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Article

Scenario Archetypes: Converging Rather than Diverging Themes

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Abstract: Future scenarios provide challenging, plausible and relevant stories about how the future could unfold. Urban Futures (UF) research has identified a substantial set (>450) of seemingly disparate scenarios published over the period 1997–2011 and within this research, a sub-set of >160 scenarios has been identified (and categorized) based on their narratives according to the structure first proposed by the Global Scenario Group (GSG) in 1997; three world types (Business as Usual, Barbarization, and Great Transitions) and six scenarios, two for each world type (Policy Reform—PR, Market Forces—MF, Breakdown—B, Fortress World—FW, Eco-Communalism—EC and New Sustainability Paradigm—NSP). It is suggested that four of these scenario archetypes (MF, PR, NSP and FW) are sufficiently distinct to facilitate active stakeholder engagement in futures thinking. Moreover they are accompanied by a well-established, internally consistent set of narratives that provide a deeper understanding of the key fundamental drivers (e.g., STEEP—Social, Technological, Economic, Environmental and Political) that could bring about realistic world changes through a push or a pull effect. This is testament to the original concept of the GSG scenarios and their development and refinement over a 16 year period.

Keywords: sustainability; future scenarios; scenario archetypes

1. Introduction

The publication of the 1987 Brundtland report, *Our Common Future*, by the World Commission on Environment and Development energized the concept of sustainable development and prompted the commitment of world leaders at the 1992 Earth Summit in Rio to development that “meets the needs of the present without compromising the ability of future generations to meet their own needs.” Undoubtedly these events helped place the sustainability agenda at the epicenter of national and international policy and research for the last 25 years. During this time it has been suggested that three dimensions are required to adequately address sustainability: ‘issues’ (i.e., the sustainability indicator spectrum from demographics to water); ‘space’ (i.e., international scale, different countries and regions); and ‘time’ (i.e., future generations, their needs and aspirations). ‘Urban Futures’ (UF) (www.urban-futures.org) is a 4-year EPSRC-funded project tasked with testing the resilience of today’s sustainability solutions through scenario-based research, considering a diverse range of issues (biodiversity, air quality, water, energy, underground infrastructure, built environment, density and decision making, organizational behavior and innovation, enterprise and social needs, aspirations and policy) within UK urban regeneration sites, assuming a time step of 40 years hence (the approximate length of time for a regeneration cycle). This paper is conceptual survey research which focuses on *future scenarios*. In this case future scenarios are not forecasts or predictions; they are plausible,

challenging and relevant stories about how the future may unfold [1–4]. The internally consistent descriptions/narratives used therein are determined by consideration of key drivers of change (e.g., STEEP—Social, Technological, Economic Environmental and Political) and provide a mix of qualitative and quantitative information that focuses upon aspects of *greatest uncertainty* and *importance*. This contrasts with scenario-building exercises which can be used as a practitioner tool in planning and community design contexts. In such cases a concise description (*i.e.*, a **vision**) of what the world looks like at some future time is produced on which consensus for a preferred future state is drawn, and a full strategy developed.

The first step of UF research was to identify and review existing futures studies (a forthcoming monograph by Hunt *et al.*, [5] identified >450 distinct scenarios variants since 1997) and then establish whether a distinct set of archetypes exists. The starting point for this paper is to investigate (based on qualitative detailing) the robustness of a set of archetypes first proposed by the Global Scenarios Group (GSG) in 1997. Conclusions are drawn as to whether the GSG scenarios might be adopted and refined for UF research that is UK-based, rather than necessitating the derivation of yet another set of scenarios.

1.1. Contextual History of GSG

In 1991 collaboration between the Tellus Institute and the Stockholm Environment Institute explored the following high-level research questions as part of the PoleStar Project (www.polestarproject.org, [6]):

1. What approaches and methods are appropriate for examining long-range socio-ecological prospects in a coherent and scientifically-grounded way?
2. What policy adjustments in the near term are necessary to assure a vibrant and verdant civilization for the future?
3. What are the implications for our values, behaviors, and lifestyles of taking seriously the concern for the well-being of people who are distant in space and time, and of the wider community of life with whom we share the biosphere?

This research resulted in the development of the polestar system, a flexible tool for quantification of integrated alternative long-range scenarios at regional, national and global scales. As such, it was used to produce detailed data sets (parameters relevant to economy, society, resource use, and environment) which, combined with the richness of scenario narratives, provided a robust methodological framework for considering fundamental shifts in global development—including discontinuities and restructuring of socio-ecological systems [7]. To carry on this legacy the Global Scenario Group (GSG—www.gsg.org), an interdisciplinary and international group with a pedigree of conducting integrated scenario assessments, was assembled in 1995 by the Tellus Institute and Stockholm Environment Institute. In 1997 Gallopin and colleagues first proposed a set of three plausible, divergent world end-states [8]—referred to as Conventional, Great Transitions and Barbarization—to which a fourth was later added [9]: **‘Muddling through’**—a passive majority (*i.e.*, not pro-active) on the grand question of the global future. Over a five-year period, six scenario variants (Table 1) were subsequently defined, refined and checked repeatedly for internal consistency [10,11]. In addition, quantification of analyzed data (using the Polestar system) was made available in a Technical

document for four scenarios; MF, PR, NSP and FW, Table 1 [7], updated in 2009 using an additional 10 years of data and an expanding literature on environmental, resource, and social developments [6]. Two others (EC and B) were not quantified, presumably because of their extreme nature.

Table 1. Global Scenario Group (GSG) Scenarios: Four archetypal social visions for the future, adapted from [1].

World end-state	Scenario variants	Archetypal Social Visions
<i>‘Conventional’</i>	Market Forces (MF)	A world that evolves gradually, shaped by dominant driving forces
	Policy Reform (PR)	A world that is influenced by a strong policy push for sustainability
<i>‘Great Transitions’</i>	New Sustainability Paradigm (NSP)	A world where new human values and new approaches to development emerge
	Eco-Communalism (EC)	
<i>‘Barbarization’</i>	Fortress world (FW)	A world that succumbs to fragmentation,
	Breakdown (B)	environmental collapse, and institutional failure

In 2005 Raskin (president of Tellus) compared GSGs’ visions of the future with five other well-reported scenario studies, WBCSD [12], OECD, [13–15], IPCC [16], UNEP [17,18] and WWV [19,20], and suggested that a common set of four archetypes could be found [21] (Table 1). Further mapping exercises have since been conducted, resulting from the development of yet more scenarios [22–32]. By combining this prior knowledge from the literature and adding in further scenario variants (based on qualitative details given within scenario narratives), a substantially increased evidence-base is provided herein to support the hypothesis that the world-end states (and scenario variants) first proposed by GSG continue to form a distinct set of archetypes (Section 2). The legacy of these GSG scenario variants are subsequently discussed in the context of providing a distinct set of archetypes relevant to anyone considering scenario-based studies (Section 3). Conclusions are subsequently drawn regarding the credibility of archetypes drawn from the GSG work (Section 4).

2. Comparing GSG Scenarios Variants with those from the Literature

In this section each GSG scenario variant is outlined within the three world end-states. Aligned to each GSG scenario variant are observations from the literature (shown in **Bold** in Table 2) that identify similarities with other scenario based studies and additional similarities that have been identified during this review (shown in *italics* in Table 2) Scenarios that fall under more than one category are listed under each.

Table 2. Scenarios grouped by GSG archetypes 1997–2011 (**Bold**—as described within the literature, *Italics*—additions from this research).

CONVENTIONAL		GREAT TRANSITIONS		BARBARIZATION	
(MF) [21]	(PR) [21]	(NSP) [21]	(EC) [21]	(FW) [21]	(B) [21]
FROG [12]	GEOpolity [12]	Jazz [12]	Sustainability First [17,18]	Security First [17,18]	A2 [16]
Business as Usual [19,81]	Technology, Economics	Values and Lifestyles [19]	B2 [16]	Fortress Europe [34]	<i>Diamonds</i> [61]
Reference [14,15]	& the private sector [19]	Sustainability First [17,18]	Local stewardship [22,39,	Fortress World [11,25,30]	<i>Decline to Disaster</i> [72]
A1 [16]	Policy variants [14,15]	Restoration [51]	40,58,59,60,67,68,79,81,83]	A2 [16]	
Markets First [17,18]	B1 [16]	Sustainable Behavior [51]	Delta [27]	National Enterprise [39	
Economy First [34]	Policy First [17,18]	Global Sustainability [22,39,	Transformed World [11]	41,59,60,68,83]	
Global Orchestration [54]	Global sustainability [22,39,	40,58,59,60,67,68,79,83]	Adapting Mosaic [54]	Regional-	
Big is Beautiful [112]	40,58,59,60,67,68,79,81,83]	Global Responsibility [41]	Survivor [51]	Stewardship [65]	
Global Economy [78,90]	Technogarden [54]	B1 [16]	Local Resilience [51]	Order from Strength [54]	
Great Escape [77]	Knowledge is King [112]	Green World [42]	Tribal Trading [81]	Scramble [54,82]	
World Markets [22,23,39,40,56,	Big Crisis [77]	Living on the No.8 wire [28]	Independent Aotearoa [28]	Clustered Networks [77]	
58,59,60,67,68,79,83]	Strong Europe [80]	Civic Renewal [43]	Eco-Communalism [30]	Transatlantic Market [80]	
Market World [11,42]	Global Co-operation [78]	CONNECT for LIFE [31]	Blueprints [82]	Continental Markets [54,78]	
Beta [27]	Policy Rules [34,35]	Global Orchestration [54]	Lettuce Surprise U [77]	Fortress Britain [23]	
Jeopardy [51]	Alchemy [51]	Global Commons [23]	Evolved Society [77]	Provincial Enterprise [22,	
Blinkered Evolution [43]	Global commons [23]	Great Transitions [25]	Regional Communities [78]	40,58,67,79,81]	
New Frontiers [28]	Gamma [27]	Sustainable world [30]	Sustainability Eventually [34,35]	Medium/Low	
Market Forces [25]	Green World [42]	<i>Hearts</i> [61]	<i>Building Lifeboats</i> [57]	-emissions [50]	
Business as usual [30]	Strong government [28]	<i>The Triple Whammy</i> [62]	<i>Medium/Low Emissions</i> [50]	Alpha [27]	
Free Markets [30]	Fruits for a few [28]	<i>Factor Four</i> [46]		Fortress Europe [34,35,42]	
<i>Riding the Tiger</i> [44]	SUCCEED through			Technogarden [54]	
<i>Triumphant Markets</i> [45]	SCIENCE [31]			<i>Lords of Misrule</i> [22]	
<i>World Markets</i> [83]	Green policy [30]			<i>Rivers</i> [35]	
<i>High Growth (F-0)</i> [46]	Technocratic [30]			<i>Turbulent Neighborhoods</i> [45]	
<i>GO for GROWTH</i> [31]	Policy reform [25]			<i>Boom and Blame</i> [69]	
<i>Growing on</i> [57]	<i>Leading the way</i> [55]			<i>Last Man Standing</i> [57]	
<i>Perpetual Motion</i> [81]	<i>Prosperous-Stewardship</i> [56]			<i>Brown Tech</i> [70]	
<i>Carry on Consuming</i> [48]	<i>Urban Colonies</i> [81]			<i>KEEP it LOCAL</i> [31]	
<i>Economy First</i> [34,35]	<i>Low emissions</i> [50]				
<i>Bazaar</i> [49]	<i>Innovation</i> [51]				
<i>High Emissions</i> [50]	<i>Business as usual (F-1)</i> [46]				
<i>Market Forces</i> [51]	<i>Powerdown</i> [57]				
<i>Uncontrolled Demand</i> [52]					

2.1. Conventional Worlds

The first GSG scenario variant within the conventional world archetype is ‘*Market forces—MF*’.

