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Perspectives

# Disruptive innovation and energy transitions: Is Christensen's theory helpful?

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ABSTRACT

Clayton Christensen's term, 'disruptive innovation' has become widespread. Unfortunately, Christensen's theory relies on far too narrow a conception of both disruption and innovation to be a central framework for thinking about low-carbon transitions. It is better understood as describing one specific mechanism of technological and industrial change that contributes to a broader framework of understanding transitions. It should also be understood as a warning and reminder: businesses, policy analysts and energy modellers alike are prone to overlook potential shifts in user demands, and the technological changes that chase and enable them.

## 1. Introduction

Clayton Christensen's term, 'disruptive innovation', has become widespread since he introduced his theory of 'disruptive technology' in 1995 [1]. Christensen's notion of disruptive innovation is alluring: it seems to promise that there are hidden opportunities, waiting to be stumbled upon, that can result in rapid and radical de-stabilisation of incumbent technologies. For a world desperately in need of a transformative shift towards low-carbon energy systems, what could be more promising?

Unfortunately, Christensen's idea relies on too narrow a conception of disruption and innovation to be a central framework for thinking about low-carbon transitions. It is better understood as describing one specific mechanism of technological and industrial change that contributes to a broader framework for understanding transitions. It should also be understood as a warning and reminder: businesses and policy analysts alike are prone to overlook potential shifts in user demands, and the technological changes that chase and enable them.

In this short *perspective*, I first set out the basic elements of Christensen's idea, making clear what is meant by 'disruptive innovation' in this context. I then examine the key shortcomings of Christensen's theory from the perspective of low-carbon transitions, before going on to show how it can still be useful.

## 2. The core of Christensen's approach

To his obvious irritation, Christensen's phrase is often used in the literature to refer to any radical or far-reaching technological change. He has argued fiercely that this devalues the original theoretical contribution, by obscuring the particular mechanisms he sought to highlight [2]. Following his argument, this *perspective* focuses on Christensen's original conceptualisation of the 'disruptive innovation' idea.

Christensen's original idea was built around an overlooked and 'overserved' set of users. Lead users, he argued, are willing and able to pay more and they are demanding of high quality. Such users strongly influence the innovation priorities of incumbent firms. The most successful firms are those that listen closely to those users and meet their needs most effectively. But innovating firms' close relationship with these lead users is, counter-intuitively, precisely the thing that makes them vulnerable to disruption.

Leading firms, Christensen argued, overlook the fact that the product improvements they deliver aren't really needed by an increasing share of users. Such low-end users would be happy with a cheaper, simpler alternative. This creates a space for 'low-end footholds', in which lower-quality alternatives undercut incumbents, producing lower-margin (and hence lower profit) alternatives to mainstream goods and services. The low margins mean that these competing options are of little interest to incumbents, but technological learning within the low-market foothold can lead to the disruptive entrant becoming dominant.

In 2003, Christensen extended the original idea to encompass 'new market' footholds, i.e. innovations that capture markets that previous did not exist [3]. These 'new market' footholds serve users who were previously not just under-served, but not served at all. The tendency of radical new technologies to disrupt existing markets is of course well-trodden theoretical territory, with Schumpeter's notion of 'creative destruction' an obvious precursor – and one might object that

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Christensen's 'new market footholds' is old wine in new bottles. However, the contribution of Christensen's analysis here is to focus strategic and analytic attention on users that are currently not served by existing products and services.

## 3. Three shortcomings of Christensen's disruptive innovation theory in the context of low-carbon transitions

As a wide range of scholars have argued [4–6], low-carbon transitions require radical change across networked sets of actors, clusters of related technology, regulatory and other institutions, and user practices. Understanding and analysing such transitions requires theoretical frameworks that can encompass this broad range of concerns. I argue that Christensen's theory does not meet this need. This is perhaps unsurprising – it was never intended to be a comprehensive analytic perspective for thinking about low-carbon transitions. But in understanding how and whether it can be useful for thinking about transitions, it is helpful to first explore the reasons that disruptive innovation in Christensen's sense falls short of providing a broad framework that can account for the dynamics of low-carbon transitions. In the following, I set out three ways in which Christensen's theory is limited in its ability to account for low-carbon transitions.

### 3.1. What is disrupted? Scales of disruption and continuity

The focus of Christensen's work is the business models and innovations of firms adopting 'sustaining' and 'disruptive' strategies, the corresponding industry dynamics, and the implications for strategic managers in firms. His perspective simply excludes wider systemic interactions and concerns. Yet for a low-carbon transition, disruption to a particular set of incumbent firms and specific technologies may have little relevance to the wider high-carbon socio-technical system, as the two examples below illustrate.

