanning has been documented, discussed, and integrated into an evolving understanding the bioeconomy domain. Furthermore, the horizon scanning materials are viewed from a metalevel--a material's existence is in itself a phenomena which may signal present and future directions of the field. The content generally deals with

areas of forest based bioeconomy, algae, regenerative agriculture, biotechnology, land use and biodiversity as some major themes. At this stage however the content itself is not presented as such but rather the values and logic is explored by our research at a more objective vantage.

Scenarios as a worldmaking framework is applied to draw out insights from the materials from gathered by horizon scanning. Worldmaking is social theory by Goodman (1978) stating individuals essentially experience life through their own world. Taking this approach, there are 'multiple, co-existing worlds' instead of subjective perceptions of a single reality. The implication of these worlds is that there are multiple presents and multiple futures. Building scenarios as worlds problematize the conventional scenario emphasis on fitting scenarios to shared and overarching framework. Scenarios as worldmaking sees the present as contingent and fluid while foregrounding contrasts and differences. Once worlds are developed, it is possible to initiate questioning between worlds and within worlds. (Vervoort et al. 2015.)

Based on the research team's analysis of materials gathered through horizon scanning, world archetypes are identified. Depth is given to these worlds by adding details loosely prompted by the Litany, Systemic Causes, Worldview, and Myth/Metaphor layers of Inayatullah's (2005) Causal Layered Analysis method. Depth is also given by describing how the triangular relationships among humans, technology, and nature are characterised in each world.

A methodological innovation of this research is to systematic 'collide the worlds' in search for ethical trouble spots. These collisions put the worlds into dialogue revealing dynamics that could be found in potential futures. All 10 possible combinations of worlds are analyzed. Additionally, the five worlds are analyzed from an intra-world perspective. (See Table 1). In these collisions, key conflicts and synergies between worlds are described.

Table 1. Possible Combinations of Worlds (intra-world cominations are italicized)

	World 1	World 2	World 3	World 4	World 5
World 1	*1 with 1*	1 with 2	1 with 3	1 with 4	1 with 5
World 2	x	*2 with 2*	2 with 3	2 with 4	2 with 5
World 3	x	x	*3 with 3*	3 with 4	3 with 5
World 4	x	x	x	*4 with 4*	4 with 5
World 5	x	x	x	x	*5 with 5*

After systematically reviewing all combinations of these future bioceonomy worlds, some are selected for an initial assessment of what ethical challenges they imply for the year 2125.

Results, discussion and implications

The following five 'world' archetypes are identified as relevant to futures of the bioeconomy, each characterised by different relationships among humans, technology, and nature: Bio-utilization, Bio-upgrade, Bio-mimicry, Bio-recovery, and Bio-equality.

In the ***Bio-utilisation*** world**,** non-human life forms produce materials, foods, and fuels for humanity. This world focuses on maximizing the growth of bio-mass and efficiently using harvested biomass. Humans develop and use technology to produce source materials from nature. People rely on natural systems to produce value and wealth. By focusing on efficient utilization of biomass, challenges to just relationships among nations and people continue to emerge from the continuation of the 'plantationocene' worldview in which land is for producing biomass and labour of people is to be exploited to produce the biomass (Haraway 2015, 162). Robotic farming technologies may mitigate some labour exploitation, but the practices of 'taking land' are continually underlying this process. Nature is frequently treated in an agrarian way, focusing on monocrops and mechanical systems for maximizing the harvest of those crops. In a knowledge-based bioeconomy, know-how related to planting, growing, harvesting, extracting, and production of products are key drivers for ongoing evolution. With deep links into humanity's agrarian past, this world is in many ways business-as-usual, but with added emphasis on efficiency, knowledge, and innovation.

In the ***Bio-upgrade*** world, life forms are considered flawed and human intervention is believed to be an appropriate way of improving their effectiveness in expressing specific traits and helping people achieve their goals. In this world, technology is used to customize and enhance organisms to perform specific tasks or produce specific outcomes. Nature, from its genetic, chemical, physical, and ecosystem levels, is manipulated and governed at will. An engineering solutionist perspective is taken toward nature. For example, most plant species rely on the least efficient form of photosynthesis, using only a fraction of the carbon dioxide molecules an enzyme captures. These plants can be edited to use a less common photosynthesis process and achieve better growth as well as better carbon capture (Mann 2018). In another example, the tradition of saving seeds from best performing individual plants may be replaced by advanced gene editing technologies. In Bio-upgrade, lifeforms with any type of useful biomass, bio-output or characteristics can and will be modified to express those traits chosen by humans or human technologies. Additionally algae and other simple life forms are quickly modified to produce exact chemical outputs. For this world, know-how related to observing and explaining genetic processes, DNA coding, predictive modelling, and lifeform design are essential. Human-made innovations can improve nature.