‘MF is constructed as a future in which free market optimism remains dominant and proves well-founded [33]’. ‘Market-driven globalization, trade liberalization, institutional modernization—relies centrally on the self-correcting logic of competitive markets to address global challenges [21].’ Populations and the global economy expand and free trade and deregulation drive growth. The availability of sufficient resources—raw materials, land, water, energy—and the means of maintaining ecological resilience in such a huge economy are critical uncertainties. The challenge of satisfying bio-physical sustainability constraints is compounded by the challenge of maintaining social and economic sustainability in a world of profound inequalities between rich and poor countries, and within each country [33]’.

‘*Market Forces*’ was originally referred to as a ‘*Reference*’ or ‘*Business-As-Usual*’ scenario [8,10]. The name ‘*Market forces*’ came later [6,9,11] and illustrates the need for a generic worldwide application for each world end-state. Whilst MF may be based upon historical patterns and business-as-usual for the future in the U.S. [6], it may not be a fair representation for a reference scenario everywhere.

Within the literature there are numerous scenarios aligning with the MF variant. Raskin [21] first suggested that the MF scenario was broadly similar to:

- First Raise Our Growth—*FROG!*—a familiar world where economic growth and success is a major concern and where human social systems are unable to meet the challenge of sustainable development, [12];
- ‘*Business as usual*’—a continuation and extrapolation of current trends with limited investment in water infrastructure, [19];
- ‘*Reference*’—a market forces approach based on current UN predictions, [13–15];
- ‘*AI*’—an integrated unsustainable world of very rapid economic growth [16], and
- ‘*Markets First*’—a world based upon market driven developments [17,18] (later developed to ‘*Economy First*’ [34,35], in which Globalization and Liberalization are embraced, economic growth is high and multinational companies dictate environmental standards, the close relationship being shown in Figure 1b).

The compatibility between ‘*AI*’ and ‘*FROG*’ has been recognized previously by Morita *et al.* [36], and the strong links between ‘*AI*’ and ‘*Markets first*’ have been reinforced by numerous authors [23,24,26,32,37,38], based upon both having a strong global-economic-self-interest/reactive focus, a commonality shared by many of the scenarios described herein (Figures 1a,b and 2). As such, ‘*Great escape*’ and ‘*Global economy*’ can also be added to the list. Table 3 shows qualitative patterns for some of the previously mentioned scenarios according to a range of key drivers from where direct alignment with MF can be seen.

Figure 1. (a) 10 Scenario studies on two axes of uncertainty, modified from [26,32]; (b) Approximate location of selected scenarios, modified from [34,35].

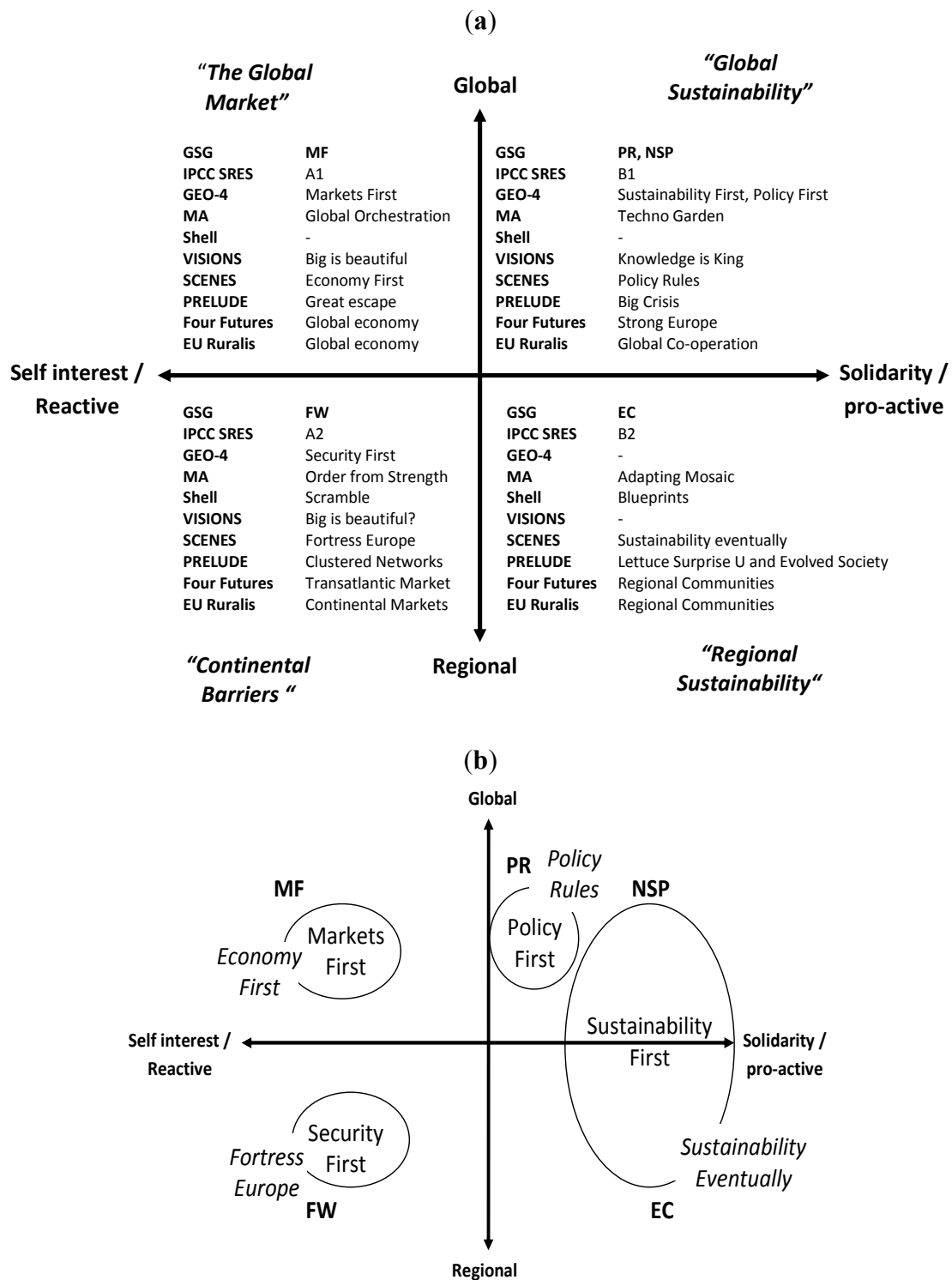


Figure 2. Various scenarios plotted against Special Report on Emissions Scenarios (SRES) axes, modified from [24]—scenario sets are identified by matching shapes/text.

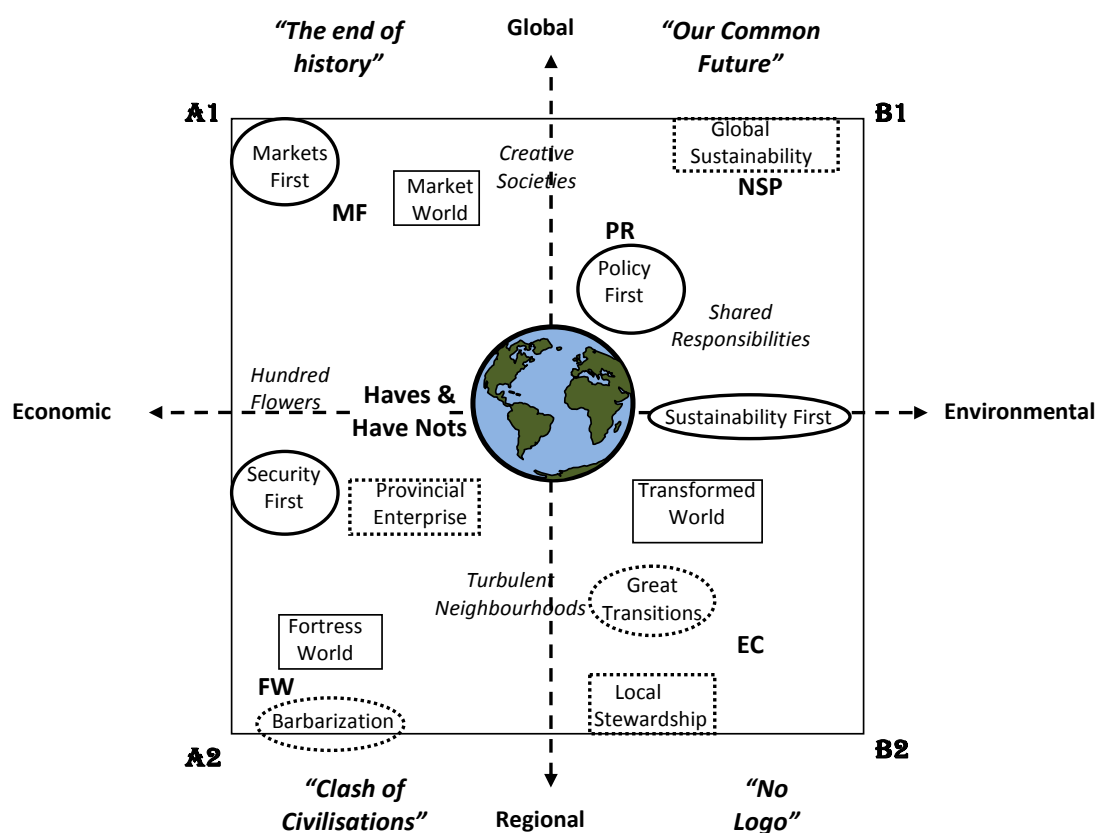
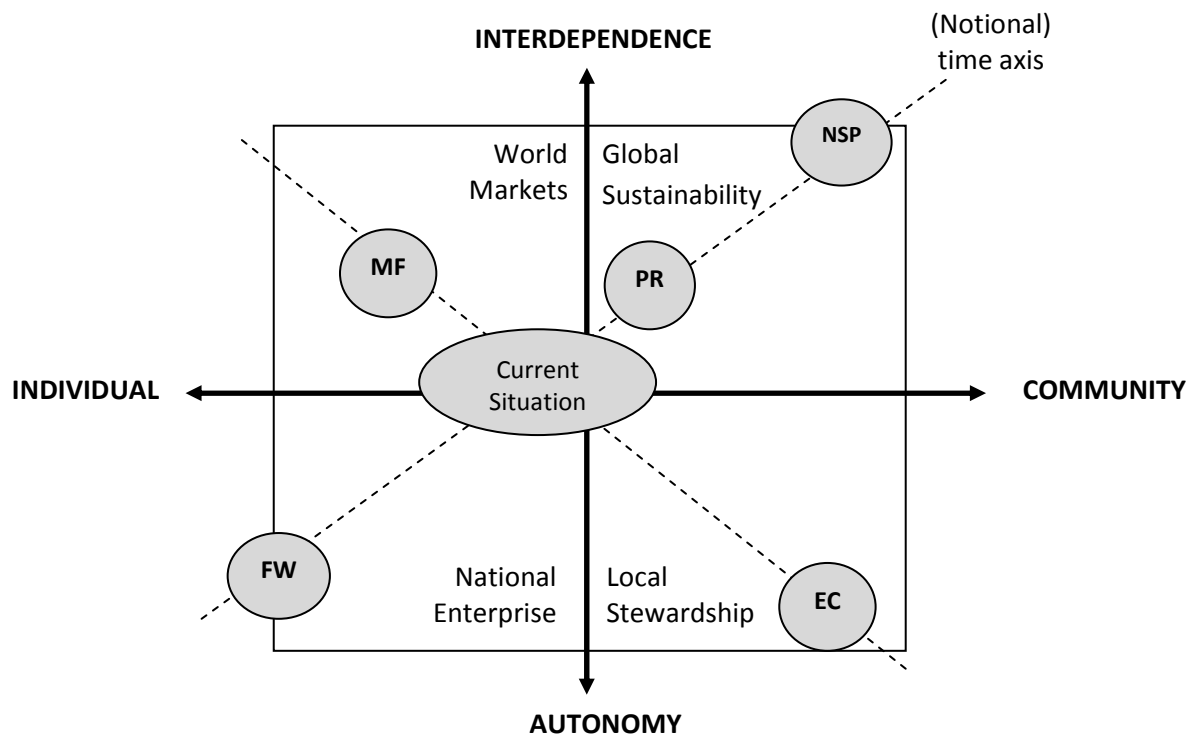


Table 3. Qualitative patterns of change in Market Forces (MF) according to Social, Technological, Economic, Environmental and Political (STEEP) drivers.

