Precursor considerations for new circular economy business models

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Abstract. Circular economy thinking encourages society to adopt sustainable patterns of consumption and production. This basic principle aligns with the objectives of the United Nations' Sustainable Development Goals (SDGs), which include improving human welfare through equal access to drinking water and sanitation; together with reliable, sustainable, and modern energy supplies for all. Traditional approaches to delivering public utility services have been rooted within the Baconian view that the environment is a pool of resources that exist for the betterment of humankind. Whilst this tradition has delivered water supply, sanitation, electricity generation, and waste management services, that have improved the lives of countless humans, the provision of these services largely relies on business models and technologies that have had significant adverse impact upon the natural environment. To inform the development of new sustainable business models, this paper explores circularity concepts from the perspective of decision makers and actors responsible for the delivery of public utility infrastructure. Through a review of the secondary literature, this paper examines core circular economy principles and maps these against fundamental business model elements to synthesise a framework of precursor considerations for future business models. This framework has potential application in testing the extent to which existing business models in the utility sector support the transition to a circular economy and how current business models can be adapted to assist the achievement of sustainable development.

Keywords. Business models, circular economy, decision makers, SDGs, infrastructure.

1. Introduction

The welfare of human communities is dependent upon utility services, including electricity generation, water supply, wastewater treatment, and the management of solid waste. The provision of these services requires physical infrastructure and human organisation, together with the on-going supply of energy and resources. The scale, complexity, and public nature of these services mean that they are typically planned and delivered by government agencies in conjunction with the private sector, often in the form of public-private partnerships [1]. Each utility project is underpinned by a business model that establishes the framework for financing and delivering the infrastructure that is required to provide the utility service.

Traditionally, the provision of utility services has been based on the 'take-make-waste' linear resource use model, where resources are extracted from the natural environment and transformed through manufacturing and distribution processes to produce the infrastructure needed to provide tangible services to communities. Each stage generates losses from the system in the form of solid waste and/or pollution. Human exploitation of the natural environment has its roots in antiquity, but humankind's scale of impact grew following the evolution of the scientific method espoused by Francis Bacon in the seventeenth century [2], and the broad adoption of utilitarianism as the principal mode of economic development within western nations, and more recently as a global ethos. The social and environmental impacts of utilities have been significant, and include resource depletion, land contamination, local and regional air and water pollution, and the global challenge of anthropogenic climate change [3, 4].

The adverse social and environmental impacts of utilities have led communities to demand that utility providers develop a social licence as an ethical justification to operate and deliver services with less environmental impact, that is not imposed by legislation or government mandate [5]. Increasingly, these social demands are being encapsulated in wider calls for a transition to a circular economy, modelled on natural processes and sustained by flows of renewable energy and the recycling of materials. The core principles and definitions of a circular economy are explored below, but at its simplest a circular economy is a system of cyclical processes that provide human communities with utility through the production and consumption of goods and services, without the generation of waste or pollution. Kirchherr *et al*. [6] recognised that the concept of a circular economy is of interest to both scholars and practitioners as a means of operationalising the implementation of sustainable development. At the macro level, three broad approaches are being used: enactment of circular economy legislation (as in China [7]); publication of government policies that encourage the adoption of circularity practices [8], [9]; and more generally through practitioner-led initiatives [10]. Nevertheless, critics of current approaches to the development of a circular economy have found the concept to be superficial and only supported by a collection of vague and separate ideas from several fields [11]. As such, current circularity thinking does not provide an agreed community of practice to support new business models for future utility projects. Consequently, project proponents are ill-equipped to explain how their proposals align with government policy which itself often lacks a rigorous rationale. The current hiatus raises the prospect of legitimate proposals for necessary public utility infrastructure being poorly received by potential funders, regulators, and communities.

To help address this situation, this paper explores the origins and principles of the circular economy concept, before considering the role of utility services in achieving the United Nation's Sustainable Development Goals and targets. As a possible mechanism for transitioning theory into practice, the structure and use of business models is explored, together with the role of different actors in the delivery of utility services. The paper concludes by mapping circular economy principles against six business model elements that have been derived from the literature, to identify a set of precursor considerations that have potential to inform new business models that could help transition society to a circular economy and deliver sustainable development through the provision of utility services.

