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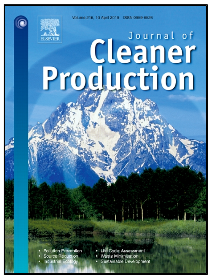

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Is technology optimism justified? A discussion towards a comprehensive narrative

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ABSTRACT

This paper is based on a discussion developed by one of the thematic working groups at the Biennial International Workshop Advances in Energy Studies (BIWAES) 2017 hold in Naples, Italy. The topic was the role of technology in energy transition and global problems. Owing to the heterogeneity of the participants in the working group, different viewpoints were put together, leading to some shared conclusions. In particular, the role played by the different narratives used in discussing the role of technology in facing global problems was pointed out as the origin of cognitive dissonance. The presented reflections address some conceptual weaknesses in the current debate on technology and global issues, framed in global policies that appear incapable to obtain tangible results. The technology optimism seems, in fact, to be based on the elusive use of both the concepts of technology and sustainability, that are put together for narrative purposes without an explicit conceptual assessment. On one hand, the factual role of technology and its beneficiary are almost never clearly addressed in the debate. On the other hand, the fact that any new technology will serve the cause of sustainability is not questioned whatsoever, without taking into account the social, political and ethical framework in which technology is supposed to be operated.

Keywords: Technology, Energy, Narrative, Business as usual, Sustainability, Higher education.

1. Introduction

Technology is a composed word deriving from Greek τεχνολογία (tékhne-logìa, treatise on a skill). Today, the word is used not only to indicate the research on the application and the use of technical instruments (i.e., all that is applicable to solve practical problems), but the technical instruments themselves. The role of technology in the society, for example, in the energy transition, is a very complex issue, as in general its possible role in the strategies aimed at facing the global problems. But even the very definition of technology may reflect quite different philosophical or ethical positions. Technology, in its broader meaning, cannot be defined as the mere result of the activity of engineers, aimed at inventing and doing something good or useful. It rather involves further dimensions, namely, technique, knowledge, organization and products (Müller et al., 1984). This definition encompasses various aspects of technology, but – as discussed in the following in this work – talking of "good" and "useful" requires as well philosophical, ethical and social frameworks presumptions that are rarely made explicit in the current narratives. In fact, since the 1980s the Institute of Electrical and Electronics Engineers (IEEE) felt the need to found the SSIT, Society on

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Social Implications of Technology (Stephan et al., 2012), aimed at exploring the role of Technological development in the social contexts. Let us then start from a very basic question. If technologies are tools that mankind use to achieve an aim, the question is: what aim? As a matter of fact, it is possible to identify it within very different conceptual frameworks, that may or may not include ideology, ethics, political opinions, technical knowledge, and so forth. The idea that technology plays a major role as one of the processes that determine the path of civilizations was developed by Ribeiro (1968), who addressed its role along with the ideology and the social organization through the concepts of "evolutive acceleration" and "historical actualization", describing the way peoples may or may not evolve in their social, ideological and technological systems. Actualization process in particular has worked whenever a society is subjugated by a more technological advanced one imposing its ideological, social and technological systems, as it has been happening for example in Latin America since literally centuries.

Scientific and socio-economic literature offers a wide range of different positions concerning the role of technology, from *essential* to *irrelevant* (see for example Zacher, 2017a). And this not only in a sustainable development and economic growth framework, but also within sustainable de-growth scenarios! Apparently, scholars are allowed to claim for anything come in their mind, offering a variety of contradictory positions, each one supported by apparently robust analyses. How is this possible? Part of the reason lies in the epistemic differences between the various conceptual frameworks within which any reasoning is developed. In fact, before building up any effective strategy for a technological road, two questions should be correctly addressed:

- Technology for what?
- Technology for whom?

These questions are rooted in the fundamental starting points of systems thinking approach to complex problems, that is, the requirement to clearly identify the boundaries, the end-users and the systemic purpose of the system (Meadows, 2008). Therefore, within the current debate on the effectiveness of technology-based actions, it is necessary first of all to define clearly the goals of the system at issue, since the technology is not *per se* a pure tool for advancements. A correct narrative taxonomy must be established, necessary for clarifying what we are talking about, and at what level. This becomes clear if we focus on the "for what-for whom" (FWFW) questions.

The need for integrated concepts encompassing environmental, social and economic dimensions entered the scientific debate in the 1970s with the publication of "Limits to Growth" (Meadows et al., 1972), that introduced the idea that environmental and economic issues cannot be treated separately. Lester Brown then first defined a sustainable society as "one that can meet their needs without compromising the chances of survival of future generations" (Brown, 1981), and a few years later this definition of sustainability became the basis for the definition of a different concept, that of sustainable development. Given in the so-called Brundtland report by the World Commission on Environment and Development (WCED, 1987), it addresses sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Brundtland's definition of sustainable development is now currently used to address the overall concept of sustainability, even if sustainable development might be regarded (see Latouche, 2004) as an oxymoron resulting from the will to put together the development, in terms of economic growth, and the overall endorsable concept of sustainability. The debate about the very concept of sustainability is presently quite vivid (see Barbosa et al., 2014), extending the original "three pillars of sustainability" (environmental, social and economic dimensions) to include explicitly other aspects of the issue. For example, Hartmut Bossel (1998) claims for a sustainability which addresses multiple dimensions: material, environmental, ecological, social, cultural, legal, economic, psychological and political. The entanglement between the concepts of sustainability and sustainable development has been treated in details by Coutinho et al. (2016) in a paper discussing the work of Ignacy Sachs. He first proposed that the concept of sustainability should have five elements: (i) social (mostly connected to inequality), (ii) economic (connected to goods and means), (iii) ecological (aimed at the environment quality and preservation), (iv) spatial (connected to human settlements territories) and (v) cultural (aimed at avoiding culture conflicts). These where then expanded (Sachs, 2002) with three further elements, namely (vi) environmental (related to the self-purifying capacity of ecosystems), (vii) national political (addresses human rights, national projects and social cohesion), and international political (concerned with UN war prevention system and the promotion of international cooperation).