	Society	Technology	Economy	Environment	Policies
Performance in MF [6]	Worsens	Slight improvement	Strengthens significantly	Worsens	Weak
	↓	↑	↑↑	↓	↓
Generic qualitative patterns of change that resonate with other scenario sets	Emphasis on individuals, low public participation in governance. Uncontrolled urbanization and an increasing ageing population. A consumerist world where the rich get richer.	The focus is on economic efficiency. However, access depends on what you can pay for. Innovative technologies respond to consumer demands.	Strongest economy with International decision-making. However there is low government intervention in a highly efficient formal economy in which most people work.	Environment worsens due to high environmental impacts. Increase in pollutants, CO ₂ emissions, resource use/capita and water stress (quality and quantity of groundwater decrease). Net deforestation.	Weak social and environmental policies.

Pridmore [22] has previously suggested a close alignment between ‘AI’ and ‘World Markets’, e.g., they are similar to the present day USA [39], with consumerist values, global governance and declining manufacturing and agriculture [23,40,41]. The close relationship with MF is illustrated in Figure 3 [30] and is confirmed by Pinnegar *et al.* [23], with the addition of ‘Market world’ [42], ‘Beta’ (An early version of EA’s ‘Jeopardy’ scenario), and ‘Global Orchestration’ (although the last of these has not been added to the list as it resonates more evidently with NSP (Section 2.1)). Around the same time EA [27] reported close links between ‘World Markets’ (previously linked to many other MF type scenarios) and their ‘Jeopardy’ scenario (an intensive materialistic consumerist culture, coupled with high economic growth, growing social fragmentation and a continuing reliance on fossil-based fuels [27], a scenario upon which ‘Blinkered Evolution’ (a world where mainstream behaviour is committed to an individualized consumption paradigm [43]) was based. Taylor *et al.* [28] confirms many of these relationships and further suggests close resemblance between ‘Market Forces’, a scenario based directly on the work of GSG that assumes economic growth paradigms, based on the experience of developed countries, are appropriate for the rest of the world [25], and their ‘New Frontiers’ scenario. This is not surprising given the references therein to market competition, individual meritocracy and unfettered consumption, as well as education and health for those that can afford it.

Figure 3. GSG scenarios within the Foresight Futures 2020 plane [30].



Several additions have been made to this list based on the adoption of similar descriptors and core values to MF:

- ‘*Riding the Tiger*’—a linear continuation of the current era [44];
- ‘*Triumphant Markets*’—a world of materialism, consumerism, free trade and market integration, [45];

- ‘*World markets*’—where material wealth and greater mobility is to the detriment of society and the environment [43];
- ‘*High growth (F-0)*’—a throw away economy with a free market model [46];
- ‘*Go for Growth*’—where economic growth continues to be driven by consumption and new technology [31];
- ‘*Growing on*’—where high economic growth is at the expense of social cohesion and environmental sustainability [39];
- ‘*Perpetual Motion*’—a society driven by constant information, consumption and competition [47];
- ‘*Carry on consuming*’—where UK supply chains are dominated by a handful of companies and global competition has put greater reliance on production and processing within the European region [48];
- ‘*Bazaar*’—a market world where free market policies, corporate restructuring and entrepreneurship offer a model for the rest of the world [49];
- ‘*High emissions*’—contributing to high environmental impacts[50];
- ‘*Market Forces*’—in this scenario the Environment Agency focus on growth, consumerism and high water demand [51] it is not surprising that this has been rebranded as ‘*uncontrolled demand*’ [52], a significant concern in the water field.

The second scenario within the conventional archetype is ‘*Policy reform—PR*’.

The PR path requires unprecedented political will for establishing the necessary regulatory, economic, social, technological, and legal mechanisms [33]. This strong policy is used to meet social and environmental sustainability goals following widespread concern over environmental deterioration, social conflict, and economic instability. This leads to a marshalling of political will to implement comprehensive government action aimed at redirecting and constraining the global economy to achieve a broad set of social and environmental goals [21]. PR assumes the emergence of a massive government-led effort to achieve sustainability without major changes in the state-centric international order, modern institutional structures, and consumerist values [33]. For example PR is assumed to have adopted the best available technologies and yet behaviour has remained relatively unchanged [6]. There is a deep and widespread commitment to economic equity and strong and harmonized policies are implemented that, by redirecting the world economy and promoting technological innovation, are able to achieve internationally recognized goals for poverty reduction, climate change stabilization, ecosystem preservation, freshwater protection, and pollution control [33].

Raskin [21] first suggested that PR was broadly similar to:

- Global Ecosystem Organization—‘*GEOpolity*’—a world where an environmental and social crisis looms and the response is to build an interlocking governance structure coordinated at the international level, [12];
- ‘*Technology, Economics and the private sector*’—where private sector initiatives lead research and development, and globalization drives economic growth, but the poorest countries are left behind [19];

- ‘Policy variants’—Decarbonization is a major theme in this world, prompted by a carbon market in which all goods and services carry a carbon price [13–15];
- ‘B1’—world that emphasizes global solutions to economic, social, and environmental sustainability with reductions in material intensity and the introduction of clean and resource-efficient technologies [16], and
- ‘Policy First’—where strong actions are undertaken by governments in an attempt to reach specific social and environmental goals, [17,18]; developed to ‘Policy Rules’ where Europe is at the forefront of a new socio-economic paradigm of public/private partnerships and leads a global shift in direction, water framework directive compliance is higher than ever—the close relationship can be seen in Figure 1 [34,35].

The compatibility between ‘BI’ and ‘GEOpolity’ has been recognized previously by Morita *et al.* [35] whilst correspondence between PR, ‘BI’ and ‘Policy first’ is reinforced by numerous authors [18,23,26,37,38]. In terms of high global-environmental-solidarity/pro-active considerations (Figures 1a,b, and 2) very close compatibility is reported between ‘BI’ and ‘Global sustainability’ [22,24]. This view is upheld by Busch [26] and Kok *et al.* [32] with the addition of the following: ‘Technogarden, Knowledge is King, Big Crisis, Strong Europe and Global Co-operation’. As ‘Global Sustainability’ and ‘BI’ align with both PR and NSP, albeit more strongly in NSP, they appear in both lists (Table 2). Table 4 shows close alignment of previously-mentioned scenarios to PR when considering qualitative patterns of change according to a range of key drivers [26].

Table 4. Qualitative patterns of change in Policy Reform (PR) according to STEEP drivers.

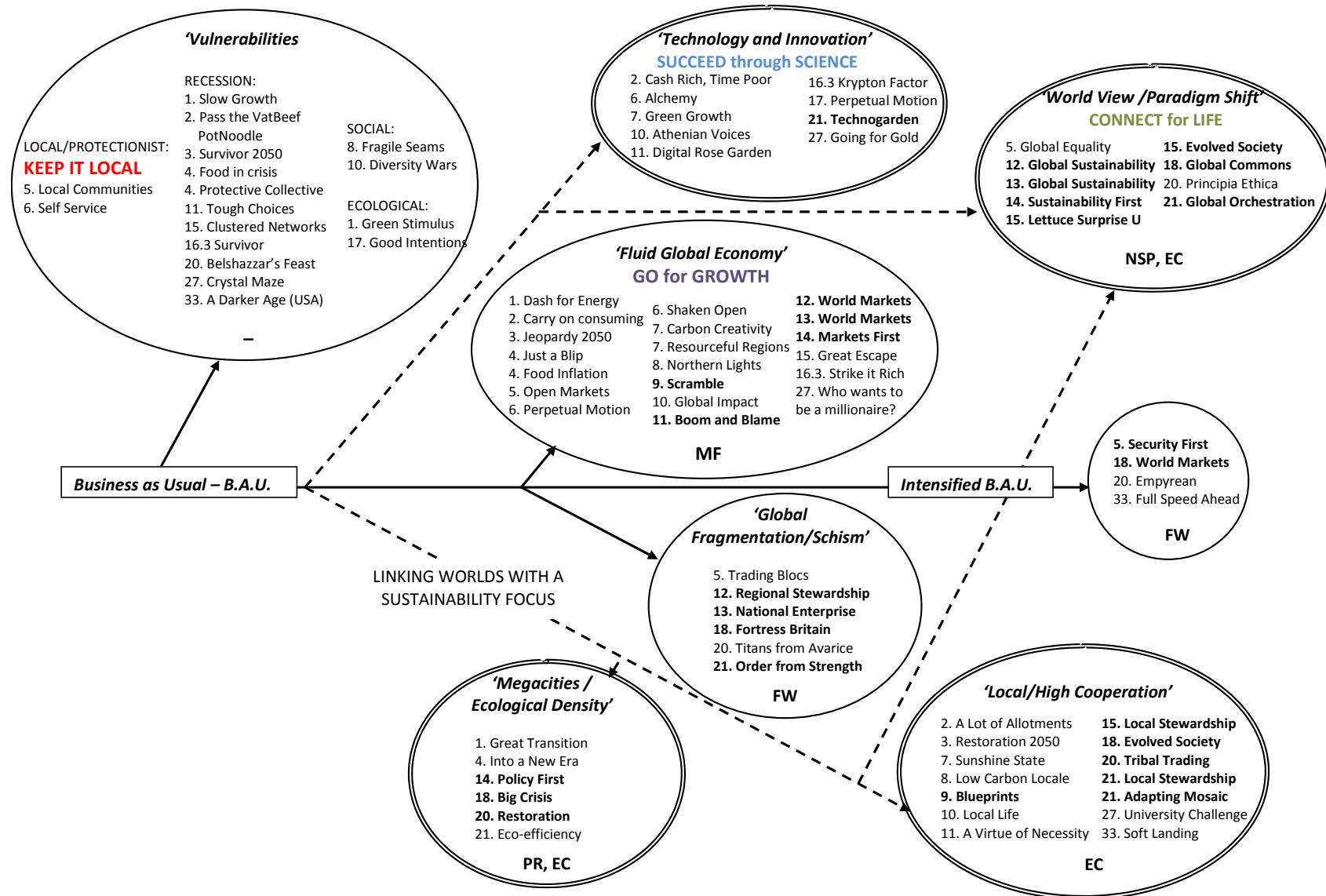
	Society	Technology	Economy	Environment	Policies
	Improvement	Significant Improvement	Strengthens	Improvement	Strong
Performance in PR [6]	↑	↑↑	↑	↑	↑
Generic qualitative patterns of change that resonate with other scenario sets	Emphasis on more community. Medium public participation in governance. Less chaotic urbanization and a growing population. User behaviors relatively unchanged.	Focus on general efficiency and environment. Promotion of technology transfer and diffusion. Best practice technology. Dependence on increases in technological efficiency to reduce consumption.	Strong economic growth with International decision making. High government intervention in an efficient and fair formal economy in which most people work.	Environment improves due to reduced environmental impacts. Reduction in Pollutants, CO ₂ emissions (20% of 1990 levels reached by 2050), resource use/capita and water stress. Moderately reduced deforestation.	Strong social and environmental policies

Whilst Makropoulos *et al.* [30] suggest that PR is on the way to NSP, Raskin [53] argues that the transition very much depends upon where branch points [8] might form. Pinnegar *et al.* [23] have aligned ‘BI’ with ‘Global commons’ (where people aspire to high levels of welfare and a sound environment, and international co-operation towards global sustainability [23]); ‘Gamma’ (An early version of EA’s ‘Alchemy’ scenario); ‘Green World’ [42] and ‘Technogarden’ (where Global markets in ecological property combine green technology, eco-efficiency, openness and competition [54]), which the Environment Agency suggests has similarities to their ‘Alchemy’ scenario (where a new regulatory environment spurs innovation in new technologies and new standards of producer responsibility [51]). Defra also noted similarities between ‘Alchemy’ and their own ‘Strong government’ scenario [43] (the latter built upon the former). Both ‘Alchemy’ and ‘Technogarden’ have been linked to Natural England’s ‘SUCCEED through SCIENCE’ scenario [31] (where the global economy continues to be driven by innovation and everyone relies on business to keep the country growing), as shown in Figure 4. The ‘Green Policy’ (where ecologists influence central policy) and ‘Technocratic’ scenarios (where public engineers and technocrats influence policy) as proposed by Makropoulos *et al.* [30] are very much policy-related and therefore not dissimilar to PR. In ‘Policy reform’ (a scenario in which negative impacts of market mechanisms are tempered by the inclusion of mitigation programs) it is argued that the socio-economic and political considerations may make it expedient for governments to take actions that favor citizens, rather than wait for the operation of the market to correct these ills [25]. As this is drawn directly on the work of GSG the direct comparison with PR is unavoidable.

