

2014 Trans-Atlantic research and development interchange on sustainability (TARDIS 2014): summary of discussions

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Abstract The Trans-Atlantic research and development interchange on sustainability (TARDIS) has been bringing together a select group of scientists and engineers for in-depth discussions on sustainability on a bi-annual basis since 2004. TARDIS 2014 included 28 individuals from across the globe discussing issues related to progress toward sustainability. The discussion included policies, technologies, societal structure and norms, business practices and culture, and time-frames. As discussed later, the focus was on four questions: (1) what progress has been accomplished in sustainability? (2) Why has there not been more progress in moving societies toward sustainability? (3) What are the road-blocks to progress toward sustainability? (4) What are the policies, technologies, and other changes that are needed to make further progress toward

sustainability? One salient conclusion from TARDIS 2014 is that while sustainability has entered mainstream thinking, significant social, economic, technological, and business barriers remain to further progress toward a sustainable path as discussed throughout this report.

Keywords Sustainability · Policy · TARDIS · Workshop

Brief history of TARDIS

The TARDIS workshops are a series of meetings on scientific topics related to sustainability held every other year alternating between Austria and the US. The first workshop was held on the subject of modeling and sustainability at Schloss Seggau in Leibnitz, Austria on October 2004. TARDIS 2006 was held on September of 2006 at the YMCA of the Rockies in Estes Park, Colorado, USA on the topic of underlying scientific principles of sustainability. The TARDIS 2008 workshop was held on October 2008 again at Schloss Seggau on energy and sustainability. TARDIS 2010 was canceled due to a shutdown of the US Government. The TARDIS 2012 workshop was held on April 2012 at Schloss Seggau in Leibnitz, Austria on the topic of time and time-frames for sustainability. The TARDIS 2014 workshop was held on June 2014 at the YMCA of the Rockies in Estes Park, Colorado, USA on the general topic of social, economic, policy, and regulatory incentives to promote sustainability in society.

Participation in TARDIS is strictly by invitation only, and participants must additionally meet the following criteria: (1) a graduate degree in a science or engineering discipline, (2) experience in scientific and engineering research as evidenced by a body of publications in the peer-reviewed or credentials and experience in the application

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and implementation of sustainability to “real life” problems, and (3) an interest in the specific topic of the workshop. The body of participants will be balanced to include adequate representation with respect to discipline (engineering, physics, chemistry, economics, policy, etc.), institutions (academic, government, private sector), and regional and national representation, (4) minorities and women will be encouraged to participate.

TARDIS 2014 themes

The TARDIS workshop series has been a mirror of the development of sustainability within the last decade. TARDIS 2014 therefore offered the possibility of taking stock of this development, not only in general terms but also analyzing differences and similarities between America and the EU. The goal of TARDIS 2014 was to fundamentally explore the question of why sustainability has not progressed as much as one would hope in the two or three decades since the concept became widely discussed. This is an important issue because one of the consensus ideas that came from the TARDIS 2014 deliberations is that the concept of sustainability has entered main stream thinking in society. Hence, the workshop was organized along the following four closely related questions:

- (1) What progress has been accomplished in sustainability?
- (2) Why has there not been more progress in moving societies toward sustainability?
- (3) What are the road-blocks to progress toward sustainability?
- (4) What are the policies, technologies, and other changes that are needed to make further progress toward sustainability?

In the four sub-sections that follow we discuss the salient findings from the TARDIS 2014 discussions, making every effort distil to the most essential elements and important points.

What progress has been accomplished in sustainability?

The discussions at the TARDIS 2014 clearly showed that the concept of sustainability has matured into a new and comprehensive paradigm for development. It has its base in a holistic perception of reality that human beings are inherently linked across the globe as well as across generations and are inseparable from their natural context. From this point of view, individuals become an integral part of a global, finite “living” system, each action of an individual influencing the whole system and acting back on

the individual’s fate by changing the system, as already laid down in various publications in the field of ecological economics (Scott Cato 2009).