Independently of the multi-faceted meanings of sustainability, sustainable development has now become a mantra, and a major role in pursuing sustainable development goals has been assigned to technology. This occurs despite the ambivalence of technology itself, considered as both the source of sustainability problems and the means for sustainability achievement (Weaver et al., 2000). This ambivalence arises from the cognitive dissonance created by the undue assimilation of the concept of "sustainability" with that of "sustainable development". This rhetorical position, be it either unintended or surreptitious, makes difficult any attempt to frame technology in the act of shaping a sustainable world. As long as development, intended as economic growth, is a pre-requisite for any narrative about sustainability, the attention for the effects of technological progress on sustainability is shifted towards the role of technology in contributing to the sustainable development (Grunwald, 2017), along with the implicit assumption that technology may be to some extent effective, viable and feasible to solve the big problems.

For more than 20 years, several scholars have promoted the awareness that a systemic approach is needed when dealing with global sustainability-related problems. Among them, Giannetti has attributed the uncertainty due to the disagreement among different approaches to a lack of "science of sustainability" (Giannetti et al., 2008). Giampietro et al. (2009) have proposed a rationale for a scientific approach, framed in the complexity theory, based on the study of the so-called metabolic patterns of socio-ecological systems, explicitly aimed at preparing effective scientific inputs to be used by the decision-making processes. To use their words, the science of sustainability is presently incapable of handling complexity, since the sustainability issues must be treated by integrating (not just putting together) different quantitative perspectives and different scales of analysis (Strand et al., 2016). For example, let us consider the critical role technology has played in energy systems development. Technological change has driven both an increase in energy use and an improvement in the quality of energy systems (Wilson, 2011), and these improvements have contributed to economic growth in many countries. On the other hand, access to energy remains a goal for 2.7 billion people worldwide (Karekezi et al., 2012), meaning that the use and the impact of technological improvements have not been equally shared, nor effectively operated, indicating systemic purposes that were likely different from what one should expect from the advancement of human knowledge and science.

Given these premises, this paper reports on the Thematic Working Group discussion hold during the Biennial International Workshop Advances in Energy Studies (BIWAES) 2017 in Naples, Italy, dedicated to the role of technology in facing global energy problems. The debate has put in light the complexity of the topic, underlining the biases of some current narratives. Two examples, smart cities and a biorefinery, are also evaluated.

2. Technology and the Societies

The aim of technology – along with the way technology is to be used to achieve it – very often is not explicitly stated, hidden in a rhetorical narrative that takes for granted that the objectives we discuss about are clear, shared, and agreed upon by everybody with no questioning. Unfortunately, this is not true, and the simple exercise to ask ourselves the FWFW questions when discussing of a new technology is a compulsory starting point for the understanding of the real situation. Otherwise, reasoning about the role of technology in the solution of any global problem becomes meaningless.

Technology is a tool acting differently depending on territorial space (local situations *vs.* global situations), time (present *vs*. transition *vs*. future) and purpose (business as usual *vs*. promoting changes). Technology is not shared equally by the different countries, societies, or communities. In particular, the access to technology is strongly dependent on social, political and economic factors. This strengthens the idea that technology is a global concept – as are the global concerns – which is incoherent with reality. As remarked by Zacher (Zacher, 2017b), the mainstream narrative about technology issues comes from that part of the world that currently exploits and designs the technology itself, and technological progress has become a value *per se*, along with the issue of technology transfer. Innovation and creativity in technology development are in fact strictly linked to the market-driven economic growth by generation of demand, equated to the satisfaction of human needs, whereas real human needs are rarely addressed *per se* as purposes. Most of the narratives about the technology put mankind at the center not only as the technology maker, but also as the only element of the geobiosphere that benefits or is harmed by (Voigt, 2016). Social implications of technology are so intertwined with all the other relevant aspects presented in this paper that they can be hardly treated one at the time, as specific aspects. Different approaches have been anyway proposed to analyze the social aspects of technological progress (Stephan et al., 2012), also from the point of view of regulatory laws, that are set up at different levels (regional, national, international) thus adding further complexity to the analysis.

The involvement of stakeholders in the decision-making process is a good practice in as much it may help both policy-makers and industry project managers ensuring optimal choices among different technological scenarios (Wright et al., 2014). Concerns raised by the stakeholders need to be taken into account in order to improve decision-making at each stage and each level. Therefore, the decision-making process needs to be primarily participative, involving a wide range of different groups of stakeholders, fulfilling the legislative requirements at the national level for the prevention of acceptance conflicts at the local level and of ethical disputes and issues. An example was provided by Hornsby et al. (2017), that implemented an early multi-criteria analysis developed as a roadmap. This roadmap includes an assessment of the socio-economic and environmental impacts related to an emerging technology from the early stages of its design process up to the operational phase, with the aim at preventing any possible conflict. On the other hand, specific attention must be drawn by policy-making actions that involve stakeholders participation only to the extent it allows to maintain the public consensus toward the administration governance. This attitude is common to further sectors besides technology, and of course it must be carefully monitored in order to assure that short-termed actions pushed for by stakeholders lobbies do not prevent the effectiveness of medium/long-termed actions inspired by the very concept of sustainability.