Christensen's historical account of the disruption brought by Japanese manufacturers to the motorbike market shows profound reordering of the competitive landscape for motorbike makers. The story provides a clear example of a new market entrant exploiting a low-end foothold and subsequently moving up-market and displacing incumbents, thus transforming the market. Yet this process had little relevance for the role of motorbikes within road transportation as a whole. This case makes clear that disruption for incumbents can be compatible with continuity for the wider socio-technical system.

In contrast, since the 1970s wind power companies adopted what Christensen would term a 'sustaining' rather than 'disruptive' strategy, competing directly with incumbents to generate grid-connected power. Their emergence has relied principally on policy support over many decades and in many countries [7], rather than the successful exploitation of either new markets or under-served users. Yet, while they do not meet Christensen's definition of 'disruptive', these technologies have had profoundly destabilising impacts on power markets [8], and are at the heart of an ongoing transition to renewable energy. Disruption at the system scale clearly does not necessarily rely on a classic 'disruptive innovation' at the firm level.

### 3.2. Overlooking other routes to disruption: limits of a niche-based view

A second limitation of Christensen's approach, from a transitions perspective, is the focus on market niches. Christensen's theory provides a neat description of a widely observed phenomenon: lead firms being disrupted by newcomers offering a simpler, cheaper alternative. This focus on the establishment of market niches, and their role in incubating radical novelty, has clear echoes in the multi-level perspective [5,9].

But focusing on this route to disruption alone would be a mistake: as a lengthy debate in the sustainability transitions literature has noted, there are many pathways to radical transformation. A niche market-based view is only one such path [10,11], and a focus on Christensen's theory overlooks alternative disruptors. Social movements, landscape developments and reconfiguration by incumbents have all been important in past transitions [12]. By neglecting these alternative routes to disruption, Christensen clearly limits the applicability of disruptive innovation theory to prospective transitions.

### 3.3. Public goods, public policy and low-carbon transitions

An exclusive focus on market niches as a spur to transitions is particularly limiting in the context of transitions to *lower-carbon* energy systems. Reducing carbon emissions is a public good, for which no natural markets exist. Without public policies in place to direct it away from high-carbon trajectories, innovation—disruptive or otherwise—should not be expected to generate a low-carbon transition [13].

Christensen's theory excludes public policy and the political processes that shape it. But as Meadowcroft has argued, a satisfactory framework for addressing low-carbon transitions must include a role for politics if it is to be a useful guide to policy [14]. The co-evolutionary interplay between innovation and regulation is critical for understanding how low-carbon transitions can come about: As Porter and van der Linde argued, environmental regulation can induce innovation [15]; the less well documented but also important fact is that innovation enables regulation – by bringing down the expected costs of regulation.

## 4. Why Christensen's approach remains relevant

The three limitations set out above make clear that Christensen's theory of disruptive innovation does not provide a framework that can account for low-carbon transitions. Assertions that a low-carbon transition requires disruptive innovation should be tempered by the fact that disruptive innovation alone may not be enough.

However, in spite of those limitations Christensen's theory does have relevance for low-carbon transitions, by highlighting important mechanisms that contribute to transitions. In particular, the value in the disruptive innovation idea is that it highlights the tendency for analysts to overlook 'overserved' users or missing markets.

### 4.1. Low-end footholds: challenging tacit assumptions about user needs

Christensen's observation that leading firms are taken by surprise by the strategic importance of over-served users is a reminder for policy analysts and low-carbon innovators to keep an open mind about what consumers will accept, and to ask themselves whether there are portions of the market that are being overserved. The positive message for policy here is the idea of the 'over-served' user. If these users are over-served in terms of energy services, then low-end foothold strategies may enable lowering of total energy service demands.

Where might we find such overserved users? One example might be mobility markets, where the costs associated with vehicle ownership are a significant portion of average household expenditure,[1] yet most vehicles sit idle for 95% of the time [16]. Ownership of a typical car provides more power, range and other features than are actually used by most motorists [17]. Little wonder that car-sharing services like Zipcar have been heralded as potentially 'disruptive innovators'[18], as have electric bicycles [19]. Transport policy is typically based on (often tacit) assumptions about the durability of the socio-technical regime around private car ownership – and Christensen's theory should be a reminder to policymakers about the potential for disruption to that model.

[1] In the US, average costs associated directly with vehicle ownership, excluding fuel, are around 10% of average household total expenditures [26]. In the UK, the figure is around 6% [27]. Similar data for the EU are available from the EEA [28].