Note that 27 years after the Brundtland Report (WCED 1987) and 22 years after the World Summit in Rio de Janeiro, sustainability has finally achieved recognition as a development path in its own right. One consequence of this line of argument according to the discussions at the TARDIS workshop is that within such a holistic view of reality that forms the basis for sustainability, the concept of growth must be thoroughly recalibrated. The recognition of this fact is of great importance insofar as the current dominant development path is based on the concept of (unlimited) economic growth. It is a major accomplishment that over the decades from the Brundtland Report, sustainability has not been absorbed as an “add-on” to the dominant development concept. But it has asserted itself as an independent paradigm that may compete over the next decades for dominance with respect to guiding politics, social, and cultural development.

Both the term sustainability and the main tenets of sustainable development have already gone main stream (Sikdar 2014a, b) in the societal discourse about the future. Conversely, the discourse about sustainability has become much more refined over the quarter century since the Brundtland Report. A diversity of thoughts and normative positions has entered this discourse which is now loaded with partly contradictory visions for the future, development goals and the possible strategies to achieve them. On top of that, we still face strong traces of the agendas set by a relatively small group of pioneers from Daly (1996) to Donella and Denis Meadows and the Club of Rome (Meadows et al. 2004) to Ernst-Ulrich von Weizsäcker and Amory Lovins (Weizsäcker et al. 1995) to Rees (1992), to name only some of the well-known exponents. This makes the current sustainability discourse colorful but at the same time divisive.

The crossing of the pioneer phase threshold however creates increased visible resistance against change. The plurality of actors and institutions are still shaped by development focussed on unlimited growth and the assumption of infinite natural capital. It has become increasingly clear that a change toward sustainability requires a profound institutional change as well as change in the behavior of individual citizens (Meadowcroft 2009; Meadowcroft et al. 2009). Such change clearly meets resistance as it requires re-thinking and re-building of the very structure of society. The discussions at the TARDIS workshop listed the current structure of subsidies, the predominant reliance on markets to solve societal challenges, and the strong preference of individualism over societal integration as particularly critical fields of tension between the current and the sustainability paradigm (Krozer 2014).

Besides the progress on the conceptual field, sustainability has, however, also made inroads in important practical ways. At the TARDIS workshop the transformation of the European energy markets that is currently under way was cited as an example (Duic 2014). This change clearly accommodates more environmentally friendly technologies. First successful business models, such as the Zero Waste initiatives that already took hold in the US and Europe were also cited as examples (Lombardi 2014).

Why has there not been more progress in moving societies toward sustainability?

Sustainability is a keyword commonly used by researchers and practitioners globally. However, even defining the goals of sustainability is fraught with difficulties and hence attaining it is difficult, if not nearly impossible. For example, Fig. 1 shows sustainability as defined in the chemical engineering literature, and as can be seen sustainability means different things to different people. Although sustainability has become a common word in industrial and academic community, this can be both good and bad. Awareness that we have to do something for sustainability is good. However, defining sustainability in a narrow framework can be a problem. Because of the variety of views on sustainability, a diversity of thoughts and normative positions has entered the discourse which is now loaded with partly contradictory visions for the future development goals and possible strategies to achieve them (Narosdoslawsky 2014). This is a real problem in moving toward sustainability. Although, Brundtland Commission's definition of sustainable development "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987) is widely accepted, it is the widely differing definitions of sustainability in the context of an

industrial or societal system that creates problem for progress. It is in this context that Sikdar (2014a, b) presented sustainability as a macro-, meso-, and microscale problem. He stated that sustainability is like an elephant as everybody sees sustainability in a different ways and defines it accordingly. Figure 2 illustrates the systems involved as macro-, meso-, and microscale problems. One needs different kinds of methodologies and tools at these different levels. Over tightening at micro-scale level can create problem at other levels. Therefore, what we need is an integrated picture of sustainability going from microscale level at industry to international to global level sustainability. The problem of going from microscale to mesoscale to macroscale is that the time scale changes at order of magnitude levels (Diwekar 2014). The other problem with this time scale is that we cannot expect good governance from political officials because their time cycles are very short as compared to the ecological time scales.