2. Circular economy principles and definitions

The concept of a circular economy has evolved from a range of academic disciplines, including ecology, economics, engineering, design, and business [10]. Advocates of the circular economy also draw on a diverse range of inter-disciplinary themes, including industrial ecology [12], biomimicry [13], sustainable manufacturing [14], and cradle-to-cradle design [15]. As a result of this varied heritage, there is no universally agreed set of principles or definition of a circular economy, with Kirchherr *et al*. [6] identifying 114 different circular economy definitions in a review of the literature. This lack of agreement raises the prospect of confusion, particularly for decisions about utility projects which often represent large-scale, long-term projects for the public good, with connotations for economic

development through job creation, as well as environmental impacts through operational carbon and water emissions. An approach to addressing this problem lies in the elucidation of a set of key principles and components from existing circular economy definitions. As a starting point, three circular economy definitions are presented below.

Geissdoerfer *et al*. [16] and Schut *et al*. [17] claim that the most prominent definition of a circular economy is that given by the Ellen MacArthur Foundation [18], which defines a circular economy as "an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."

Kirchherr *et al*. [6] added the concept of scale to their definition of a circular economy as "an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."

Prieto-Sandoval *et al*. [10] explicitly recognise the need for societal change in defining a circular economy as "an economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and material loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces and consumes". Moreover, Prieto-Sandoval *et al*. [10] identify four components necessary to establish the circular economy concept: (1) the recirculation of resources and energy, the minimisation of resources demand, and the recovery of value from waste, (2) a multi-level approach, (3) its importance as a path to achieve sustainable development, and (4) its close relationship with the way society innovates.

With respect to the last component, Hofstra and Huisingh [19] (cited in Prieto-Sandoval *et al*. [10]), distinguish four types of eco-innovations: exploitative eco-innovations that pay little attention to environmental issues but meet legal requirements and pursue cost decreases; restorative eco-innovations that are corrective in that they tend to develop solutions for damage that has been done to the environment; cyclical eco-innovations that clearly embrace the circular economy ethos by sustainably harvesting resources and closing loops; and regenerative eco-innovations that are similar to an ecosystem's ability to create added value (for example, sustainable forestry schemes that not only yield timber and other bio-products, but also protect water supply catchments from soil erosion and excessive nutrient loss). This classification of eco-innovations is similar in approach to the use of the waste hierarchy (Figure 1(a)) in the resources management sector, where prevention and reuse of waste are given preference over recycling, recovery, and disposal of materials [20]. In this context, a proposed eco-innovation hierarchy (Figure 1(b)), that preferences regenerative systems over cyclical, restorative, and exploitative eco-innovations, provides a useful addition to the debate about circular economy principles.

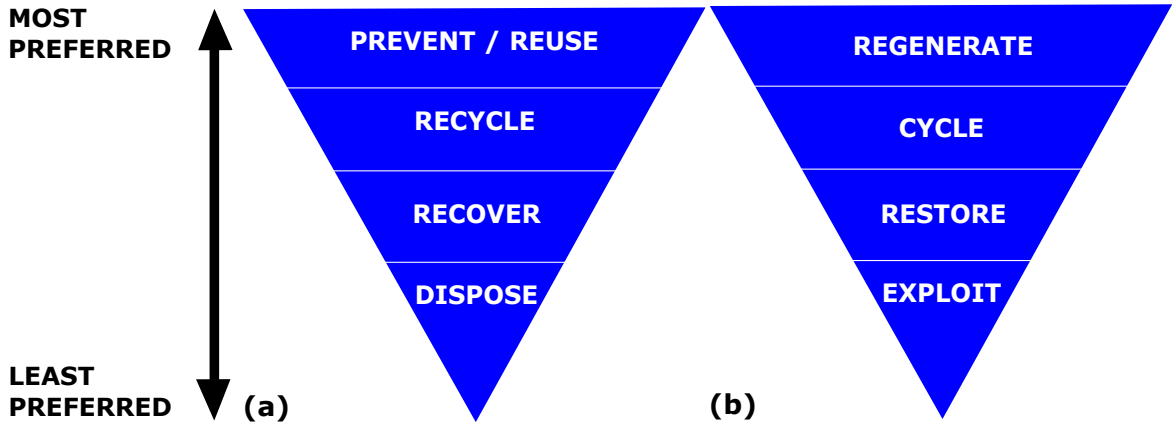

Figure 1 (a) The waste hierarchy (simplified by the authors from European Commission [20], and (b) The proposed eco-innovation hierarchy (developed by the authors from Hofstra and Huisingh [19]).