Several additions have been made to this list based on the adoption of similar descriptors and core values to PR:

- ‘Leading the way’—UK Government takes a hands on approach to ensure the transition to a low-carbon economy; investment in environmental research and technology is high [55];
- ‘Prosperous stewardship’—a global player in economic terms with high regulation, innovation and a dry climate [56];
- *Urban Colonies*—good environmental practice is at the heart of the UK’s economic and social policies; new urban planning policies; consumption has fallen; resource use is now a fundamental part of the tax system and disposable items are less popular [47];
- ‘Low emissions’—resulting in reduced environmental impacts [50];
- *Innovation*—Previously *Alchemy*, in this world people work in regulation and compliance; environmental concerns are the problem of manufacturers and service providers — supply side regulation (for water) is an accepted integral part of the economy [52];
- ‘Business as usual—B-A-U’ describes strict controls for land-use planning, a balance between growing volumes and increasing recycling rates, and adoption of techno-fixes for carbon capture [46]—as such it describes perfectly a policy-centric B-A-U for the UK; and
- ‘Powerdown’—refers to the path of self-limitation, cooperation and sharing; an orderly equitable transition to a low-carbon economy, which mirrors the steps being taken within a PR world [57].

Figure 4. Archetypes by theme clusters (**Bold text shows scenarios included in this study**), modified from [31].



2.2. Great Transitions

The first variant within the great transitions archetype is ‘*New Sustainability Paradigm—NSP*’.

NSP sees new humane globalization (rather than localism) change the character of urban industrial society [21]. A values-led change catalyzed by the push of deepening crises and the pull of desire for a just, sustainable, and planetary civilization. This new paradigm is rooted in human solidarity, universal access to education and health care services, ecological resilience, reduced consumerism (technology is as good as it gets but matched also by a step-change in behavior [6]), improved well-being, e.g., creativity, leisure, relationships, and community engagement) and quality of life [33]. NSP is a more cosmopolitan vision than EC, because it is a world that would transcend and transform urban and industrial civilization, and maintain global linkages and solidarity, rather than retreat into localism [10]. The improved social cohesion reduces conflict; crises may still linger, but the world is able to confront them with enhanced institutions for reconciliation and cooperation [33].

Raskin [21] first suggested that this scenario is broadly similar to:

- *Jazz*—where markets are harnessed for finding solutions to sustainable development [12];
- *Values and Lifestyle*—Sustainable development, with an emphasis on research and development in the poorest countries [19,20], and
- *Sustainability First*—a world in which a new development paradigm emerges in response to the challenge of sustainability, supported by new, more equitable values and institutions [17,18].

According to the Environment Agency this scenario is also very similar to their ‘*Restoration*’ scenario (a world where societal values and behavior are oriented more towards sustainable development goals as a result of greater awareness and perception of environmental risk [51]—subsequently renamed to ‘*Sustainable Behavior*’ [52]). They also suggest similarity with Foresights ‘*Global Sustainability*’ scenario, (e.g., that it is similar to the Netherlands [39]) also known as ‘*Global responsibility*’ [41,58], a world with: a strong index of sustainable economic welfare and climate management, conservationist values (biodiversity is stable), global governance, renewable energy, less resource-intensive manufacturing, equity, and improved air and water quality [59,60]. Previously, Pridmore [22] suggested a closer alignment between ‘*Global sustainability*’ and ‘*BI*’ [16], based upon a strong global-environmental focus, this relationship being confirmed by de Vries [24] in Figure 2. Hence, the subtle similarities with ‘*Green World*’ (aligned previously with PR) cannot be ignored. Table 5 shows the close alignment of a number of the scenarios aligned under NSP, according to key drivers [26].

Taylor *et al.* [28] suggest that some elements (*i.e.*, restorative stages) of their ‘*Living on the No.8 Wire*’ scenario (where New Zealand reacted too late to sustainability challenges and got left behind globally, but social cohesion has permitted an indigenous and inventive subsistence in the economy, as seen in other Pacific Islands) resonate well with ‘*Restoration*’ (mentioned earlier). This in turn is assumed by Defra [43] to closely resemble their ‘*Civic renewal*’ scenario (a world where British citizens and consumers, rather than British politicians, begin to change their behavior—this being a strong characteristic that resonates well within NSP).

As can be seen in Figure 4, Natural England align their ‘CONNECT for LIFE’ scenario (where people now connect through vast global networks [31]) with ‘Global Orchestration’ (a world of sustainable development, economic growth, fair trade, global public health, global education, global NGO and multilateral organizations [54]).

Table 5. Qualitative patterns of change in New Sustainability Paradigm (NSP) according to STEEP drivers.

	Society	Technology	Economy	Environment	Policies
Performance in NSP [6]	Significant improvement ↑ ↑	Significant improvement ↑ ↑	Strengthens ↑	Significant improvement ↑ ↑	Strong ↑
Generic qualitative patterns of change that resonate with other scenario sets	Strongest emphasis on community. Highest public participation in governance. Large reduction in population. Significant voluntary Improvement to user behavior.	Best practice technology [6]. Focus on general efficiency and environment. Promotion of Technology transfer and diffusion, encouragement of open source.	Sustainable economic growth with no dominant scale for decision making. Place of work is variable by region and societal group.	Lowest pressure on natural environment. Greatest reduction in pollutants, CO ₂ emissions, resource use/capita and water stress. Net reforestation.	Strongest social and environmental policies. Human well-being and the environment are central to long-term planning initiatives.

In addition it is closely related to ‘Global Sustainability’ (mentioned previously), ‘Sustainability First’ (mentioned previously) and ‘Global commons’ (a world where people aspire to high levels of welfare and a sound environment—driven through International co-operation towards global sustainability [23]). It is interesting to note that ‘Sustainability First’, whilst being environmentally-focused, provides a balance between global and regional (*i.e.*, spanning somewhere between NSP and EC), although its position is best described by Figure 1b rather than 2. ‘Great Transitions’ is a world in which the three pillars of sustainable development are strengthened and behavioral patterns that characterize modern societies, such as consumerism, give way. As such a new level of satisfaction that is not materialistic is defined [25]. It is worth noting that de Vries [24] locates ‘Great transitions’, a combination of EC and NSP as defined by Hammond (1997), in the lower right-hand quadrant in Figure 2; however, when NSP is disassociated from EC within this archetype, the former would move vertically upwards (into the upper quadrant) whereas the latter would move marginally downwards. Macropoulos *et al.* [30] align their ‘Sustainable world’ (a world where integrated solutions are the aim) directly with NSP, as it draws narratives from this research.

Several additions have been made to this list, based on the adoption of similar descriptors and core values to NSP, these are:

- ‘Hearts’—Environment wins, Society Wins—This is a world in which demography, politics, economics, and sustainability gel. It is the future that the Brundtland Commission pointed us towards [61];

- ‘Triple Whammy’—based upon a combined approach to environmental, social and economic sustainability [62]; and
- ‘Factor Four’—a more sustainable, low-impact food system that improves significantly demand-side management in addition to re-use, recycling and composting [46].

The second scenario within the great transition world is ‘Eco-communalism—EC’.

Eco-communalism envisions a patchwork of semi-isolated and self-reliant communities; quite sustainable with high equity, low economic growth, low populations [8,63] with a bio-regional focus, a highly localist vision and face-to-face democracy, [21]. EC contrasts with NSP by: embracing the principles of strong decentralization; small-scale technology; and economic autarky [10]. It has been suggested by Gallopin et al. [8] that an EC world could emerge out of an NSP world, if powerful consensus arose for localism, diversity and autonomy. Just as likely, however, it could emerge from the recovery of Breakdown [8]. A major threat to sustainability could come from the possibility that some of the more or less isolated communities develop into aggressive, expansionist forces that attempt to dominate neighboring communities [8].

Raskin [21] first suggested that this scenario is broadly similar to:

- ‘B2’ [16], which de Vries [24], in Figure 1, aligns closely with:
- ‘Local stewardship’—a world with conservative values, regional/national governance, locally-based financial and other services, and small-scale intensive agriculture and manufacturing [41,59,60]—like Denmark, Sami [39] — this relationship being confirmed by Pridmore [22], EA [51] and Pinnegar et al. [23], the last of these authors include also:
- ‘Delta’—an early version of EA’s ‘Survivor’ scenario, and:
- ‘Adaptive Mosaic’—a world of local regional co-management; common property institutions; integration of local rules regulating trade; local, non-market rights; local communities; local equity and cooperatives [54].

The Environment Agency suggested similarities between their ‘Survivor’ scenario (a scenario in which the consumers become more frugal and self-reliant with resurgence in traditional regional and local cultures and values [51] — subsequently renamed to ‘Local Resilience’ [52]) and Foresight’s ‘Tribal Trading’ scenario (a world shrunk to their own community, a global economic system that is severely damaged with infrastructure falling into disrepair, local food production and services and local transport - typically by bike and horse. There are local conflicts over resources: lawlessness and mistrust are high. The state does what it can—but its power has been eroded [47]). Landcare Associates suggest that some elements of their ‘Independent Aotearoa’ scenario (also known as the ‘Shire’) were broadly similar to ‘Tribal Trading’: the link to EC is easily recognized given the references to a world that has international geopolitical instability, strong social cohesion and a voluntary disconnect from globalization. In other words, as Taylor describes it: equitable, educated, environmental—friendly and dull. Macropoulos et al. [30] align their ‘Eco-communalism’ (green visions of bioregionalism, localism, face to face democracy, small technology and economic autarky) directly with EC. From Figure 1a, b other scenarios include: *Blueprints*, *Lettuce surprise U*, *Evolved Society*, *Regional Communities and Sustainability eventually* (a world where water demand has structurally decreased, derived from ‘Sustainability First’ [34,35]).

During this research the following additions have been made to this list, based on the adoption of similar descriptors and core values to EC:

- ‘*Building lifeboats*’—the path of community, solidarity and preservation [57] and
- ‘*Medium/Low emissions*’ [50].

2.3. Barbarization

The first scenario within the barbarization archetype is ‘*Fortress World—FW*’.