The other difficulty related to sustainability is that the study of sustainability of our planet is fraught with several problems. The difficulty is that at the planetary scale when ecosystems, societies, and economies are considered, the system becomes very large and very complex. Uncertainties become time-dependent and decision forecasting is essential in order to study the sustainability of the planet. These are difficult areas of research. Cabezas (2013) defines sustainability as a path or system trajectory moving in various dimensions of ecology, society, time, economy, energy. This is depicted conceptually in Fig. 3. The multidisciplinary nature of sustainability issues means going beyond one discipline where understanding and communicating become difficult but very important. This can be a significant hurdle, given that people are more comfortable in their own discipline. Further, sustainability is a global problem, and there is no international body to address this. This is a major hurdle in the implementation sustainable policies.

Fig. 1 Data mining for sustainability: Chemical Engineering Research (Srinivasan 2014)



Fig. 2 Micro-, meso-, and macroscale in sustainability

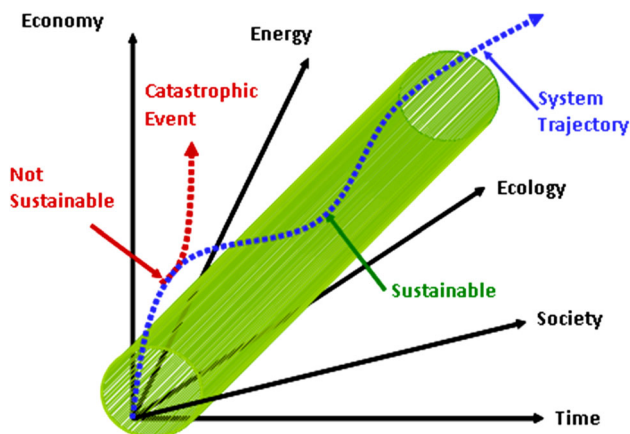
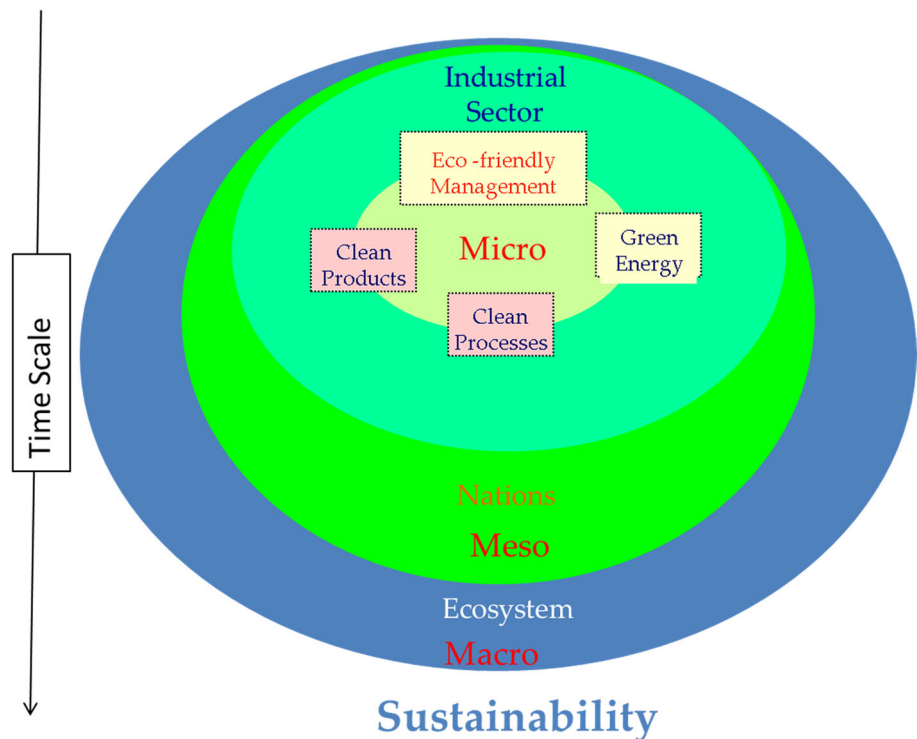


Fig. 3 Sustainability as a path through time (Cabezas 2013)

What are the road-blocks to progress toward sustainability?