The **Bio-Mimicry** world positions nature as an ultimate creative force and teacher. Solutions to human problems are sought by studying nature and natural systems. Unlike Bio-Upgrade, this worldview treats nature as the 'state of the art' produced by billions of years of evolution. In this world, nature is valued for its models and templates, which are frequently applied to human technologies as a means for achieving sustainability goals. In emulating natural systems, humans use technology to seek balance with Earth's ecosystems. Nature is regarded as the penultimate creative force and is adored for its ingenuity. Human invention is improved when inspired by solutions found in nature. Know-how related to systems thinking, observing and explaining biological phenomena, design, and applied creativity are key for this world.

In the **Bio-Recovery** world**,** people are highly aware that human pressure in the form of urbanization, agriculture, and extraction of minerals and oil has degraded land and ecosystems around the world. Feeling accountable for causing this situation, radical human-made technology is applied to recover these ecosystems as rapidly as possible. A key motivation is the belief that once nature is restored, nature will be able to better provide resources for humanity and other species. Restored soil, marine, and forest ecosystems are seen as the most effective way to capture much of the carbon dioxide humans have released by burning fossil fuels. 'Active ecology'--rapidly developed insights derived from research conducted using big data and machine learning tools--informs ecological interventions (White et al. 2015). Start-ups emerge to

apply robotics, space-based monitoring, big data, blockchain and artificial intelligence to restore ecosystems and manage them once they are recovered. The stated goal in this world is to restore and preserve 50% of earth's available land in as 'natural' a state as possible. Due to the massive deployments of technology to make this happen, the term 'natural' means something different than 'wild' as these preserved territories are carefully managed. An example of the Bio-Recovery perspective can be found in the work of World Resources Institute (Wu et al. 2018). This world relies on know-how related to assessing the health of an ecosystem, devising technological interventions to support restoration, and monitoring the recovery of ecosystems as well as their CO2 consumption.

The **Bio-equality** world proclaims that all life holds equal value and rejects the idea that nature must do something for humans in order to be valued or respected. In this world, humans understand themselves to be among and in relation to many other Earthlings. All living species who have survived the ecological devastation wrought by climate change (+2C to +8C) are considered the 'kin' of humanity (Haraway 2015). People are not above nature and are not entitled to use its technology to manage or interfere with its processes. "Right now, the earth is full of refugees, human and not, without refuge" (ibid., 160). This world is imbued with a transspecies framework for justice.

Table 2. Ten Inter-World Collision Points & Synergies

	Conflicts	***Synergies***
Bio-utilization with Bio-upgrade	*Conservative stakeholders of established markets potentially destabilized by new innovations that could disrupt status quo.* *An 'upgraded lifeform' could have unexpected negative impacts on 'biomass crops'.*	*These two worlds have similarities in how they regard nature. Both see it as something to be made subservient to human needs.* *These two worlds ultimately focus on the material production potentials of nature.* *Both apply technology to obtain their objectives.*
Bio-utilization with Bio-mimicry	*History of established human made knowledge and practice over nature, confronted with knowledge drawn from nature are fundamentally at odds. [e.g. Bio-Utilization would suggest humans is better at desiging perfect systems.]*	*They are both using nature, but in different ways. One sees it as a source of materials, and the other sees it as a source of ideas.*
Bio-utilization with Bio-recovery	*Taking and giving back carbon and biodiversity on this front wages two opposing perspectives. Carbon and biodiversity are valued differently. However a respect for the careful management and abundance is held by both camps.*	*When sustainable practices are in use, Bio-utilization prioritizes keeping natural systems in a productive state over the long-term. Bio-recovery has a similar objective, but is defining productive more broadly toward planetary objectives.*