Authoritarian rule, elites in “fortresses”, poverty & repression outside; an authoritarian response to the threat of breakdown; from protected enclaves, elites control an impoverished majority and manage critical natural resources [9,10,33] Strategic mineral reserves, freshwater and important biological resources are put under military control, as are favored resort areas, including nature and hunting preserves, from which the poor are excluded [8]. This is a world in which wealth, resources and conventional governance systems are eroding and alliances are formed to protect the privileges of rich and powerful elites in their bubbles of privilege. Outside the fortress, the majority is mired in poverty, denied access to scarce resources and restricted in mobility, expression and basic rights [8]. Authorities employ geo-engineering techniques to stabilize the global climate, while dispatching militia to multiple hotspots in an attempt to quell social conflict and mass migration. But the results are mixed: emergency measures and spotty infrastructure investment cannot keep pace with habitat loss and climate change; inadequate food and water to desperate billions [33]. Technology is maintained in the fortresses, even with some continued innovation, but deteriorates elsewhere. Local pollution within the fortress is reduced through increased efficiency and recycling. Pollution is also exported outside the enclaves, contributing to the extreme environmental deterioration induced by the unsustainable practices of the desperately poor and by the extraction of resources for the wealthy [8]. In this kind of future, sustainable development is not in the cards, a half-remembered dream of a more hopeful time [33]. Global equity is very low, though it could be high within the fortress, and outside. For those unfortunate enough to be born poor, life is Hobbesian: nasty, brutish, and short. A general uprising of the excluded population is plausible and the collapse of FW could lead to Breakdown [8,23,53].

Raskin [21] suggested that this scenario was broadly similar to:

- GEO’s ‘*Security First*’ scenario is a world of great disparities, where inequality and conflict prevail, brought about by socio-economic and environmental stresses [17,18];
- GEO-4, 2008, this was developed by Duel *et al.* [35] into ‘*Fortress Europe*’ as shown in Figure 1b; a world in which Europe closes its borders and concentrates on a series of security issues, a central goal of which is self-sufficiency; co-operation is difficult, alliances change and water conflicts intensify) and
- AEO’s ‘*Fortress World*’ scenario, the later being developed from the former [25].

The last of these scenarios has been linked directly to ‘A2’ (A high regional-economic focus [16] by de Vries [24], in addition to ‘*Barbarization*’ which includes FW and B [11] (see Figure 2).

It can be seen that ‘*Security First*’ is the least localized of the scenarios considered under FW, thus far—economics being broadly similar in each case. The reference to ‘*clash of civilizations*’ [64] in Figure 2, is understandable given the context of a world in which global affairs and interactions are between “civilizations” rather than nation-states. Table 6 [26] shows the close alignment of a number of scenarios under NSP according to key drivers, these relationships being confirmed by Zurek [37] and Westhoek *et al.* [38].

‘*Fortress World*’, as derived by Makropoulos *et al.* [30], is based upon narratives drawn from FW and therefore shows considerable similarities: e.g., environmental conditions that deteriorate rapidly; pollution; climate change; and ecosystems degradation that interact and amplify the crisis. The links between FW and ‘*National Enterprise*’ as identified by Makropoulos *et al.* [30] can be seen in Figure 3; a world committed to building capabilities and resources to secure a high degree of national self-reliance and security. In ‘*National Enterprise*’, Political and cultural institutions are strengthened to buttress national autonomy in a more fragmented world [47]—in a similar way to present day Switzerland [39], although increasingly like present day North Korea, Fortress India (so named due to its fortified borders) and others.

Table 6. Qualitative patterns of change in Fortress World (FW) according to STEEP drivers.

	Society	Technology	Economy	Environment	Policies
Performance in FW [6]	Worsens Substantially	Relatively unchanged	Weakens	Worsens Substantially	Very Weak
	↓ ↓	↔	↓	↓ ↓	↓ ↓
Generic qualitative patterns of change that resonate with other scenario sets	Focus on individuals Lowest public participation in governance due to its breakdown. Human wellbeing, the environment and natural resources are victimised to meet security demands.	However, there is a huge increase in R&D for military. The emphasis is on security of supply and access to technologies is closely guarded.	A weak economy with national decision making Disintegration of economic and social fabric accompanied by emergent underground economies.	Highest pressure on natural environment. Increase in pollutants, CO ₂ emissions, resource use/capita and water stress (quality and quantity of groundwater decrease). Net deforestation.	Weakest social and environmental policies.

More recently NESG [31] have aligned ‘*National Enterprise*’ with ‘*Regional Stewardship*’ [65] and ‘*Order from Strength*’ [54]. This was presumably related to the fact that all these scenarios include the requirements for ‘high regulation’ (*i.e.*, national level policies), security and protectionism within a climate of fear—all of which are consistent with the descriptors of FW. Pinnegar *et al.* [23] recognized that ‘*Order from Strength*’ correlated well with their ‘*Fortress Britain*’ scenario (This scenario assumes that people aspire to personal independence and material wealth within a nationally-rooted cultural identity that gets in the way of global sustainability) in addition to UKCIP’s ‘*Fortress Britain*’ [66], ‘*Provincial Enterprise*’ (a precursor to ‘*National Enterprise*’ [67]); ‘*Fortress Europe*’ [42] ‘*A2*’ and the Environment Agencies ‘*Alpha*’ scenario [27]—subsequently changed to ‘*Survivor*’ (EA, 2006) and the ‘*Medium-High emissions*’ scenario [68]. Whilst Landcare Associate’s ‘*Fruits for a few*’ (benefits

of global market access, communications, health protection and use of natural resources are aspects reserved to an elite, which also values sustainability, [28]) has been linked closely to ‘Technogarden’ (aligned previously with PR) reference to a dissenting and landless majority of population resonates also with FW (Section 2.3). Busch [26] and Kok *et al.* [32] confirm a number of these relationships (Figure 1a,b) with the addition of: ‘Scramble, Transatlantic Market and Continental Markets’

Several additions have been made to this list based on the adoption of similar descriptors and core values to FW:

- ‘Lords of Misrule’—a fortress world with socio-political backlashes and regressive development in institutions [49];
- WBCSD’s ‘Rivers’ scenario—a world of ‘Haves and Have-nots’ [12];
- ‘Turbulent neighborhoods’—a world of physical security, muscular military action and the formation of a fortress Europe [45];
- ‘Boom and Blame’—a world of privileged enclaves and ghettoized communities [69];
- ‘Last man standing’—the way of war and competition operate in this world—globally disconnected, a survivalist approach [57];
- ‘Brown Tech’—a world in which the security of the “haves” is a constant issue with gated communities, and apartheid style townships and barriers for the “have-nots” [70];
- ‘Keep it local’—a society that revolves around nations feeding and providing for themselves [31,71];

The second scenario within the barbarization worlds is ‘Breakdown—B’. This archetype is the least well-adopted within the literature, perhaps because it is the world we would least like to consider possible. In addition it is likely to be a difficult scenario in which to test things (e.g., sustainability solutions) because it might be considered ‘too-far-gone’.

In this variant, the vicious cycle of chaos, conflict and desperation spiral out of control. The security apparatus within remaining privileged areas cannot contain the tide of violence from disaffected individuals, terrorist organizations, ethno-religious groups, economic factions, and organized crime. Collapse of civil order becomes widespread, as populations become increasingly desperate and governments weaken. Refugees fleeing from chaotic zones destabilize neighboring areas, inadvertently contributing to widening waves of disorder. To stem migration, increasing resources are devoted to police powers, border security, and control of the activities of citizens. The global economic, finance and governance systems founder, though the media lingers to spread fresh news of upheaval. The retreat of globalization is particularly devastating for industrial economies highly dependent on trade and imported natural resources. The results are: rising unemployment, economic depression, political instability, and outbreaks of civil disorder, even in rich countries. This self-reinforcing chain of events eventually leads to a general disintegration of social, cultural, and political institutions, deindustrialization (to varying degrees in different regions), and in many regions a return to semi-tribal or feudal societal structures. With the collapse of markets and investment generally, technological progress halts—and the level of technological capability regresses. Population eventually begins to decrease as mortality rates surge with economic collapse and environmental degradation. Many couples, deeply pessimistic about the future, choose not to bring children into the world. In

a bitter irony, equity increases but only because everybody gets poorer. Breakdown conditions could persist for many decades before social evolution to higher levels of civilization again becomes possible [8].

Raskin [21] first suggested that this scenario was broadly similar to:

- IPCC's 'A2' scenario [16]—a fragmented unsustainable world. It is interesting to note that Raskin does not align 'A2' with FW and yet this shows that incredible similarities do exist.

'*Diamonds*' [61] and '*Decline to disaster*' [72] have been added to the list due to their reference to devastation of ecosystems and a triple bottom line in tatters, which includes: global economic depression, crippling energy shortages, local and regional wars, rampant terrorism, crime, corruption and more.

3. Discussion

This research has shown that, based upon the descriptions given within their scenario narratives, seemingly disparate visions of the future can be aligned under the three world end-states and six scenario variants first proposed by GSG. In some cases the similarities are not surprising given that the work derives directly from, or links to, GSG. For example, the AEO—African Environmental Outlook scenarios [25] were developed using the rich narratives from four of the GSG scenarios (PR, MF, NSP, FW) combined with IPCC emissions data [16], and in the case of Global Environment Outlook [17,18] the GSG actors were directly involved [73]. In other cases, the adoption of a similar methodological approach or adoption of identical 'key drivers' leads to unavoidable similarities. For example, Makropoulos and colleagues [30] developed seven water-based scenarios that directly references GSG's work [9,10] and that of Schilling [74]. What is most reassuring is that, whatever the methodological framework adopted a significant number of scenario variants developed by a range of authors all align to the three world states and six visions derived by GSG; in this paper >150 scenarios have been aligned with the GSG scenarios based solely on information provided in their narratives (Table 7). Based on these findings, this discussion section considers whether the archetypal set of scenarios first proposed by GSG might be deemed appropriate for adoption by research institutions wishing to test against existing scenarios, rather than to derive, refine and test for internal consistency yet another scenario set.

3.1. Archetypes: Are the Three World End-States Proposed by GSG Appropriate?

In 1998 Hammond based the title of his book '*Which World? Scenarios for the 21st Century*' [11] on the results of the 2050 project (a joint venture between the Brookings Institution, the Sante Fe Institute and the World Resources Institute—of which Hammond was director) and in line with GSG investigated three possible world end-states (Market, Transformed and Fortress) within seven continents. The three worlds suggested by Hammond map directly onto the four GSG archetypes derived by Gallopin *et al.* [8] and adopted by Raskin [21] (not surprising given that Hammond was part of the GSG team).

Van Asselt *et al.* [4] subsequently suggested four scenario archetypes based on their key combining elements: '*Think Green*'—Environmental protection; '*Money maker*'—high economic growth;

Table 7. Scenario archetypes, adapted from [36].

Archetypes	Scenario Sub-Group : [7,8,9,10,12,13,16,21 and 84—126] Those highlighted in bold are also included in Table 2	No Scenarios	Link to GSG
‘Current Trends’	<i>Conventional</i> : no significant change and/or continuation of current trends	12	MF, PR
	<i>High Growth</i> : government facilitates business, leading to prosperity	14	
	<i>Asia Shift</i> : economic power shifts from the West to Asia	5	
	<i>Economy Paramount</i> : emphasis on economic values deterioration in environmental and social conditions	9	
‘Sustainable Development’	<i>Our common Future</i> : increased economic activity is made consistent with improved equity and environmental quality	21	NSP, EC
	<i>Low consumption</i> : conscious shift from consumerism	16	
	<i>Breakdown</i> : Collapse of Human Society	5	
‘Pessimistic’	<i>Fractured World</i> : Deterioration into antagonistic regional blocs	9	FW, B
	<i>Chaos</i> : Instability and Disorder	4	
	<i>Conservative</i> : World economic crash is succeeded by risk-averse regime	2	
‘High-Tech Optimist’	<i>Cybertopia</i> : information and communication technology facilitate individualistic, diverse and innovative world	16	-
	<i>Technotopia</i> : technology solves most of humanity’s problems	5	

Table 8. Scenario archetypes, adapted from [31].