In looking at barriers to sustainability, the US Federal Government represents a large bureaucratic organization that has been directed to move toward sustainability. Many of the barriers faced by the federal government are also present within other large organizations, especially those with a hierarchical structure. Due to this similarity, the federal system will be used to articulate some of these barriers and provide examples of how to overcome them.

The federal sector in the US is the largest purchaser of goods and services, the largest consumer of energy, and in 2013 about 35 % of the \$3.5 trillion US budget was spent by federal agencies. The federal sector has the leverage to require actions through regulations, policies, procedures, contracting resources, executive orders, regulations, and laws. It also has the power to be a sustainable role model for the rest of the country. There is a long-standing practice of US presidents, through the process of issuing Federal Executive Orders, to order facilities to adopt sustainable practices in order to serve as an example for others to follow. Despite this effort, many barriers exist.

Sustainability presents complex issues and challenges that cannot be viewed individually or easily solved with existing methods. It is more than simply installing technological fixes. It is about changing values toward both the use of and care of natural resources. It is done by changing the system of operation. The structure of any system determines the systems behavior (Doppelt 2010). Systems are composed of elements, interconnections, and functions (Meadows 2008). Once the relationship between structure and behavior in a system is identified, the barriers in advancing sustainability in the federal sector can be identified when looking at the system from this perspective.

Changes in the elements of the federal system, like changing the light bulbs in an office to LEDs, hardly help. The huge purchasing power of the federal government can be a leverage to move the system toward sustainability if it

is applied in concert across the whole system. Changing all of the light bulbs in all of the government offices would serve to initiate a big change to lower electricity bills, drive the price of sustainable products down due to increase in availability, and serve to change the culture around lighting. The barriers to changing the elements are lack of knowledge, risk avoidance for something new, and a culture of complacency.

The interconnection, both within the hierarchical organization of a federal government agency and between governing agencies, is an important leverage point. Governance is traditionally compartmentalized, laws and statutes further stovepipe actions and decisions within government organizations (National Academy of Science, NAS 2013). The current practice is for scientists to focus their expertise on one topic and they may be unaware of important constraints in other areas of the interconnected system. The lack of interaction between sustainability practitioners and scientific research is a barrier to sustainable outcomes, but it is one that is not limited to government organizations. Sustainability requires connections between groups who normally do not interact and the culture to make these connections is not yet part of the government system.

Sustainability issues also involve connections between social, economic, and environmental issues. Most government organizations are given the mission to address only one issue or one part of an issue. Collaborative approaches are good, but it is often hard to identify appropriate stakeholders, and to get them all at the “table” at the same time (TARDIS 2014).

Connections among these realms usually vary by their scope, scale, and timeframe. The timeframe for action is especially important. Politicians have the power to make decisions, yet run in typically 2- and 4-year cycles. Human lifespan is about 80 years, and environmental problems related to sustainability operate on cycles of hundreds of years. To move toward sustainable systems, bureaucratic organizations must learn how to operate in a multi-cycle system in which each system has a different periodicity (TARDIS 2012). Another roadblock in the federal sector is that budgets and priorities are often designed for 1-year cycles and regulations for resource use do not allow for multi-year operations.