The connection between circular economy and sustainable development is explicit in two of the three definitions presented above. The next section explores this relationship further in the context of the role of utility services in attaining the United Nation's Sustainable Development Goals (SDGs).

3. The circular economy, sustainable development, utility services nexus

The United Nation's General Assembly's Resolution 70/1 "Transforming our World: the 2030 Agenda for Sustainable Development", commits signatory nations to achieving sustainable development in three dimensions – economic, social, and environmental – in a balanced and integrated manner [21]. Although the Resolution does not explicitly reference the transition to a circular economy, Article 9 envisages "a world in which consumption and production patterns and use of all natural resources are sustainable" and this aspiration is reflected in the Resolution's 17 Sustainable Development Goals and 169 targets.

Specifically, Goal 12 focuses on the achievement of sustainable consumption and production, and as illustrated in Figure 2, can be thought of as forming the hub of the circular business model concept. Seven other goals inform (are themselves informed by) circular business models. Access to equitable education, and promotion of lifelong learning (Goal 4) is fundamental to personal development and the functioning of human communities. The role of utility services in delivering universal improvement in human welfare is reflected in Goal 6, which identifies the need for equal access to drinking water and sanitation, and Goal 7, which focuses on access for all to affordable, reliable, sustainable, and modern energy supplies. Work and economic development (Goal 8) are the driving force of sustainable development, and relate closely to Goal 9 (industry, innovation, and infrastructure), and Goal 11 (sustainable cities and communities). The interactions between the circular economy, sustainable consumption and production, and humankind's impact upon the global environment are the focus of Goal 13 – action to combat climate change.

What is missing from Resolution 70/1 is clear, practical guidance on how the Sustainable Development Goals and targets will be achieved. To help explore how the theory underpinning Sustainable Development Goals and targets might transition into practice, the use of business models in the utility sector is described in the next section.

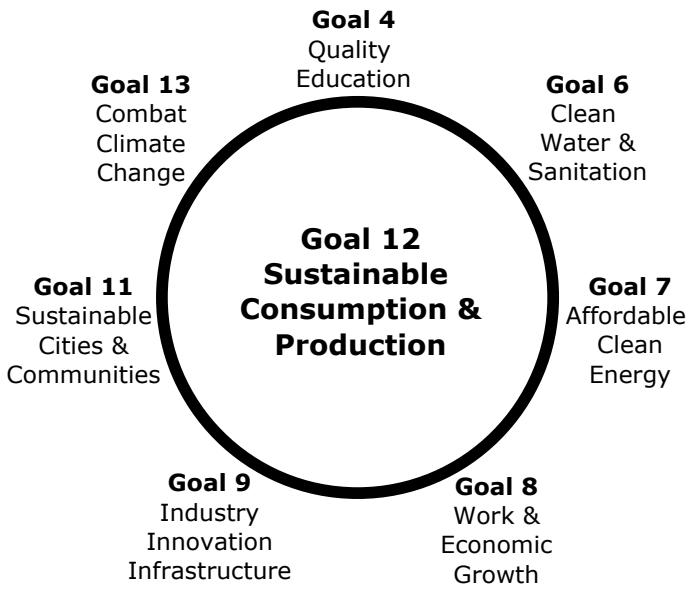

Figure 2. UN Sustainable Development Goals (SDGs) that relate to circular business models.

4. The use of business models in the utility sector

The term "business model" was first used in the academic literature more than sixty years ago [22, 23]. However, detailed analysis of the structure and function of business models did not occur until the early years of the present century, following the widespread failure of "dot-com" businesses that had stimulated frenzied financial trading on the back of strongly promoted, but poorly developed business models [24]. With parallels to the development of the concept of a circular economy, early business models were criticised as lacking a theoretical basis [25]; although Zott *et al*. [26] have recognised that conceptual dissent is nothing extraordinary during the development phase of new concepts that have wide-ranging usefulness and multidisciplinary applicability.

One of the most cited definitions of business models (according to Burkhart *et al*. 2011 [24]) is the one given by Timmers [27], who defined a business model as: "an architecture for the product, service and information flows, including a description of: the various business actors and their roles; the potential benefits for the various business actors; and a description of the sources of revenues". As an alternative, Alt and Zimmermann [28] provide a definition that is perhaps more apposite in the context of facilitating change in the face of new economic principles. Their definition is comprised of six generic elements (Figure 3): Mission (which describes the goals, vision and value proposition of the business); Structure (which encompasses the actors and governance of the specific industry, and the business model's focus, in terms of its geographic scope and industry); Processes (which covers value creation, customer orientation, and the business coordination mechanism); Revenues (which include business logic and sources of revenues); Legal issues (which have to be considered in the context of all of the business model components); and Technology (which can influence all other components through innovation and emerging technologies).