Archetypes	Details (refer also to Figure 3)	Link to GSG
‘Business as usual’	A world that prioritizes government and the economy.	MF
‘Sustainability’	A world that prioritizes the environment - through efficiencies of scale in urban settings, or through decentralization and focus on communities and locales.	PR, NSP
‘Paradigm shifts’	A world where current assumptions about future governance or the economy are overturned. They are often connected to worldview and value shifts that are <i>enabled by new technologies</i> .	EC
‘Collapse (vulnerability)’	A world with economic difficulties, social schisms and/or environmental degradation.	FW
‘Technological Age’	A ‘high tech’ world transformed primarily by technological fixes.	-

Table 9. Scenario archetypes, adapted from [32].

Archetypes	Details (refer also to Figure 1a)	Link to GSG
‘The Global Market’	Global developments steered by economic growth result in a total dominance of international markets with a low degree of regulation. Environmental problems are being dealt with when solutions are economically interesting	MF
‘Global Sustainability’	A globalized world with an increasingly proactive attitude of policy-makers and the public at large towards environmental issues and a high level of regulation. Three main variations can be discerned. One where the global solution is technology change, one with strong governance structures and one with a broadly supported paradigm shift.	PR, NSP
‘Regional Sustainability’	A regionalized world, where most—broadly supported initiatives improve the state of the environment and move toward sustainable solutions are bottom-up with a major role for NGOs and multi-level governance structures	EC
‘Continental Barriers’	A regionalized world based on economic development. The market mechanism fails, leading to a growing gap between rich and poor. In turn, this results in increasing problems with crime, violence and terrorism, which eventuates in strong trade and other barriers	FW

We already live in a technological age—what is distinctively important is what pulls or pushes the technological adoption to occur, and how this might be intertwined with user-behavior (Section 3.3). This is remiss in other scenario sets and something on which the GSG scenario variants provide significant clarity. Notwithstanding this observation, similar adoption has occurred within the water engineering field (e.g., Macropoulos *et al.* [30]) which is not surprising given that technology is considered to be a key driver.

Kok *et al.* [32] highlighted the practical implications for being able to link scenarios and use additional information from other studies provided that scenarios could be categorized in a similar structure. The difficulty here is ensuring that internal consistency is assured whilst characteristics are being cherry picked. Table 9 was created for the CLIMSAVE scenarios project, based on the similarities found between scenarios (Figure 1a). Once again the match to GSG archetypes is very strong.

Therefore it appears that the three world end-states proposed by GSG are sufficiently diverse, distinct, clearly defined, well-grounded, defensible, and wholly appropriate including key world drivers (social, technological, economic, environmental, political, organizational, and security) that are as relevant today as they were some 16 years ago. Moreover, if data from Morita [36] are included it might be suggested that there is >30 years worth of evidence to back up GSGs scenario archetypes. As such user buy-in is achieved easily, as evidenced by the critical acclaim of Hammonds’ book [127] and the significant global citations of GSG’s work within the scenarios literature.

3.2. Scenario Variants: Are Six Variants Appropriate?

In general, practitioners recommend that two scenarios be considered the minimum (one is too easily mistaken for a forecast) and four scenarios appear to be the maximum number for easy audience engagement while still allowing for depth and rigor of analysis [128]. In many cases when tasked with getting an audience to imagine a different scenario to their place of reference, it is not inappropriate to assume that the audience are likely to draw from images of places that may not conform to their sense of normality and yet, albeit subconsciously, are related to something they have seen, or heard of, in

other parts of the world. This may be the underlying reason why MF, PR, NSP and FW scenarios work so well and have been so well-adopted within the literature even when derived in seemingly different ways—credibility is gained because people can imagine living there. In this context this is not necessarily an end-state, *i.e.*, it is some manageable time period, not some vague and static point. That said, the use of a national tagging (e.g., assuming the UK is a PR world and the USA is a MF world) could be misleading as it very much depends upon the scale being considered. For example, at the national scale, the UK might be assumed to align with the characteristics used to define PR and yet glimpses of each of the different world-end states may be evident nationally (the next county) or locally (*i.e.*, the next street or the next house).

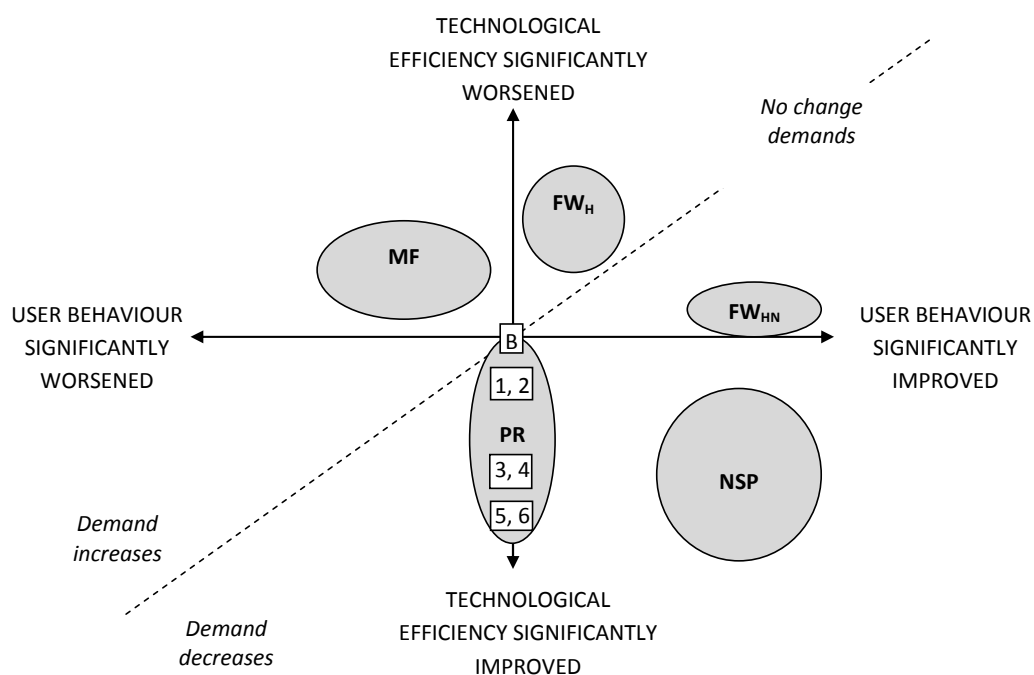
It is interesting to see that ‘*Breakdown—B*’ scenario is less-well adopted within the literature (only three of the scenarios assessed here align with Breakdown), and whilst a narrative was developed by GSG, detailed numerical analysis was not considered. This perhaps reinforces the notion that this marginalized world end-state variation is less useful analytically than FW, where the premise is to avoid the immediate threat of Breakdown. Therefore, it is not surprising that authors align it closely with FW using two ‘axes of uncertainty’ (Figure 1). However, it could be argued that breakdown can occur at any point in time from any scenario, exemplified in the 1990’s by the LA riots (MF breakdown?) or in 2011 by the UK riots (PR Breakdown?) and the overriding goal in these cases is to restore democracy. Whilst ‘*Eco-communalism—EC*’ is well-adopted within the literature, it once again was not explored by GSG with detailed numerical analysis. According to Raskin [129], this is because GSG didn’t want to emphasize a scenario it felt to be implausible in light of soaring cross-border interdependence (except as an offshoot, perhaps, of other scenarios). Raskin suggests that the EC/NSP distinction is “clear-cut”; in NSP, the extension of human identity to embrace global citizenship becomes the foundation for the construction of supra-national institutions for effectively addressing supra-national challenges and pursuing opportunities (*i.e.*, some degree of nation-state sovereignty is ceded to global governance). In EC, state sovereignty is challenged, but in a localizing direction. Therefore quantification would have been (and still is) straightforward [129].

3.3. Can GSG Scenarios be Used with an ‘Axes of Uncertainty’ Approach?

Many of the UK scenarios reported here (including OST) adopt an ‘axes of uncertainty’ approach (Figure 1 to 3) as distinct from the ‘key drivers’ approach used by GSG (Section 2). It is a testament to the flexibility and applicability of the GSG scenarios that they can be mapped accordingly and yet still keep the necessary divergence that allows for meaningful research-based (sensitivity-type) analysis within a controlled system boundary (Figure 3). The placement of the scenarios (or the size of the containing bubble) within any of these grid like structures is not exact, and will be, to some extent, subject to judgment. Moreover it is important to appreciate certain caveats; scenarios may be located within the same quadrant and share an archetypal vision, but not be identical; that is, they will more than likely have subtle variations within characteristic sub-sets. Notwithstanding this shortfall, for research purposes the process of plotting GSG against any existing (or new) set of axes facilitates identifying similarities between scenario variants and can be used to identify potential research areas for further interrogation.

For example, in Figure 6 the four GSG scenarios (MF, FW, NSP and PR) are mapped against two key drivers (SOCIAL—user behavior and TECHNOLOGICAL—technological efficiency). The mapping process reveals a level of detail within the GSG scenarios that makes them rather unique amongst others found within the scenarios literature. First, technological efficiency and behavior adoption in each scenario is diverse and yet can be traced back to a single driving force within the scenario (*i.e.*, that which pushes or pulls a change to occur). For example, in PR and NSP it is evident that both adopt high levels of sustainable technological efficiency; however, in PR, changes are pushed through policy impacting very little on changing user behavior (which, it could be argued, is not altered for the better or constrained from getting worse). In many respects this matches directly the approach being taken within the Code for Sustainable Homes in the UK, which might be considered as weak, medium and strong forms of PR, where B represents the baseline of where we are now, and 1 (least sustainable) to 6 (most sustainable) represents the various levels of the Code. This compatibility is extremely important when making scenarios directly relevant to current National policy makers and stakeholders. Conversely, in NSP individuals' willingness to change their behavior (to be more sustainable) is the pulling force which requires adoption of more higher efficiency technologies; whilst policy facilitates this action, it is not required as a stimulus to effect change. Sustainability performance is based on voluntary reduced demand performance (e.g., 80 liters per person per day of water or zero heating requirements in homes). What is most interesting is that the performance of NSP could match exactly that achieved in FW_{HN} (*i.e.*, for those that have-not) but for completely different reasons. The push in FW_{HN} is lack of available resources (perhaps rationing) that demands a significant step-change in behavior; likewise, the push in FW_H is security of supply. In MF, the pull is peoples' growing demand, which in this world must be met and the push is an expanding economy where more goods are made widely available.

Figure 6. Four GSG scenarios mapped onto technological efficiency and user behavior axes (B is baseline, 1–6 represent various Levels of Code for Sustainable Homes).



4. Conclusions

In summary the GSG scenarios are credible, internally consistent, thought-provoking (*i.e.*, within and outside ones comfort zone) and carry a pedigree that can be traced back over 20 years. In addition, having evaluated the various mapping exercises undertaken within the literature, this present research suggests that a significant number (>150) of scenarios since 1997 can be mapped to the original archetypes derived by the GSG (this increases to almost >280 if the timeframe is increased to 1980). The greatest advantage of the GSG approach is that the world end-states can be mapped onto any set of axes (thereby facilitating detailed interrogation) resulting in scenarios within each quadrant (a key requirement for meaningful futures sensitivity analysis); this is testament to the original conception of the GSG scenarios and their subsequent refinement over a 16 year period. Moreover the scenarios are highly dramatized, showing a deep understanding of the key fundamental drivers of change. The most relevant scenarios for UK-based research appear to be MF, PR, NSP and FW, although it should be recognized that the level of refinement within narratives will be directly related to the scale of adoption (*i.e.*, national *vs.* local). Therefore further work is required to quantify the relevant (sustainability) indicators within scenarios; this is the focus of future UF research publications.