In the context of developing countries, technological progress has been focused mainly on assimilation and catch-up to technologies that were invented by industrialized countries (Ribeiro, 1968; Romijn, 2011). However, considering the drawback of energy technology trajectory in industrialized countries, developing countries need to foster alternative strategies for their energy systems. This is imperative as their energy expansion goal comes together with other vital goals, namely, poverty eradication and tackling climate change. The central strategy for doing this is by utilizing local energy resources in a sustainable manner, improving existing technologies, and developing local capabilities (Dahlman et al., 1987). They can take advantage of the global technological progress and adopt technological advancement brought by industrialized countries, only if the respective technology fits their local context. This is in line with the concept of appropriate technology, which sustains growth using the small unit as possible while retaining the human-nature organic relationship to eliminate adverse effect of modern technology (Pattnaik and Dahl 2015). In particular, besides local environmental constraints and the economic and industrial situations, social and cultural aspects are expected to play a major role in any local-based technology innovation strategy, for example, in terms of political and societal planning. An example worth studying is Bhutan. The Bhutan Government views technology as something that can bring either happiness or misery, and struggles for choosing the former (Johnson, 2017). The country's development goals do not focus solely on economic growth, but instead on the happiness of its people. Bhutan's "National Gross Happiness" development plan consists of four pillars: 1) Sustainable and Equitable Socio-Economic Development; 2) Conservation of the Environment; 3) Preservation and Promotion of Culture and 4) Good Governance (UNDP, 2017), and Bhutan's poverty rate was successfully reduced to the level as targeted in its Millennium Development Goals. Moreover, almost 75% of its land is covered in forest, which absorbs three times more CO_2 than its population produces. As a result, Bhutan has become the world's most "carbon negative" country (Neslen, 2015). It is anyway worth remarking that even when technological progress transferred from the global north improved agricultural productivity and in turn reduced poverty in the global south, unintended consequences and side-effects adversely affected water use, soil degradation and chemical run-off beyond the cultivated areas. This happened for example as a result of the so-called "green revolution" (Pingali, 2012). However, it appears mandatory to include both developed and developing economies in the contextualization of technologies, pointing out the specific role as either a local or a global issue.

3. Technology and the Economy

The perception that technology has created dangerous environmental side effects started growing in the 1970s. Nevertheless, the idea that technology might and should be some sort of "neutral" road to benefit all human beings as well as societies and the planet is still well rooted in modern thinking, regardless the evidence of the dependence of technological development and uses on the economy. As already observed, it is a general mindset that human society can use technology to find proper solutions that will eventually handle, if not overcome, most of our problems. How these added technologies require added resources is quite rarely addressed. A framing effect acts, where the problems are mentally housed within the boundaries of the human economy. The mandate for economic growth, embedded in the assumptions of sustainable development, contributes to create a narrative on the role of technology that does not take into account any of the global systemic features with which any new technology has to face, be them environmental, social or economic. When a system is sufficiently complex to develop self-organizing feedback networks, it is likely to develop functioning patterns that keep maximizing its power, as a consequence of the systemic rearrangements occurring upon external modifications of the system inputs (Odum, 1996), possibly making ineffective the newly introduced technology. Simple cause-and-effect linear chains are constantly proposed as effective descriptions of the reality, whereas, in the analysis of our energy future, a systemic approach would be more comprehensive, therefore appropriate.

The prevailing mindset considers the geobiosphere as a sub-system of the global economic system– whereas the opposite is true – at the same time considering sustainability as equivalent to sustainable development, and thus economic growth. Economic growth is considered the same as improved quality of life, but this ignores how the economy profits from natural, social, and human capital (Giannetti et al., 2015). It is interesting to observe how several scientists, when participating in the "technology for sustainable development" debate, seem to put aside their usual conceptual and epistemological background and tools, made of logic, data, deduction, observations, analysis and truth, to embrace rhetorical arguments set only on ideological biases. Claims like "The only way to attain sustainable balance between civilization and nature is through technological development" (Bisk and Bołtuć, 2017), or "There is no alternative to business as usual carrying on [...]. The single place where the greatest impact on carbon dioxide emissions can be achieved is in the area of personal behavior" (Kelly, 2016) are so sadly naïf to result almost unquestionable, whatever meaning one may want to attribute to the words.

In the framework outlined by Srnicek and Williams (2015) and Likavcan and Scholz-Wäckerle (2017), technologies should be mostly addressed to repurpose and recombine existing ones, to meet a qualitative development in a no- or de-growth economy. Digitalization technologies, big data and information and communications technology (ICT) are good examples of means that may equally well play a role for the economic growth mantra or for a more sustainable society in which the use of resources takes into account the actual limits of the geobiosphere. On the other hand, technological improvements might be related to measurable quantities. Heikkurinen (2016), for example, claims that technology in a social system is in some way proportional to the matter and energy throughput, being therefore intrinsically useless for in pursuing any de-growth scenario. Another critical point for the new technology towards a more sustainable future is of course the Jevons' effect, named after the English economist that first pointed out how an increase in the efficiency in the use of a resource, due to a technological improvement, gives rise to an increase of the consumption rate of that resource, due to a consequential increase of the demand (Jevons, 1865) and the lowering of the price. Environmental economists have long debated about Jevons' paradox but, as a matter of fact, it does not seem that a shared agreement has been set about how/when it should be taken into account. A result is that, for example, the International Renewable Energy Agency recommends to increase the technologies for the overall energy efficiency, "and thus decrease total primary energy demand" (IRENA, 2017), in so denying several factual examples of the validity of Jevons' effect concerning different resources (Polimeni et al., 2008).