	In some cases, the forests have been restored because the forestry industry had economic motivation to restore them.	*Both worlds aim to utilize human survival.*
Bio-utilisation with Bio-equality	*These two worlds may be in greatest conflict. Bio-utilisation destroys habitat for non-human lifeforms while bio-equality ideals are seen as unrealistic in relation to meeting human needs.*	*Given the opportunity of growth and ability to engage with new abundance the assumption is that financially it is more profitable to follow the path in which new values are being established (i.e. matured sustainable development, ecology, circular etc.) If bio-equality is a mainstream value, the utilisation perspective will be compelled by market forces to meet it.*
Bio-upgrade with Bio-mimicry	*For these worlds, the fundamental difference is their views of nature. Mimicry respects nature as perfectly ordered and creative. Upgrade sees nature as flawed and chancy.* *Upgrade puts technology into nature. Mimicry puts nature into technology.*	*Both worlds are, at some level, in awe of natural systems, even if bio-upgrade seeks to improve those systems. Both worlds draw from nature's potential, upgrade seeks to enhance nature via human intervention, the other sees to enhance human design via nature.* *There is a common emphasis on improving technology.*
Bio-upgrade with Bio-recovery	*A risk in bio-upgrade comes from unintended consequences, such as a upgraded organism coaxing the evolution other organisms such as viruses or parasites. Such a system could severely interfere with a bio-recovery intervention.*	*Both worlds are motivated by helping nature flourish. For bio-upgrade, this means modifying organisms to help them succeed. For bio-recovery it means assisting organisms in rebuilding their ecosystems and habitats.*
Bio-upgrade with Bio-equality	*These two worlds despise each other. Bio-upgrade is too wreckless with non-human lifeforms which Bio-equality sees as kin.*	*Helping other species succeed in a changed climate and environment is a shared goal between both worlds.*
Bio-mimicry with Bio-recovery	*The radical technological interventions of Bio-recovery often overtake slower natural processes. Bio-mimicry see Bio-recovery's urgent actions as violating the 'perfect solutions from nature'.*	*Biomimicry can be useful in developing bio-recovery technologies. For instance a swarm of drone bees to help pollinate the plants could be inspired by understanding how insects pollinate plants in nature.*

Bio-mimicry with Bio-equality	*Bio-equality and Bio-mimicry do not agree about the essential value of nature. Bio-equality criticizes bio-mimicry for its insistence on utilizing nature for human ends.* *Bio-mimicry finds Bio-equality too idealistic. Meeting human needs by emulating nature is better than exploiting nature.*	*These worlds share a high regard for nonhuman living beings in nature. There are differences in how this reverence is paid, for bio-mimicry, other living beings in nature are a creative force while for bio-equality they are equal peers.*
Bio-equality with Bio-Recovery	*At their most fundamental levels, these worlds see nature very differently while having overlapping assumptions. Recovery is driven by more immediate survival needs of resistance, where equality is more inclusive and more long term symbiotic transformation.*	*Both worlds seek to help non-human living beings succeed in difficult circumstances. For bio-equality, there is a greater emphasis on the direct relationship between nature and humanity. Whereas in bio-recovery there is greater emphasis on applying technology to 'restore ecosystems'.*

Table 3. Five Intra-World Conflicts and Synergies

	Conflicts	**Synergies**
Bio-utilization	*Land-use decisions require balancing human needs for material, food, energy and habitat. Human habitats place pressure on wildernesses and 'natural areas' because of their benefits to humans.*	*Shared assumptions regarding utilization as ultimately necessary allow for more cohesion in decisions and actions that produce biomass.* *Stewardship of natural areas so they can later be used by humans is valorous.*
Bio-upgrade	*Disagreements regarding the ownership of genetic information and know-how are common among key players.* *There are different playing fields for individual DIY makers versus big science and companies.*	*Simply Bio-upgrade can be seen as the pursuit of knowledge and applying it as a solution.*
Bio-mimicry	*Innovators see risk in sharing their discoveries about natural systems so that they can be first to profit from them.*	*The potential drawn from nature seems limitless, and similar patterns are shared enthusiastically but applied*

		diversely across many sectors.
Bio-recovery	*There could be overlapping efforts or competing strategies for restoring a specific area of land. In such cases, one start up or initiative may have very different ideas from another.*	*The common cause of recovering degraded lands unites communities and nations in action.*
Bio-equality	*A world that gives high value to non-human lifeforms may have challenges in defining where the boundaries of this policy are. Is it better to reduce the number of fellow beings are harmed or do qualitative aspects, such as relative sentience, matter more.*	*Expanded sense of 'kin' leads to a new set of mainstream values that simultaneously reify human rights while raising the rights of other living things.*

From this systematic review of world collisions, a few conflicts can be assessed to hold particularly strong implications for future decision-makers. Some of the key ethical quandaries people may face in a future bioeconomy are focused on balancing needs. For instance, land-use must be balanced between human needs for productive biomass crops and nonhuman needs for preserved habitats.

A methodologically similar study has been made by Birch (2016). He analysed interviews with Canadian policy actors for their future visions, reinforcing his findings with a sampling of policy documents. From that material, he found four definitions of bioeconomy visions: product-based, substitution, renewable-versus-sustainable, and societal transitions (ibid., 4). All of these definitions could be argued to be found, to differing levels, in the five worlds proposed in this paper. For instance, the bio-utilisation world proposed in this paper is closely linked to Birch's *product-based* definition of bioceonomy, while *societal transitions* may be most fitted for equality, and *substitution* relates to the need to a move to a *low carbon future* in a technological manner and fits well with the bio-upgrade world (ibid. 4-9). However these are not exact matches.