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Conflict of Interest

The authors declare no conflict of interest.

References

1. Kahn, H. *On Escalation: Metaphors and Scenarios*; Praeger: New York, NY, USA, 1986.
2. Schwartz, P. *The Art of the Long View*; Doubleday: New York, NY, USA, 1991.
3. Van der Heijden, K. *Scenarios: The Art of Strategic Conversation and The Sixth Sense*; John Wiley and Sons: NY, USA, 1997.
4. Van Asselt, M.B.A.; de Niet, R.; Peters, S.S.M.; Rijkens-Klomp, N.; Rotmans, J.; Slooff, W. *Towards Visions for a Sustainable Europe: An Overview and Assessment of the Last Decade of European Scenario-studies*; ICIS: Maastricht, The Netherlands, 1998.
5. Hunt, D.V.L.; Lombardi, D.R.; Atkinson, S.; Barber, A.; Barnes, M.; Boyko, C.T.; Brown, J.; Bryson, J.; Butler, D.; Caputo, S.; *et al.* *Using Scenarios to Explore Urban UK Futures: A Review of Futures Literature from 1997 to 2011*; Working Document, 2012.
6. Electris, C.; Raskin, P.; Rosen, R.; Stultz, J. *The Century Ahead: Four Global Scenarios*; Technical Documentation: Tellus Institute: Boston, MA, USA, 2009.
7. Kemp-Benedict, E.; Heaps, C.; Raskin, P. *Global Scenario Group Futures: Technical Notes*; Polestar Series Report Number 9; Stockholm Environment Institute: Stockholm, Sweden, 2002.

8. Gallopin, G.C.; Hammond, A.; Raskin, P.; Swart, R. Branch Points: *Global Scenarios and Human Choice. A Resource Paper of the Global Scenario Group*; PoleStar Series Report Number 7; Stockholm Environment Institute: Stockholm, Sweden, 1997.
9. Raskin, P.; Banuri, T.; Gallopín, G.; Gutman, P.; Hammond, A.L.; Kates, R.; Swart, R. *Great Transition: The Promise and Lure of the Times Ahead*; Stockholm Environmental Institute: MA, USA, 2002.
10. Raskin, P.; Gallopín, G.; Gutman, P.; Hammond, A.L.; Swart, R. *Bending the Curve: Toward Global Sustainability*; Stockholm Environmental Institute: MA, USA, 1997.
11. Hammond, A.H. *Which World? Scenarios for the 21st Century*; Island Press: IL, USA, 1998.
12. WBCSD. *Exploring Sustainable Development: Global Scenarios 2000–2050, Summary Brochure*; World Business Council for Sustainable Development: Geneva, Switzerland, 1997.
13. OECD. *The World in 2020: Towards a New Global Age*; Organisation for Economic Development and Cooperation: Paris, France, 1997.
14. OECD. *Environment Outlook*; Organisation for Economic Development and Cooperation: Paris, France, 2001.
15. OECD. *Environmental Outlook to 2030*; Environment & Sustainable Development, Organisation for Economic Development and Cooperation: Tehran, Iran, 2008; Volume 1.
16. IPCC. Emissions Scenarios: Summary for Policy Makers. In *Special Report on Emissions Scenarios (Intergovernmental Panel on Climate Change)*; Nakicenovic, N., Ed.; Cambridge University Press: Cambridge, England, 2000; pp. 3–12.
17. UNEP. *Global Environment Outlook 3*; United Nations Environment Programme: Nairobi, Kenya, 2002. Available online: www.unep.org/geo/geo3/ (accessed on 03 September 2011).
18. UNEP. *Global Environment Outlook 4*; United Nations Environment Programme: Nairobi, Kenya, 2007.
19. Gallopin, G.C.; Rijsberman, F. Three global water scenarios. *Int. J. Water* **1997**, *1*, 16–40.
20. WWV. *World Water Vision Commission Report 2000. A Water Secure World: Vision for Water, Life and the Environment*; Earthscan: London, UK, 2000. Available online: http://www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/Visions/CommissionReport.pdf (accessed on April 2012).
21. Raskin, P. Global Scenarios in Historical Perspective. In *Ecosystems and Human Well-being Scenarios*; Island Press: IL, USA, 2005; Volume 2, pp. 35–44.
22. Pridmore, A.; Bristow, A.; May, T.; Tight, M. *Climate Change, Impacts, Future Scenarios and the role of Transport*; Tyndall Centre for Climate Change Research, Norwich, UK, 2003.
23. Pinnegar, J.K.; Viner, D.; Hadley, D.; Dye, S.; Harris, M.; Berkout, F.; Simpson, M. *Alternative Future Scenarios for Marine Ecosystems (AFMEC)*; Technical Report; Cefas: Lowestoft, Suffolk, UK, 2006.
24. De Vries, B.J.M. Scenarios: Guidance for an Uncertain and Complex World? In *Sustainability or Collapse? An Integrated History and Future of People on Earth*; Costanza, D., Graumlich, L., Steffen, W., Eds.; MIT Press: Cambridge, MA, USA, 2005; pp. 379–397.
25. Ochola, M.C.; Abdelrehim, A.; Ayugi, P.J.; Ayeni, B.; Asamoah, J.; Gowa, E.; Roberts, J. *Africa Environment Outlook 2*; United Nations Environment Programme: Washington, DC, USA, 2006; pp. 412–480.

26. Busch, G. Future European agricultural Landscapes—What can we learn from existing quantitative land use scenarios studies? *Agric. Ecosyst. Environ.* **2006**, *114*, 121–140.
27. EA. *Water Resources for the Future: A Strategy for England and Wales*; UK Environment Agency: Bristol, UK, 2001.
28. Taylor, R.; Frame, B.; Delaney, K.; Brignall-Theyer, M. *Four Future Scenarios for New Zealand: Work in Progress*, 2nd ed.; Manaaki Whenua Press: Lincoln, New Zealand, 2007.
29. Rothman, D.S. A Survey of Environmental Scenarios. In *Environmental Futures: The Practice of Environmental Scenario Analysis. Developments in Integrated Environmental Assessment—Volume 2*; Alcamo, J., Ed.; Elsevier: Amsterdam, The Netherlands, 2008; pp. 37–65.
30. Makropoulos, C.; Memon, F.A.; Shirley-Smith, C.; Butler, D. Futures: An exploration of scenarios for sustainable urban water management. *Water Policy* **2009**, *10*, 345–373.
31. NESC. *Natural England Scenario Compendium*; Natural England Commissioned Report NECR031; Natural England Reports: Bristol, UK, 2009; p. 115.
32. Kok, K.; Gramberger, M.; Karl-Heinz, S.; Jager, J.; Omann, I. *Report on the New Methodology for Scenario Analysis, Including Guidelines for Its Implementation, and Based on an Analysis of Past Scenario Exercises*. The CLIMSAVE Project, 2011. Available online: <http://www.climsave.eu> (accessed on April 2012).
33. Raskin, P.D.; Electris, C.; Rosen, R.A. The century ahead: Searching for sustainability. *Sustainability* **2010**, *2*, 2626–2651.
34. Kämäri, J.; Alcamo, J.; Bärlund, I.; Duel, H.; Farquharson, F.; Flörke, M.; Fry, M.; Houghton-Carr, H.; Kabat, P.; Kaljonen, M.; *et al.* Envisioning the future of water in Europe—The SCENES project. *E-Water* **2008**, pp. 1–28.
35. Duel, H.; Meijer, K.; Loos, L.; Kämär, J. SCENES: Exploring the European Water Futures. In *Proceedings of the International Workshop on Climate Change Impacts and Adaptation: Reducing Water-Related Risks in Europe*, Brussels, Belgium, 6–7 July 2010.
36. Morita, T.; Robinson, J.; Adegbulugbe, A.; Alcamo, J.; Herbert, D.; Lebre, E.; Nakicenovic, N.; Pitcher, H.; Raskin, P.; Riahi, K.; *et al.* Greenhouse Gas Emission Mitigation Scenarios and Implications. In *Climate Change 2001: Mitigation*; Cambridge University Press: Cambridge, UK, 2001; pp. 115–166.
37. Zurek, M.B. *A Short Review of Global Scenarios for Food Systems Analysis*; GECAFS Working Paper 1; GECAFS International Project Office: Wallingford, UK, 2006.
38. Westhoek, H.J.; van den Berg, M.; Bakkes, J.A. Scenario development to explore the future of Europe's rural areas. *Agric. Ecosyst. Environ.* **2006**, *114*, 7–20.
39. Sami. *The Future of Services to the Public*; Saint Andrews Management Institute: St Andrews, UK, 2007.
40. Foresight. *Environmental Futures*; Office of Science and Technology, Department of Trade and Industry: London, UK, 1999.
41. OST. *Foresight Futures 2020: Revised Scenarios and Guidance*; Office of Science & Technology, Department for Trade & Industry: London, UK, 2002. Available online: www.foresight.gov.uk (accessed on 07 July 2011).

42. PMSU. *Net Benefits: A Sustainable and Profitable Future for UK Fishing*; Prime Minister's Strategy Unit, Cabinet Office: London, UK, 2004. Available online: <http://www.cabinetoffice.gov.uk/media/cabinetoffice/strategy/assets/ria.pdf> (accessed on April 2012).
43. Defra. WR0104: *Lifestyle Scenarios: The Futures for Waste Composition*; Summary Report; A project for Defra's WREP: Brook Lyndhurst, London, UK, 2007.
44. Keith, A.; O'Brien, R.; Prest, M. *The Future of the Global Economy to 2030*; Outsights Ltd: London, UK, 2008.
45. Bertrand, G.; Michalski, A.; Pench, L.R. *Scenarios Europe 2010: Five Possible Futures for Europe*; Working Paper; European Commission, Forward Studies Unit, 1999.
46. SEEDA. *Taking Stock: Managing Our Impact. An Ecological Footprint of the South East Region*; South East England Development Agency: London, England, 2003.
47. OST. *Foresight—Drugs Futures 2025: The Scenarios*; Office of Science and Technology: Outsights Ltd: London, UK, 2005.
48. Steedman, P.; Schultz, W. *Future Scenarios for the UK Food System. A Toolkit for Thinking Ahead*; Food Ethics Council: Brighton, UK, 2009.
49. Ratcliffe, J. Imagineering global real estate: A property foresight exercise. *Foresight* **2001**, *3*, 453–475.
50. Hulme, M.; Jenkins, G.L.; Lu, X.; Turnpenny, J.R.; Mitchell, T.D.; Jones, R.G.; Lowe, J.; Murphy, J.M.; Hassell, D.; Boorman, P.; *et al.* *Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report*, Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia: Norwich, UK, 2002.
51. EA. *Exploring the Future: Guidance Toolkit for Using Environment Agency Scenarios 2030*; Science Report: SC050002/SR2, UK Environment Agency, Bristol, UK, 2006.
52. EA. *Demand for water in the 2050's*; Briefing Note: UK Environment Agency, Bristol, UK, 2010.
53. Raskin, P. World Lines: A framework for exploring global pathways. *Ecol. Econ.* **2008**, *65*, 461–470.
54. MEA. *Ecosystems and Human Well-Being: Scenarios*; Millennium Ecosystem Assessment: Island Press: IL, USA, 2005; Volume 2.
55. Go-Science. *Land Use Futures: Making the Most of Land Use in the 21st Century*; The Government Office for Science: London, UK, 2010.
56. UKWIR. *21st Century Distribution Networks*; UK Water Industry Research Limited: London, UK, 2010.
57. Heinberg, R. *Powerdown: Options and Actions for a Post Carbon World*; New Society Publishers: Gabriola, Canada, 2003.
58. ERAG. *Energy Systems in 2050 Energy Review: Working Paper*; Advisory Group, Cabinet Office Performance and Innovation Unit, 2001.
59. Evans, E.P.; Ashely, R.; Hall, J.; Penning-Rowsell, E.C.; Sayers, P.; Thorne, C.; And Watkinson, A. *Foresight Future Flooding*, Volume I and Volume II. Office of Science and Technology, London, 2004.