The FWFW approach may have several consequences for business and requires actions to get a combination between narrative and systemic understanding. Actions may prepare managers, entrepreneurs, unions in a coherent manner that promotes knowledge and facilitate future actions. Training programs that incorporate more systemic ways of understanding and managing multi-perspective and adaptive management problems will help managers to act and make decisions under the FWFW umbrella that will continually evolve oriented towards organizational and social learning. Proactive entrepreneurs will have not only to be attentive to inadequacies and opportunities within the existing markets, but may also deeply reflect on the consequences of the emergence of technological and social innovations. Relying on the FWFW approach as an inherent part of their struggle, unions may enable workers to meet their needs in less harmful ways representing the working class within the environmental movement.

An interesting approach aimed at integrating social responsibility and profit-driven activities is that provided by the Corporate Social Responsibility (CSR) framework. In the definition reported also by the Financial Times ((http://lexicon.ft.com/Term?term=corporate-social-responsibility--(CSR)), CSR is "a business approach that contributes to sustainable development by delivering economic, social and environmental benefits for all stakeholders", following the so-called triple bottom line of Profit, People, Planet. As a matter of fact, CSR is anyway a business approach, that reflects a "responsibility" toward planet and/or environment only as a side effect. As pointed out by Milton Friedman (1970), "In [a free economy] there is one and only one social responsibility of business to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game". In this respect, CSR may be regarded as as a branch of risk management, as far as episodes like the *Exxon Valdez* oil spill, or the Nike child labor scandal are certainly not matching the systemic purpose of the Companies involved, that is, the profit. However, in CSR the transgenerational aspect contained in the very definition of "sustainability" is quite often lost.

4. Technology narrative and the real world

The ethical issues connected to the realm of economy have been always matter of concern in modern societies, especially in a free market based framework of activities. Pioneering works like those by Howard Odum (1971), Lester Brown (1981) and later Hans Küng (1991) have rationalized from a scientific perspective the relationship between ethical issues and the economy, underlining the need of integrating the ethical view in the market-driven society, and in more recent years several new conceptual approaches have enriched the debate in this sense. Depending on the school of thought, the discipline involved, and the emphasis given to specific aspects of the matter, new concepts have been proposed to integrate the economic activity in a more general perspective, often summarized by the concept of sustainability. Among these new approaches, Natural Capitalism (Hawken et al., 2008), Industrial Ecology (Lifset and Graedel, 2001), Ecological Economics (van den Bergh, 2001; Voinov, 2008) and Regenerative Design (Lyle, 1996) address the integration of the technical aspects of sustainability in the more extended boundary of the socio-economy. Other general conceptual frameworks that explicit the sustainability issues are the Blue Economy (Silver et al., 2015), the Green Economy (Brand, 2012; UNDESA, 2012), the Green Growth (Janicke, 2012) and the Bioeconomy (Mills, 2015), though each of them are outlined and defined differently depending on the context. The concept of Circular Economy (Ghisellini et al., 2016; Kalmikova et al., 2018; Korhonen et al., 2018) is presently addressed as a potential tool for making classical economy coexist with sustainability and social issues. It is intended as a framework for addressing the reduce, reuse and recycle activities in the production processes and in the circulation and consumption of goods and services, in order to (even partially) replace the traditional linear chain of making, using and disposing. An analysis of all these approaches is far beyond the scope of this paper, but the variety of them certainly support the idea of a strong need for a new narrative, or – at least – a new attention to be paid on what is the real *Weltasnchauung* which any narrative about technology is based on.

4.1 Technology and Climate Change

The debate about the possible use of innovative technologies to handle the climate change problems is manifold. Back in 2010, the Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) established the so-called Technology Mechanism, with the objective of "accelerating and enhancing climate technology development and transfer. It consists of two complementary bodies that work together, the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The TEC is the Technology Mechanism policy arm and analyses policy issues and provides recommendations to support countries in enhancing climate technology efforts" (UNFCCCa, 2018). "To determine their climate technology priorities, countries undertake technology needs assessments (TNAs), aimed at the implementation of prioritized climate technologies" (UNFCCCb, 2018). Article 10 in the Paris Agreement then puts the basis of a Technology Framework, intended as to supervise the Technology Mechanism activities for technology development and transfer. Technologies addressed in the mainstream narratives are related to CO_2 capture, renewable sources cost abatement, energy efficiency, energy mix, infrastructures, totally new energy sources (e.g., nuclear fusion), mitigation and adaptation strategies. Unfortunately, again, the FWFW argument indicates that most of the efforts based on technological innovations have not the ultimate goal of limiting emissions. The reality tells us that most of the new technologies are being developed to face climate change issues *provided that* at the same time the business as usual of the economic growth purpose is kept working. As declared in the Paris Agreement (Art. 10, par. 5), "Accelerating, encouraging and enabling innovation is critical for an effective, long-term global response to climate change and promoting economic growth and sustainable development".