Business models help managers to design, implement, operate, change, and control their business [29, 30] and are used by government agencies and utility providers to identify the future demand for a particular service within a catchment (town, city, or region); to specify the primary technology solution; and estimate the charges that will be levied on users of the utility. Demand for utilities within a catchment is a function of the size of the human population and the expected level of well-being within

the community. The role of technology is crucial to the delivery of utilities. Improvements in the environmental performance of utilities can be driven by technical innovation in the design of equipment, leading to more efficient processes that require less inputs and enable better reuse or recycling of residual materials. Whilst the current systems of patents and design controls can support innovation, the excessive protection of intellectual property can limit the wider use of cleaner, more efficient technology, leading to the continuation of environmental impacts where utility providers cannot gain access to, or cannot afford to deploy, the latest innovations [31].

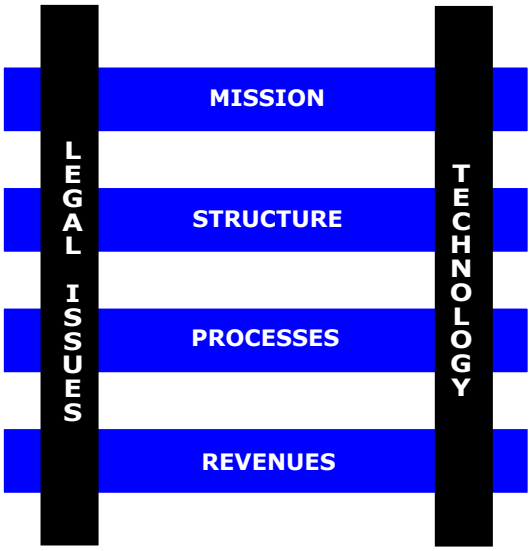

Figure 3. The six business model elements (adapted and simplified by the authors from Alt and Zimmerman [28]).

Decisions about utilities are made within a complex paradigm involving a range of actors. In democratic societies, governments are elected with the expectation that they will deliver upon their public commitments to ensure the provision of utilities, whilst protecting communities and the environment. Politicians are motivated by a desire to hold public office with the objective of delivering policies that attract on-going support from their electorate. Elected representatives devolve the work of policy development to their appointed executives, and ultimately politicians measure success (of both their policies and executives) through the ballot box. At a lower tier of government, municipalities may actively deliver (or manage the delivery of) local utilities, for example the collection of solid waste from households. More commonly, private sector solution providers contract with various tiers of government to build the necessary infrastructure and provide utility services to communities. Private companies are primarily motivated by profit and growth, and in the utilities sector their objective is to secure long-term contracts and success is measured by the profitability of the venture.

Governments can finance utilities through public sector borrowing [32], or alternatively they may appoint a solution provider through a public-private partnership (PPP) arrangement [1], with the solution provider being responsible for securing the necessary capital in the form of equity and loans. The community provides the long-term funding for the infrastructure through service payments that are made during the operational life of the asset. In centrally planned economies, national, regional, and local governments may take a more direct role through ownership of the infrastructure and day-to-day management of service provision.

The project lifecycle for a utility service (also referred as whole-of-life-cycle (WoL)) considers the utilisation span of the service from the design stage, through procurement, construction, service

operations and facility management [33]. WoL contracting can extend for up to three decades which is often the case of PPPs for the delivery of economic and social infrastructure, such as utility services [34]. To enable better use of business models within project lifecycles, the next section presents a framework that could be adopted to operationalise circular economy principles in the utilities sector.

5. A synthesised framework for operationalising circular economy principles

Table 1 maps the components of the definitions published by the Ellen MacArthur Foundation [18], Kircherr *et al*. [6] and Prieto-Sandoval *et al*. [10] against the six business model elements identified by Alt and Zimmerman [28].