60. Evans, E.P.; Simm, J.D.; Thorne, C.R.; Arnell, N.W.; Ashley, R.M.; Hess, T.M.; Lane, S.N.; Morris, J.; Nicholls, R.J.; Penning-Rowsell, E.C.; *et al.* *An Update of the Foresight Future Flooding 2004 Qualitative Risk Analysis*; Cabinet Office: London, UK, 2008.
61. SA. *Raising Our Game: Can We Sustain Global Civilization?* SustainAbility: London, UK, 2007.
62. CA. *The State of the Countryside, 2020*; The Countryside Agency: West Yorkshire, UK, 2003.
63. Raskin, P. *The Great Transition Today: A Report from the Future*; GTI Paper Series; Tellus Institute: Boston, MA, USA, 2006.
64. Huntington, S.P. The clash of civilizations? *Foreign Affairs* **1993**, *72*, 2–49.
65. HFP. Futures Working Group; Workshop Report. Kings College, London, UK. 12 October 2007.
66. UKCIP. *Socio-Economic Scenarios for Climate Change Impact Assessment: A Guide to Their Use in the UK Climate Impacts Programme*; UKCIP: Oxford, UK, 2001.
67. Watson, J.; Tetteh, A.; Dutton, G.; Bristow, A.; Kelly, C.; Page, M. *UK Hydrogen Futures to 2050*; Working Paper 46: Tyndal Centre for Climate Change Research, , Norwich, UK , 2004.
68. Berkhout, F.; Hertin, J. Foresight futures scenarios: Developing and applying a participative Strategic Planning tool. *GMI* **2003**, *37*, 37–52.
69. HSE. *HSE futures Scenario Building: The Future of Health and Safety in 2017*; Research Report RR600; Health and Safety Executive: Bootle, UK, 2007.
70. Holmgren, D. *Future Scenarios: How Communities Can Adapt to Peak Oil and Climate Change*; Chelsea Green Publishing: Vancouver, Canada, 2009.
71. NERR. *England's Natural Environment in 2060—Issues, Implications and Scenarios*; Research Report NERR031: Natural England Reports: Bristol, UK, 2009.
72. Hala, W.E.; Marien, M. Global megacrisis: Four scenarios, two perspectives. *Futurist* **2011**, 26–33.
73. Raskin, P.; Kamp-Benedict, E. *Global Environmental Outlook Scenario Framework*; Background paper for UNEPS third Global Environmental Outlook Report (GEO-3); Stockholm Environmental Institute: Stockholm, Sweden, 2004.
74. Schilling, W. Urban Drainage: Quo Wadis. In *Proceedings of the XXX IAHR Conference (International Association of Hydraulic Engineering and Research)*, Thessaloniki, Greece, August, 2003.
75. Wilson, P. Africa in the Global Scenarios. In *Africa 2025: Launching Africa's Long-Term Perspective Study*; Sall, A., Mureithi, L., Eds.; African Futures: Midrand, South Africa, 1999; pp. 51–69.
76. Tibbs, H. Sustainability. *Deep. News* **1999**, *10*, 1–71.
77. EEA. *Land-Use Scenarios for Europe: Qualitative and Quantitative Analysis on a European scale*. EEA Technical report No 9, EEA, Copenhagen, Denmark, 2007.
78. EURuralis. *EURuralis 1.0 A Scenario Study on Europe's Rural Areas to Support Policy Discussion* [CD-ROM]; Alterra: Wageningen, The Netherlands, 2004.
79. IAG. *Long-Term Reductions in Greenhouse Gas Emissions in the UK*; Inter-departmental Analysts Group, 2002. Available online: www.berr.gov.uk/files/file38187.pdf (accessed on 30 August 2010).
80. Mooij, R.; Tang, P. *Four Futures of Europe*; CPB: Den Haag, The Netherlands, 2003.

81. PIU. *The Energy Review*; The Policy and Innovation Unit: The Cabinet Office: London, UK, 2002.
82. Shell. *Shell Energy Scenarios to 2050*; Shell International BV: Den Haag, The Netherlands, 2008.
83. UKCES. *Horizon Scanning and Scenario Building: Scenario for Skills 2020: A Report for the National Strategic Skills Audit for England 2010*; Evidence Report 17; UK Commission for Employment and Skills, London, UK, 2010.
84. Barney, G.O. *Global 2000 Revisited: What Shall We Do? The Critical Issues of the 21st Century*; Millennium Institute: Arlington, VA, USA, 1993.
85. Bossel, H. *Earth at a Crossroads: Paths to a Sustainable Future*; Cambridge University Press: Cambridge, UK, 1998.
86. Coates, J.F.; Jarratt, J. *What Futurists Believe: Agreements and Disagreements*; World Future Society: Bethesda, MD, USA, 1990; Volume 14.
87. Coates, J.F. Factors Shaping and Shaped by the Environment: 1990–2010. *Futur. Res. Q.* **1991**, *7*, 5–55.
88. Coates, J.F. Long-term technological trends and their implications for management. *Int. J. Technol. Manag.* **1997**, *14*, 579–595.
89. Cornish, E. *92 Ways Our Lives Will Change by the Year 2025*; The World Future Society: Bethesda, MD, USA, 1996; Volume 30.
90. Costanza, R. Four visions of the century ahead: Will it be star trek, Ecotopia, big government or mad max? *Futurist* **1999**, *33*, 23–29.
91. CPB. *Scanning the Future: A Long-Term Scenario Study of the World Economy 1990–2015*; SDU Publishers: Den Haag, The Netherlands, 1992.
92. Duchin, F.; Lange, G.-M.; Thonstad, K.; Idenburg, A. *The Future of the Environment: Ecological Economics and Technological Change*; Oxford University Press: New York, NY, USA, 1994.
93. GBN. *Twenty-First Century Organizations: Four Plausible Prospects*; GBN: Emeryville, CA, USA, 1996.
94. Glenn, J.C.; Gordon, T.J. *1997 State of the Future: Implications for Action Today*; American Council for the United Nations University: Washington, DC, USA, 1997.
95. Glenn, J.C.; Gordon, T.J. *1998 State of the Future: Issues and Opportunities*; American Council for the United Nations University: Washington, DC, USA, 1998.
96. Henderson, H. Looking Back from the 21st Century. *Futur. Res. Q.* **1997**, *13*, 83–98.
97. Hughes, B.B. Rough Road Ahead: Global Transformations in the 21st Century. *Futur. Res. Q.* **1997**, *13*, 83–107.
98. IDEA (Innovators of Digital Economy Alternatives) Team. *Creating the Future: Scenarios for the Digital Economy*; Simon Fraser University: Vancouver, Canada, 1996.
99. Kahane, A. Scenarios for energy: Sustainable world vs. global mercantilism. *Long Range Plan* **1992**, *25*, 38–46.
100. Kinsman, F. *Millennium: Towards Tomorrow's Society*; W. H. Allen: London, UK, 1990.
101. Linden, E. *The Future in Plain Sight: Nine Clues to the Coming Instability*; Simon & Schuster: New York, NY, USA, 1998.
102. McRae, H. *The World in 2020: Power, Culture and Prosperity*; HarperCollins Publishers: London, UK, 1994.

103. Meadows, D.H.; Meadows, D.L.; Randers, J. *Beyond the Limits*; Chelsea Green Publishing Company: Post Mills, VT, USA, 1992.
104. Mercer, D. *Future Revolutions: A Comprehensive Guide to the Third Millennium*; Orion Business Books: London, UK, 1998.
105. Millennium Project. American Council for the United Nations University 1997. Available online: <http://www.millenniumproject.org/millennium/scenarios/index.html> (accessed on 17 July 2011).
106. Nakicenovic, N.; Grubler, A.; McDonald, A. *Global Energy Perspectives*; Cambridge University Press: Cambridge, UK, 1998.
107. Olson, R.L. Alternative images of a sustainable future. *Futures* **1994**, *26*, 156–169.
108. Price, D. Energy and human evolution. *Popul. Environ.* **1995**, *16*, 301–319.
109. Ramphal, S. *Our Country, the Planet: Forging a Partnership for Survival*; Island Press: Washington, DC, USA, 1992.
110. Repetto, R. *The Global Possible*; Yale University Press: New Haven, CT, USA, 1985.
111. Rotmans, J.; de Vries, H.J.M. *Perspectives on Global Change: The TARGETS Approach*; Cambridge University Press: Cambridge, UK, 1997.
112. Rotmans, J.; van Asselt, M.B.A.; Anastasi, C.; Greeuw, S.C.H.; Mellors, J.; Peters, S.; Rothman, D.S.; Rijkens-Klomp, N. Visions for a sustainable Europe. *Futures* **2000**, *32*, 809–831.
113. Schindler, C.; Lapid, G. *The Great Turning: Personal Peace, Global Victory*; Bear & Company Publishing: Santa Fe, NM, USA, 1989.
114. Schwartz, P. The new world disorder. *Wired* **1995**, *3*, 104–107.
115. Schwartz, P.; Leyden, P. The long boom: A history of the future 1980–2020. *Wired* **1997**, *5*, 115–131.
116. Science Advisory Board (SAB). *Beyond the Horizon: Using Foresight to Protect the Environmental Future*; Report No. EPA-SAB-EC-95-007/007A; Science Advisory Board, US EPA: Washington, DC, USA, 1995.
117. Shinn, R.L. *Forced Options: Social Decisions for the 21st Century*; Harper & Row Publishers: San Francisco, CA, USA, 1982.
118. Stokke, P.R.; Boyce, T.A.; Ralston, W.K.; Wilson, I.H. Visioning (and preparing for) the future: The introduction of scenarios-based planning into Statoil. *Technol. Forecast. Soc. Change* **1991**, *40*, 131–150.
119. Sunter, C. *The New Century: Quest for the High Road*; Human and Rousseau (Pty) Ltd./Tafelberg Publishers Ltd: Cape Town, South Africa, 1992.
120. Svedin, U.; Aniansson, B. *Surprising Futures: Notes from an International Workshop on Long-Term World Development*; Swedish Council for Planning and Coordination of Research; Friibergh Manor, Sweden, 1987.
121. Toffler, A. *The Third Wave* Tomorrow: New York, NY, USA, 1980.
122. Van den Bergh, M. Charting a Course: Preparing for the Oil and Gas Business of the 21st Century. Speech presented at the State University of Groningen, Groningen, The Netherlands, 1996.
123. Wallerstein, I. The Capitalist World Economy—Middle-Run Prospects. *Alternatives: Social Transformation and Humane Governance* **1989**, *14*, 279–288.

124. Wilkinson, L. How to Build Scenarios. *Wired*; Conde Nast Publications: San Francisco, CA, USA, 1995; pp. 74–81.
125. World Bank. *World Development Report 1995—Workers in an Integrating World*; World Bank: Washington, DC, USA, 1995.
126. WRI. *The Transition to a Sustainable Society*; World Resources Institute: Washington, DC, USA, 1991.
127. Kai, N. Review: Which world? Scenarios for the 21st century. *Environ. Sci. Policy Sustain. Dev.* **1998**, *40*, 25–26.
128. Stout, D. The Use of Scenarios in Foresight 1994—1999. An Information Document Prepared for the OST. Office of Science and Technology, 2002. Available online: www.foresight.gov.uk (accessed on 18 July 2011).
129. Raskin, P. Personnel communication, 2011.

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