Without entering the details of the wide range of initiatives that link technology development and climate change, the conclusion of the recent Report by the UK Centre for Climate Change Economics and Policy, entitled "The Sustainable Infrastructure Imperative" (CCCEP, 2016), reads: "Building sustainable energy infrastructure provides a triple win: it boosts growth, reduces air pollution and greenhouse gas emissions, and expands and improves energy access". Again, the emphasis of the entire report is put on the economic growth, as confirmed by the United Nations Secretary-General Ban Ki-Moon himself, who addressed the launch of the Report with the words (UN, 2016): "With this report, I sincerely hope that decision-makers in the public and private sector have a set of concrete recommendations for sustainable low-carbon economic growth".

The gaining of public consensus is a powerful feature upon which narratives of research and development are based on. One of the prerequisites in EU research planning is the necessity of always having a public acceptance and consensus through the stakeholders involvement, especially those who have economic interests in the same planning activities. On the other hand, strategic plans quite rarely address the FWFW questions, limiting to generic, rhetoric and surely endorsable declarations about a better future for everybody. New technologies, aiming at keeping business as usual, are presented as responsible steps forward to handle the gravity of the climate change problem. Fracking, shale oil etc. are promoted as necessary for a *transition* towards a fossil-fuels independent global society, but the investors' requirement (be them public or private) remains that of keeping a sufficiently high Energy Return on Investment (EROI), making the market the validator and the real end-user of technology improvements. In this way, a narrative is promoted that shifts the attention from what should be really done, in so contributing to create the false perception of a technology which is always good for solving global problems and for everyone.

4.2 Technology and the Smart Cities

Several sustainability-related issues based on the development of new technologies have become popular in the public and scientific debate. Among these, a quite actual issue is that of the Smart Cities, cities that use Information and Communication Technology (ICT) to enhance their livability, workability and sustainability (Smart Cities Council, 2013). Internet of Things and Big Data should allow to increase smart operational efficiency (see for example CCCM, 2018), making it possible for citizens to have access to a "culturally vibrant and happy life". Generally speaking, the effects of innovative technologies – in particular ICT-based ones – in making a city more sustainable seem to be largely overestimated, in as much the very meaning of "sustainable city" is not addressed whatsoever. For the European Union, sustainability of a smart city is based actually on the presence of more competitive industry and Small-Medium Enterprises (SMEs), as well as on smart energy, smart transportation, and ICT (European Commission, 2012 and 2013). Based on the literature on smart cities, it seems that the main problems of an urban community are traffic congestion and slow internet connectivity, supposedly a major obstacle to the business. As recommended by Industrial Internet of Things (IIoT) global digital publication, "Smart city management models must integrate a new ecosystem of value creators and innovators", with "innovative spaces" where they are supported in "monetizing new business models" (IIoT, 2018). It is interesting to note how the word "ecosystem" is often rhetorically used to describe a smart city to emphasize its highly interconnected nature, at the same time neglecting most of the components that make a system an "ecosystem", the living creatures (Odum, 1996). In the smart cities narrative, vegetation is relegated to the role of parks and green areas, without considering the importance of plants for the well-being of all animal species in the city, nor the ecosystemic services in terms of evapotranspiration and temperature regulation (Almeida et al., 2018). Animals presence is *never* addressed, in spite of their important role in the city overall sustainability: insects guarantee the health of green areas as well as that of birds and migratory species, bats eat mosquitoes, while the communities of dogs and cats provide an enormous service in term of the (human) citizens well-being, in particular that of aged people and children, and so they should be regarded as part of the citizenry for biophysical, systemic and ethical reasons. To neglect this important part of the city system in a policy-planning activity means to be blind of the interconnection network of all social, environmental and economic aspects and problems which the smart city narrative advocates. Interestingly, as a matter of fact, children, animals, and plants do not drive, do not use the internet, do not produce business, and do not participate in the electoral choice game, neither by voting nor by being voted.

The narrative on smart cities is very often characterized by a surprisingly high cognitive dissonance. From a systemic point of view, the problem is that the current city smartness is the change, innovation and optimization of processes inside, but without taking into account the necessary change in local stocks and the inflows from the supporting area (Brown and Ulgiati, 2011). In this respect, a quantitative estimation of the resources required from supporting areas to make a city smart is hardly addressed, nor a rigorous systemic approach is proposed (Ascione et al., 2011). In this conceptual framework, technology is assigned of a power that it has not, that to address and solve the problems of the city community. Under this discourse, the city would survive and operate independently of its surroundings. Besides traffic management, data access and ease of doing business, much more serious problems occur outside the technological realm: poverty, unemployment, forced immigration, pollution, marginalization and violence are all aspects of a city life that seem to be ignored or absent from the description given by the enthusiastic smart city narrative focused on the problem of the traffic congestion, talking about communities that simply do not exist.