The function or purpose of the system is a place where actions could be taken which “change the game” around sustainability. Each federal agency has its own mission, purpose or reason to exist. Often these include legal limitation of authority, so that an agency may be allowed to address only one focus area. These single-agency initiatives are designed to advance one agency’s mission. A change in the function changes a system profoundly, even if every element and interconnection remains the same (NAS 2013). Because sustainability issues cross

organizational boundaries, this is a significant barrier in moving toward a sustainable system.

Culture change

The approach often used to implement sustainability mandates entails cutting and pasting new jargon into old initiatives. This approach must be replaced with one that promotes innovation, risk taking, and allows for trial and error that may result in failure. The government needs to take a fail-safe attitude toward developing a new system. Lovins (Bioneers Conference 2011) once said “The best way to start having good new ideas is to stop having old bad ones.” How can this be achieved? The work of sustainability change agents within the federal sector has been influenced by the systems thinking approach developed by Donella Meadows. In her ground-breaking analysis of systems, a high ranking leverage point that can affect change is the mindset out of which the system arises (Meadows 2008). A mindset change in how leadership is defined is an important component of this shift. Government agencies must recognize that leaders exist at every level and within every discipline of the organization. Leadership allows agencies to grow initiatives that enrich the workplace and better align agency behaviors with intentions, and leadership is about integrating actions into our everyday business, not simply motivating people to do more (Jones-Crabtree et al. 2010).

Structural changes

Recognizing leaders in the organization is an important step and for these change agents to be effective, it must be followed by a change in the system’s structure. Sustainable systems have a structure that allows for self-organization, which is the strongest form of systems resilience. Self-organization means the ability to allow components to interact in concert to move toward an enriched system (Baumeister et al. 2013). This is usually accomplished by allowing anyone within the system to add to or change any aspect of the system as the need arises. Bureaucratic organizations lack the ability to self-organize and because of this, pose many barriers in moving toward sustainability. Insistence on a single culture, following rigid rules of protocol and behavior, promoting specialization that serves to focus on only one part of the system, and avoiding the risk necessary for system change often wipes out the raw material of innovation (NAS 2011).

Change in measuring results

Tools that are necessary in making sustainability decisions need to be developed. Indicator sets and appropriate

metrics need to be made available to government offices that assess programs and projects as they progress toward sustainability. Solutions to complex problems are best measured by metrics that provide the right feedback to the right part of the system at the right time. Monitoring with meaning acknowledges that the why, how, and when are often more important than the what. This includes fostering measures of success that serve to correct the course, provide timely feedback to the right people, and track the learning process (Jones-Crabtree et al. 2010). Behavior change may be its own indicator, perhaps difficult to measure but worthy of noticing, reporting, and celebrating. Dissecting the why, how, and when of specific successes or challenges can reveal inconsistencies, shedding light on what needs to be reworked or reinforced within the system or closing gaps between the measure itself and the sought-after outcomes.

Vision change

A vision concentrates on the future and outlines what the organization wants to be, or how it wants the world in which it operates to be. With vision, one must boldly declare a direction even if it is one no one else has taken. Vision is critical to leading by example. It is a source of inspiration, and supports the emergence of clear decision-making criteria. Sustainability is not an endeavor to undertake by oneself. Rather it requires the building of a ‘base camp’ that capitalizes on the energy in a group which is stirred by a common sense of purpose. Inviting cross-boundary, interdisciplinary, and cross-sector social innovators to the “table,” whether their points of view appear in line with each agency, can offer valuable sources of information about trends, potential leverage points, and new directions. A meeting of sustainability thought leaders at a conference like TARDIS is one way to foster this exchange of ideas.

What are the policies, technologies, and other changes that are needed to make further progress toward sustainability?