A limitation to this study concerns the uncertainty to which we can expect these worlds to persist over time. However, it can be argued that due to their general depiction of core human needs and ambitions, these world are strong candidates for continuing long into the future. However, due to developments of bioeconomy systems, some worlds may fade away, others may become stronger, and worlds that are unknown to us today and even indescribable in today's terms may suddenly appear. While the present features these worlds as simultaneously existing, it is possible to imagine them occurring in a linear sequence, one world transitioning into another; in a pairing; or otherwise running in parallel and in competition. However our initial expectation has been that these are parallel and simultaneous. In any of these forms, the worlds can serve as a tool for anticipating future ethical questions within scenarios or future narratives.

Conclusions

One common assumption of the bioeconomy is that it will be a *post petroleum economy* (Aguilar et.al 2018) where biomass feedstock simply functions to replace fossil-based chemicals and products. On one hand this is seen as an essential ethical role to mitigate climate change by fixing what is wrong in the current broken model, an argument that is hard to disagree with in the present race to meet the Paris Agreement. However from a futures perspective this assumes a continuum of the same or similar industrial model, just with supplemented low carbon options that address problematic areas in the current system but do not in fact offer a new transformative system. To add to the problem these innovations can be seen as 'technically impeccable' having successfully developed and optimised the existing and upgraded systems to match new standards. However that in itself does mean that it is ethically the right way forward for the future, even if they are technologically superior. In this respect the colliding worlds are both complicated and revealing, and the attitudes of the worlds reveal more than just some new level of technological sophistication. In this way, the colliding world provides insights into how a future bioeconomy will be socially different.

Thus colliding worlds as a framework for evaluating a diverse body of material helps identify and compare the values, assumptions, and compatibilities of various types of actors. Often research like this is discussed in isolation within its own industry setting, but futures research in practice is often multidisciplinary or transdisciplinary (Bell 2002) and requires looking at a topic from many sectors with many perspectives. For the next steps in the *Bioeconomy & Justice* project, the insights generated by this colliding worlds exploration and other research activities will be used as an opportunity to bring experts in to explore and add detail to these evolving rappelling structures in a process of creating complete scenarios. It is the hope of the project that these scenarios will serve as catalysts for identifying key troubled contexts which will require robust and new ethical considerations.

References

Bell, Wendell (2004) *Foundations of Futures Studies, Vol. 1.* Transaction Publishers. Brunswick, New Jersey.

Birch, Keen (2016) Emergent imaginaries and Fragmented Policy Frameworks in the Canadian Bio-Economy. *Sustainability,* Vol. 8 (1007), 1-16.

Goodman, N. (1978) *Ways of worldmaking*. Inianapolis, Indiana: Hackett Publishing Company Inc.

Haraway, Donna (2015) Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin. *Environmental Humanities*, Vol. 6, 159-165.

Heinonen, Sirkka (2000) *Prometheus Revisited: Human Interaction with Nature through Technology in Seneca*. Societas Scientarum Fennica (The Finnish Society of Sciences and Letters), Helsinki.

Inayatullah, Sohail (2005) Causal Layered Analysis — Deepening the future. In: *Questioning the future: methods and tools for organizational and societal transformation*, 1–22. Tamkang University Press, Taipei.

Mann, Charles (2018) Can Planet Earth Feed 10 Billion Material. March 2018 *The Atlantic.* https://www.theatlantic.com/magazine/archive/2018/03/charles-mann-can-planet-earth-feed-10-billion-people/550928/ , Accessed 15.5.2018.

Vervoort, Joost M., Roy Bendor, Aisling Kelliher, Oscar Strik, and Ariella E.R. Helfgott. 2015. "Scenarios and the art of worldmaking". *Futures* 74: 62-70.

White, R.L., Sutton, A.E., Salguero-Gómez, R., Bray, T.C., Campbell, H., Cieraad, E., Geekiyanage, N., Gherardi, L., Hughes, A.C., Jørgensen, P.S., Poisot, T., Desoto, L., Zimmerman, N. (2015) The next generation of action ecology:

Novel approaches towards global ecological research. *Ecosphere*, Vol. 6(8), article no. 134. https://doi.org/10.1890/ES14-00485.1

Wu Wu, Andrew – Faruqi, Sofia – Angondo Ortega, Andres – Brolis, Eriks (2018) From Tree-Planting Drones to Shade-Grown Tea: Businesses Are Making Money by Reforesting the Planet. 18.1.2018 World Resource Institute Blog. https://www.wri.org/blog/2018/01/tree-planting-drones-shade-grown-tea-businesses-are-making-money-reforesting-planet , Accessed 7.2.2018.