The role of technology in the smart cities issues is therefore highly biased, and the FWFW questions assume a crucial relevance. The Smart City model talked about at the EU level, for example, is clearly a Western World Smart City. In the 256 pages of the report "The making of a smart city: best practices across Europe" by the EU Smart Cities Information System (EU, 2017), the word "mobility" appears 114 times, and the word "business" 67. None of the words "child/children", "welfare", "poverty", "violence", "disability", "inequality", "gender", "happiness", "vegetation", "animal(s)", are present. Interestingly, the word "green" appears 31 times, but only five of them are related to green spaces or areas. Along with green economy and green growth, these best practices contemplate green energy, green jobs, green power, green buildings, green roofs, green cooling and green heating, green electricity, green research, green contributions (?) and – of course – green mobility and green parking. As a matter of fact, the model is just not exportable to most world cities, where most part of mankind lives. The number of slum dwellers worldwide is constantly increasing, forming about one billion people excluded from any participatory political and economic issue of the city they live in. Indeed, it is hard to address "smart interconnectedness" where there is no electricity, or fast-ICT access to sanitary data where there are no sanitary infrastructures, or talking of a "culturally vibrant and happy" smart living where the problem is just that of living, or surviving. But this cognitive dissonance when talking about technology and smart cities might go even farther: the plausible failure of the policies addressed by the Paris Accord to keep temperature increase below 2 °C will make much of the smartness we are discussing about senseless even for Western European cities, for example, London, as far as electric public transportation infrastructures are unlikely to be operated in a partially flooded town (Strauss, 2015).

4.3 Technology in a circular economy perspective: the case of biorefinery

Over the last decades, the transition to a decarbonized energy system has resulted in greater bioenergy production, with an expected growth of biofuels, such as bioethanol (EtOH) and biodiesel, from 2% of market share today up to 27% in 2050 (Stafford et al., 2017). In particular, bioethanol production has sharply increased, with USA and Brazil leading producing countries (Wiloso et al., 2012; Zabed et al., 2017). At an initial stage, the feedstocks used for EtOH production were sugar and starch crops, such as corn, maize, wheat, sugar beet, cassava, sweet sorghum, sugar cane, among others (de Vries et al., 2010). Worldwide, these so-called first generation crops have been grown mainly driven by dedicated subsidization policies supporting the production and use of transport biofuels (Sorda et al., 2010; Lamers et al., 2011). Nevertheless, first generation energy carriers have been criticized for competing with food production (UN, 2007; IFG, 2007) as well as for showing an insufficient energy return on energy investment, due to the relatively small yield per hectare, and high environmental impacts (Pimentel et al., 1981, 1988; Pimentel, 1991; Giampietro et al., 1997; Ulgiati et al., 2008). The proliferation of subsidy policies has worsened the global picture, as they fostered the continuous cropping of a single culture constituting a major agro-ecological risk (Gomiero, 2017). The employment of second and third generation feedstocks, such as lignocellulosic biomass, non-food crops, bio-based waste raw materials in general and algae, has been commonly recognized to overcome the food versus fuel conflict (McKendry, 2002), in line with the concept of integrated biorefineries. Namely, a biorefinery is "the sustainable processing of biomass into a spectrum of value-added products (chemicals, materials, food and feed) and energy (biofuels, power and heat)" (Kamm and Kamm, 2004), working similarly to a traditional petroleum refinery.

In this context, the European Union (EU) directive encouraged the employment of second and third generation feedstocks, in order to reduce land use change, ensure food security and decrease greenhouse gases (GHGs) emissions (Directive 2009/28/EC; COM 15 final, 2014). The implementation of integrated biorefinery systems has required the development of highly innovative approaches for a deeper understanding and improved management of water-energy-materials-environment nexus towards new circular economy pathways. A circular model where products and materials continue to circulate seems to be more advisable than the common linear consumption and production trends. Integrated biorefineries seem to perfectly fit the circular economy model in which agriculture, land, research and industry work together to create new sustainable products, employment and competitiveness. Nevertheless, legislative dispositions and some scientific evidences underline that the feasibility of integrated biorefinery in a circular economy perspective has to be carefully evaluated, mainly in the broader context of sustainable pertinence. The relevant scientific literature of different bio-based production pathways (Zucaro et al., 2017, Fiorentino et al., 2017) highlighted the relevance of: (i) feedstock cultivation or used raw materials; (ii) selected transformation routes for each final bio-product and (iii) the biotechnological processes involved in their transformation (Hattori and Morita, 2010; Erickson et al., 2012; García et al., 2014). In this regard, the choice among different conversion routes as well as the selected technological processes might amplify or reduce the impact of the whole supply chain and establish economic competitiveness with the fossil counterpart. The environmental loads generated through the whole chain of bio-based products have to be carefully quantified and assessed to ensure adequate decisions and to avoid too optimistic claims as with first-generation biofuels. The expected advantages of bio-based production routes consist in significantly reducing greenhouse gas emissions and fossil fuel use. The consumption of non-renewable energy and the consequent effect on global warming are of paramount relevance, but climate change is not the only variable to account for. According to Rockström et al. (2009), the biophysical threshold of the climate system, defined by the critical value of the CO_2 concentration, has been crossed, but planetary boundaries were even largely overtaken in other Earth-system processes, such as biodiversity loss and interference with biogeochemical cycles. Therefore, the impact of the bio-based production should also be weighed on chemical pollution as well as on water and land use, throughout the evaluation of generated impacts on water, air and soil affecting human and ecosystems health.

Recent scientific literature stresses the need to thoroughly ponder pros and cons of biorefineries and other circular economy systems, never neglecting two fundamental aspects: (i) the identification and quantification of environmental and socio-economic impacts has to be implemented both at local (considering site-specific conditions) and global levels; (ii) the evaluation of technological advances cannot be limited to the final target to be achieved, an end in itself, but has to be broadened in a wider context of external implications. This investigation on biorefinery process is therefore particularly instructive, as far as it shows clearly that technological choices, in terms of allocation of investment resources, are strictly linked to several aspects that common perception tends to neglect when reasoning about technological improvements. The role of subsidization policies, the transportation issue, the competition with different land use, the biotechnological processes upstream and downstream the biofuel production, the return on investment values, the generated impacts are all aspects that must be taken into account for a genuinely sustainable approach. This clarifies how technology *per se* is not an answer, at least, as far as the questions are not correctly set.