There are numerous books devoted to discussing the subject of sustainability policies in Klepper and Stähler (1998), Elzen et al. (2004), Benn et al. (2014) and Costanza (1992) from many different perspectives, including promoting sustainable consumption (Staniškis 2012). These include international policies, business, and environmental perspectives. Rather than recap this material again, here we discuss some of the salient points from the TARDIS 2014 discussions:

- (1) The economic and social risk associated with innovation has to be reduced to the point where economic actors, i.e., private firms, investment banks, and governments, feel comfortable with investing the necessary resources in new technologies and new business models. This may require the creation of new financial instruments, perhaps some form of business risk insurance underwritten by government but without the government itself dictating the direction of innovation.
- (2) The trend toward the dematerialization of economic activity has to be encouraged, because it may be the only way to maintain economic growth without overtaxing the physical and biological capacity of the Earth. Exactly what policies will effectively encourage this trend is difficult to predict, but one can imagine, for example, lowering taxes on businesses which are less-dependent on material and energy consumption.
- (3) The trend toward the increasing use of renewable energy has to be promoted, because meeting the forecasted energy needs of the developed and developing world may be environmentally and possibly economically difficult with carbon-based energy generation technologies. This may be a case where lowering the business risk associated with the deployment of renewable energy technologies could be effective. It should be understood, however, that there are economic actors, private firms, and even nation states, whose capital stock relies heavily on their fossil fuel reserves. Their legitimate interests have to be part of the discussion.
- (4) Support and encouragement for cross-disciplinary thinking has to be not only tolerated but proactively encouraged, because the solution and mitigation of sustainability issues almost never lies within the conceptual limits and thinking modes of any one particularly discipline. Even though recent times have seen tremendous “discussion” on the need for multidisciplinary, trans-disciplinary, and cross-disciplinary thinking, the reality is that most academic disciplines along with the financial support and publishing avenues remain largely locked on their disciplinary “rails” and struggle to break out of long established barriers.

At some level, one suspects that the aforementioned issues and needs may be symptoms of a deeper problem. That problem may be the lack of an appropriate Sustainability Cultural Narrative as discussed at TARDIS 2014. A cultural narrative is a set of beliefs, opinions, and modes of thought which generally tell people “how things are done.” This may be subtle and probably unspoken, but it is real.

For example, the reason why murder is not acceptable is that we humans have a cultural narrative which says that the unjustified killing of a human being is not acceptable. Unfortunately, our Sustainability Cultural Narrative is still either in infancy or at best adolescence, i.e., it is still in development. Had we a well-developed and widely accepted cultural narrative addressing sustainability such as we have for murder, addressing the aforementioned sustainability issues would be infinitely easier.

What such a narrative would look like is difficult to describe and probably impossible to predict in detail. But the general outline would have to say that gaining private or public benefit individually and collectively at the cost of damaging the critical physical and biological elements of the planet on which we live is unacceptable. To be effective, the cultural narrative would have to be supported by some form of social or economic sanctions. Again predicting what these sanctions might be is risky and probably futile, but one can imagine legally binding citations for extreme violations and economic incentives for more sustainable behavior. For example, there could be higher electricity prices for high consumers, lower ones for low consumers, and punitive fines for extreme consumers.

Summary conclusions

A detailed recapping of all that has been discussed here is probably unnecessary, but some of the recurring themes will be recapped in general terms. The first theme is that sustainability is a complex issue defined by path rather than a static and well-defined goal. It is, therefore, necessary to formulate sustainability strategies and criteria for metrics and indicators with the perspective that they are inherently time-dependent. The second theme is that while sustainability or sustainable development has become widely accepted, it has done so in the context of a wide range of opinion. This makes it difficult to find the common ground which is necessary for action. The third common theme is the recognition that significant changes in the culture and structures of the organizations are necessary to make progress toward sustainability. One reason is that actions and technologies that promote sustainability tend to be novel and, therefore, riskier than “business as usual.” Hence, organizational cultures and structures that are risk tolerant may be necessary. The last theme refers to the need for a cultural narrative that supports sustainability at multiple levels in society from the ordinary citizen to business and government leaders. This is not only important but also critical for the implementation of sustainability practices and policies to become wide-accepted and practiced. In summary, progress toward sustainability has many difficult challenges many of which have been discussed here. This

calls for persistence, patience, and faith the future of humanity.

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