Table 1. Circular economy principles and components mapped against business model elements

Business model elements	Circular economy principles and components
1. Mission: • Goals, vision • Value proposition	• Create a new paradigm in the way that human society is interrelated with nature • Recognise the risk of doing nothing and perpetuating existing social and environmental impacts • Prevent the depletion of resources • Close energy and material loops • Replace end-of-life concept • Create environmental quality, economic prosperity, and social equity to benefit current and future generations • Take urgent action to change current utility practices
2. Structure: • Actors and governance • Focus (regional, industry)	• Politicians, government agencies, utility providers, investors, regulators, communities • Micro-level (enterprises and consumers) • Meso-level (eco-industrial parks) • Macro-level (city, region, nation, international) • [Governance principles?]
3. Processes: • Value creation • Customer orientation • Coordination mechanism	• Use of renewable resources, including renewable energy • Eliminate the use of toxic chemicals that impair reuse • Eliminate waste • Recover value from waste • Reusing, recycling and recovering materials • Superior design of materials, products and systems • Inter and intra generational equity • Equal access to water, sanitation, and sustainable energy • [Use of environmental and eco management systems]

4. Revenues:
• Business logic
• Sources of revenues
	• Cyclical and regenerative environmental innovations to produce goods and services that provide revenue streams
	• Adopt an eco-innovation hierarchy:
	  o Regenerate
	  o Cycle
	  o Restore
	  o Exploit

5. Legal and ethical issues	• Regulatory compliance (and beyond) • Corporate social responsibility • Ethical reporting
6. Technology	• Discontinue use of polluting and inefficient technology • Promote innovation and adoption of cleaner technology

In undertaking this mapping exercise, two important aspects of Alt and Zimmerman's business model elements [28] do not appear to be addressed in the three cited definitions: governance and coordination mechanism. Although a detailed consideration of appropriate governance mechanisms is beyond the scope of the current paper, a useful starting point could be the Equator Principles [35]. Similarly, a suitable coordination mechanism could perhaps be derived from a consideration of the International Standard for Environmental Management Systems: ISO 14001 [36].

To facilitate the broad use of this framework, the bullet points in the second column of Table 1 have been verbalised as a set of precursor considerations for utility business models that are aligned with each of the six business model elements (Table 2).

Table 2. A framework of precursor considerations for utility business models

Business model elements	Circular economy considerations
1. Mission: • Goals, vision • Value proposition	Is the business model assisting the achievement of sustainable development by contributing to the creation of environmental quality, economic prosperity, and social equity for all generations through closed energy and material loops that do not deplete natural resources?
2. Structure: • Actors and governance • Focus (regional, industry)	Are the actors involved in the creation and execution of the business model (including politicians, government agencies, utility providers, investors, regulators, and communities), demonstrating their joint responsibility to act in accordance with a set of agreed principles when producing or consuming utility services at the micro-, meso-, or macro-level?
3. Processes: • Value creation • Customer orientation • Coordination mechanism	Is the business model creating value through the deployment of management systems and technologies that enable the use of renewable resources, and the reuse, recycling, and recovery of materials to facilitate equal access for all to water, sanitation, and sustainable energy?
4. Revenues: • Business logic • Sources of revenues	Is the business model enabling the supply of utility services and the generation of revenues based on a business logic that preferences regenerative and cyclical innovations over restorative and exploitative innovations?
5. Legal and ethical issues	Are utility providers, through the execution of business models, demonstrating their corporate social responsibility by complying with (and where possible, exceeding) regulatory requirements and are they documenting this through ethical reporting?
6. Technology	Is the business model requiring utility providers to phase out the use of polluting and inefficient technology and promoting innovation and adoption of clean technology?

6. Conclusion – towards circularity practice in the utility sector

This paper has sought to explore the challenges and opportunities that the transition to a circular economy presents within the utility sector. In particular, the current lack of consensus on what is meant by the term *circular economy* has potential to cause confusion amongst and between theoreticians and practitioners. To help address these issues, a framework of six precursor considerations for utility business models has been synthesised and is presented in Table 2. This framework could be used to test the extent to which existing business models in the utility sector support the transition to a circular economy and the achievement of sustainable development.

The work presented in this paper could be extended by applying this framework to existing utility business models through an analysis of annual reports and other documentation published by utility companies. Such a process would help determine whether utility providers are operationalising sustainable development through the adoption of circular economy principles and practices. There is also potential to develop the framework to inform corporate scorecards; as an assessment method for government and enterprise policies and strategies; aid the development of procurement specifications and evaluation criteria (particularly for public utility projects); and inform the design of curricula for economists, engineers and scientists seeking to work in the public utilities sector.

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