5. Technology, Communication and Higher Education

A systemic approach that integrates the FWFW questions requires new narratives, in which systems act to match action and information with their goals (Giampietro et al., 2011; Pattee, 1995). Goals and actions need an agreed validation process that "test the knowledge claims used as a basis to make collective choices" (Jasanoff, 2005). Agents, observers, validators and institutions in a system will perform their role more coherently if they are informed and critically aware of the functioning of the system, if they have the capacity to pose the "for whom/for who question" at the stage of the validation of each action to be undertaken. In this sense, it is arguable that technology is needed in a sense which recovers the primordial meaning of the word: the study of the techniques used to address practical problems.

The predicament of our species (see for instance Catton 1980; Dittmar, 2014) urges the development of new approaches to tackle "problems introduced through policy issues where, typically, facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz and Ravetz, 1991, 1993), a "post-normal" science in which sustainability arguably has a central role (Konig et al., 2017). Such systemic approach has implications for actions at both the educational and at the research level. Such actions have the goal to prepare the members of the communities to incorporate the new narratives and systemic knowledge in a way that is coherent with the knowledge itself. A preliminary list of tasks is proposed, whereas the connection between the tasks and actors is left open to. At the educational level, we first need to generate and implement an educational program that incorporates systemic knowledge and perspective, trains to use the FWFW questions in a way that is coherent with the systemic perspective. The integration of sustainability principles into curricula (Ferrer-Balas et al., 2010) will allow students to work on current, real problems with new interdisciplinary and systemic approaches. Moreover, such educational program should support a communication approach that makes assumptions and biases explicit when developing the corresponding narratives. As for the education, at least two levels can help developing appropriate approaches: civic education and higher education, the former involving all the population. Higher education, by involving millions of undergraduates, some of whom will convert into policy-makers, holds a major role in propagating sustainability concepts, aiming at improving and adjusting the technologies available or developing. Civic education addresses a major role of the high school environment but also of its community – consisting of teachers, staff, students and their parents – mainly through teacher training and continued education practices on sustainable processes.

At the research level it seems necessary to:

- develop the theoretical basis for the investigation and implementation of new narratives, in particular, concerning the a pedagogy aimed at implementing the education methods that supports it. Such studies are needed to develop tools that are respectful of the different histories and cultural traits of different human communities, while at the same time allowing the common aspects of the new narratives to emerge (see for example Hauge and Barwell, 2017);
- study, develop and design techniques to make the FWFW questions an underlying component of the process of attributing value and even, in many instances, motivate research efforts. An example in this respect is the higher level of involvement of those communities that are affected by some of the techniques being developed (Ceccarelli, 2009; Mustafa et al., 2006, Nature, 2018);
- help communities at various levels (local groups, cities, provinces, countries) to develop, organize and implement the informed validation process, including the ways to understanding one's role in it (agent, observer, institution);
- re-analyze the role of the intellectual/researcher/scholar within the community, in particular in times of ecosystem crisis (Functowicz and Ravetz, 1993; Pereira and Saltelli, 2017).

In defining new educational contents and methods, community members need to become not only intellectually prepared, but also emotionally, mentally and socially. That is why the new narrative needs to encompass humanities and scientific fields, with the multidisciplinary contributions by a variety of knowledge carriers: economists, educators, artists, media scholars and the like. Contributions will be needed from professors at any level of the education system: schools, universities and training centers. Contributions of scholars inside and outside universities and research centers will be needed in a correlated manner with multiple actors involved to achieve one of the tasks illustrated above and with multiple tasks being developed in each institution. Conceiving a widespread communication program aimed at the extended community will allow a coherent treatment of the two actions. That will be the forum to analyze and discuss the solutions and/or the scenarios extrapolated by communication network groups, in so creating some sort of network of "neutral" experts to build awareness in people at different communicative and educational levels. Within this context, technologies intended as the study of techniques used to address practical problems find the place to be developed so that techniques are assessed, validated, accepted or rejected.

6. Conclusions

In the Working Group, besides trying to remove from the discussion on the possible role of technology biases given by possible ideological beliefs, we addressed the systemic perspective of the discussed aspects, pointing out how boundaries and systemic purposes can be actually strongly biased in the current debate at all levels, namely, public, policy-making and scientific. The debate about the possible role of technology in meeting the energy future and other global concerns does not present any scientific objectivity. Engineering, political, social, economic and environmental issues are in turn put together in different fashions to draw conclusions that are often detached from the reality, or covering only parts of this reality, at the same time lacking logical structure, allowing any sort of contradictory claims about the role/use of technology. What should be a logical mandatory pre-requisite in any attempt to seriously analyze global complex problems as well as to propose strategies for their solution is almost always lacking: a correct systemic framework to explicit what we want to do and the purpose of what we want to do, answering first of all the questions “technology for what?” and “technology for whom?”. Without having clarified this *Weltanschauung*, anything may be said about energy and technology. As long as global and local energy systems are run by corporations, any attempt to change things at specific levels by technology will fail, since the system will rearrange itself to maintain the profit, which is the real systemic purpose.

As long as we consider the geobiosphere as a sub-system (a resources provider) of the human-made economic system, any attempt to fix environmental and social problems by keeping the business as usual, i.e., the mantra of economic growth, will fail. The reality tells us the reverse: geobiosphere is not a sub-system of the economy, economy is a sub-system of geobiosphere. As systems thinkers know, trying to keep alive at any cost the operation of a sub-system will give rise to a re-arrangement of the super-system – the geobiosphere – that will self-reorganize to absorb and make ineffective our attempt, then continuing its own way. The Kyoto Protocol is a clear example for it. It just failed, as it kept a business as usual perspective, whilst trying to solve the problem of emissions and of temperature increase. The present economic system cannot converse with the geobiosphere and expect it to adapt to its own rule. It is the geobiosphere, as the super-system in which we are embedded, that is laying the cards for the economy, but present economy is deaf. Keeping a business as usual course while trying to solve climate change problems is destined to failure because the economy has a different systemic purpose (profit, growth) than the super-system, the geobiosphere. Geobiosphere is autopoietic, and has its own survival as its systemic “purpose”, in the – almost tautologic – sense of the Darwinian conceptualization. This survival will be pursued with or without humans.

The topics and the examples discussed during the Working Group activity at the BIWAES Conference by the participants, and then presented in this work, are profoundly complex and interconnected. Technologies are being developed so fast that their overall future implications are hardly foreseeable. Policy-makers and, in general, central or local administrators usually have to do with policy choices that have to be promptly taken before the new technology comes up, taking into account also possible moral and ethical consequences. This can create problems at different decisional levels, that should be anyway investigated and assessed through objective and scientific methods (Rundle and Conley, 2007). Concerning the implications that this discussion addresses, policy-makers should be prepared to frame the technology aspects considering in particular:

- a broad and long-termed assessment of technologies sustainability
- the need for integrated and multi-criteria tools in the planning of policy actions
- the need for continuous re-adjustment of tech-use strategies during their application.

Away from mono-dimensional perspectives, an integrated decision-making tool is needed in order to ascertain not only the environmental or economic aspects, but also the social, political and cultural desirability. In fact, several studies have highlighted the necessity of a broad-based approach in which different tools and multi-criteria methods are combined to merge different competences coming from scientific research, economics, social sciences and even human psychology (see for example Giampietro and Ramos-Martin, 2005).

Being technology a tool to achieve a goal, we focused our attention on what this goal should be, compared to what it actually is and to what the corresponding narratives claim it is. A list of conclusions are finally proposed, aimed at further stimulating the debate on technology and future at different, yet deeply interconnected, levels:

- No consensus seems to exist on the meaning and scopes of technology in helping to face global problems, and the debate is quite often focused in single different pieces of technology, without a systemic, integrated perspective.

- Diverging and incommensurable positions are common, coming directly from a variety of tacit presumptions and biases.

- The intrinsic interconnectedness of technology with politics, economy and environmental issues is usually neglected, in favor of simplified narratives that give for granted the “goodness” of technological innovation.

- There is a strong need for a correct contextualization of debate on technology, under several points of view:
  - ✓ economic/political (developed vs. developing vs. undeveloped countries)
  - ✓ social (wealthy vs. poor countries)
  - ✓ ethical (tech. for all vs. tech. for somebody vs. tech. for the geobiosphere)
  - ✓ spatial (local vs. global technology)
  - ✓ temporal (long-term vs. short-term technology).

- The need for open, shared and openly-described narratives is mandatory. The FWFW questions may certainly help to gain a more deep awareness about what is happening around us, but the development of new ways to communicate and disseminate this kind of knowledge appears to be mandatory as well. In this sense, the role of Higher Education in forming an aware citizenry is never overestimated. The use of specific topics, or specific case studies, like those presented in this discussion, may represent a first step.

It is finally worth recalling the long debate about the societal role of the scientist, who is at the same time called to produce new ideas – then converted into technology – validate and address their use and predict the consequences. Based on the discussion above, it seems that now the scientist is also called to provide an integrated, systemic picture of the social advancement promised by the new technology, as far as its effective contribution to address the global concerns we are facing depends more and more on ideological and social aspects.

So, is technology optimism justified? In this form, the question has hardly a definite answer. The feeling we all had during the discussion is that any answer could be given, depending on how technology is defined, what is intended to be its purpose, and who is expected to be the real end user. We might certainly say that some kind of optimism is intrinsically, by definition, associated to technology, so some form of conceptual trust on technology is certainly justified. On the other hand, the kind of optimism that the current debate associates to technology, based on the sustainable development-based mindset, appears in many respects senseless. It seems, in fact, to be based on the elusive use of both the concepts of technology and sustainability, that are put together for narrative purposes without an explicit conceptual assessment. On one hand, the factual role of technology and its beneficiary are almost never clearly addressed in the debate. On the other hand, the fact that any new technology will serve the cause of sustainability is not questioned whatsoever, without taking into account the social, political and ethical framework in which technology is supposed to be operated. Certainly, the clarification of these issues, that are at the very basis of each narrative, appears to be a pre-requisite for *any* serious analysis.

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Highlights

- This paper is based on a discussion developed by one of the thematic working groups at the Biennial International Workshop Advances in Energy Studies (BIWAES) 2017 hold in Naples, Italy.
- The presented reflections address some conceptual weaknesses in the current debate on technology and global issues.
- No consensus exists on the meaning and scopes of technology. The questions "Technology for what?" and "Technology for whom?" are mandatory for any serious debate.
- There is a strong need for a correct contextualization of technology debate, under economic/political, social, ethical, spatial and temporal points of view.
- A shared and openly-described narrative is mandatory.