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What stalls a renewable energy industry? Industry outlook of the aviation biofuels industry in Australia, Germany, and the USA

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ABSTRACT

Despite the global aviation industry's strong endorsement of a switch to aviation biofuels, fossil fuel remains the dominant energy source for air travel. Drawing on a multiple case study of 58 organizations in the emerging aviation biofuels industry relevant to Australia, Germany, and the USA, we unpack the lessons learned from this stalling industry. First and foremost, we identify a key difference in industry outlooks and corresponding strategic mindsets. Specifically, the two outlooks—industry optimism and industry pessimism—seem to correspond to specific strategic mindsets. Whereas industry optimists (1) stressed diversification, (2) were demand-driven in their decisions about R&D, and generally (3) had a learning orientation to innovations, industry pessimists emphasized the need for (1) premium pricing, (2) government intervention, and (3) economies of scale as key drivers of industry development and growth. We also found geographic differences in industry outlooks among biofuel entrepreneurs and other stakeholders in Australia, Germany, and the USA. Through our findings, we offer insights for policymakers and other industries seeking to transition to renewables.

1. Introduction

Many industries aim to transition from coal to renewable energy (UTS Institute for Sustainable Futures, 2017). However, some industries, such as aviation, still depend on oil (Kandaramath, Yaakob, and Binitha, 2015). Sustainability innovations—new products or services that are directed toward economic, social, and environmental goals (Schaltegger, Hansen, and Lüdeke-Freund, 2016; Waldron, Fisher, and Pfarrer, 2016; York, O'Neil, and Sarasvathy, 2016)—are of increasing practical importance for many industries (e.g., solar cell technology, biotechnology, utilities), but also present tremendous uncertainty and ambiguity for entrepreneurs and intrapreneurs. Some sustainability innovations have been remarkable failures, such as Better Place, an ultimately unsuccessful solar battery-charging and switching service (Noel and Sovacool, 2016), or the Nordic Climate Cluster, an innovation network that disbanded only 2 years after it was established (Sarasini, 2015).

Sustainability innovations inevitably disrupt the status quo, which implies that the outcomes of these sustainability innovations are inherently unpredictable (Rennings, 2000). Furthermore, their key success factors are poorly understood. More specifically, researchers know little about how industry prospects (industry optimism versus pessimism) are associated with stakeholders' strategic mindsets and how this may, in turn, shape an industry's progress toward commercialization (Marcus, 2015).

This study expands existing knowledge regarding the limitations of commercialization of new technologies, or, more specifically, renewable energy (Choi et al., 2016; Mousavi and Bossink, 2017). Existing research shows many hindrances to the adoption of new technologies (Gegg et al., 2014). These include policy discontinuity, technological feasibility, cost considerations, long lead times, technological uncertainty, and expensive or delayed regulatory approval (Choi et al., 2016; Mousavi and Bossink, 2017; Simshauser, 2014). Through a case study of the nascent aviation biofuel industry (sometimes also called sustainable aviation fuels or SAFs), we unpack the underexplored issue of industry outlooks (industry optimism vs. pessimism). More specifically, we examine organizational actors' strategic mindsets and industry outlooks to improve our understanding perceptions regarding obstacles to the adoption of new technologies.

The paper is structured as follows. First, we discuss the literature relevant to industry outlook and commercialization. We argue that, in general, sustainability innovations face several challenges that impede their adoption by airlines and, thus, hinder industry growth. We highlight the current state of knowledge regarding possible limiting and

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enabling factors. Then, we highlight the centrality of the airline industry in the global economy—from the perspective of not only its economic contributions, but also its environmental harm. Second, we outline our methodology. Third, we present the findings regarding our informants' optimism or pessimism on the industry and how this affects their strategic mindsets regarding sustainability innovations. Finally, we conclude with lessons that can be drawn for other sustainability innovations and industry contexts.

2. Background and literature review

2.1. Is optimism required for business innovation and success?

Although many companies are greatly motivated to develop sustainability innovations, they face many pitfalls (Marcus, 2015). The difficult and complex economics of the underlying new technologies (typically large upfront capital expenditures with long, uncertain payoffs) and the lack of critical human success factors may partly explain the relatively slow progress in sustainability innovations so far (Prajogo, 2015; Schrettle et al., 2014). Existing research shows that new products and processes face many other challenges, too. These include technological feasibility (Singh and Das, 2014), cost considerations, including supply chain establishment (Markman and Krause, 2016; Qantas Airways Ltd, 2013), long lead times for user acceptance (Mani and Nandkumar, 2016), technological uncertainty (Hileman and Stratton, 2014), expensive regulatory approval (Fremeth and Shaver, 2014; Howes et al., 2017), political uncertainty or policy discontinuity (Biofuels Digest, 2014; Gilder and Stiles, 2017), and policy failures (Howes et al., 2017).

With respect to renewable energy, it is not clear whether it has historically really paid to go green thus mitigating these barriers in the long term (Schaltegger et al., 2016). Value creation from sustainability innovations may lead to (1) cost savings, (2) regulatory compliance, (3) brand building, or (4) a price premium for green products (Orsato, 2006). Knowledge about these preconditions for the economic payoffs of sustainability innovations does not imply that they are easy to execute (Belz and Binder, 2017; Pinkse and Groot, 2015). Many firms have not been able to create win-win outcomes with their sustainability innovations because they have not effectively deployed all the elements of effective business models (Dean and McMullen, 2007; Nambisan and Baron, 2013). That is, these strategies sit outside the main business framework, which may undermine value creation for customers, effective value delivery, and successful value capture (Marcus, 2015).

Business models first exist in the minds of strategic decision makers (Teece, 2010). Unlike many practicing entrepreneurs that highlight the importance of optimism for business innovation and success (e.g., Gauthier, 2013), recent academic research has generally stressed the benefits of managerial pessimism (Baron, Hmieleski, and Henry, 2012). This body of research argues that managerial pessimism results in more realistic, critical assessment of alternatives (Hmieleski and Baron, 2009). Thus, there is some tension in the viewpoints between practitioners, who stress the importance of optimism (e.g., Seligman and Csikszentmihalyi, 2000; Snyder and Lopez, 2009, Welch and Welch, 2005), and academics, who generally prefer pessimism (e.g., Lovallo and Kahneman, 2003a, 2003b; Hmieleski et al., 2013). The present qualitative study seeks to re-examine this tension—but apply it to the industry level of analysis (so industry outlook optimism/pessimism rather than generalized optimism/pessimism)—and study the interdependence between industry outlooks and strategic mindsets.

We want to emphasize from the start that we do not presume that entrepreneurial optimism should, by necessity, be considered a key success factor. In fact, a lot of evidence in the entrepreneurship literature shows that optimism may not only explain entrepreneurial success, but also undermine it, especially once optimism exceeds an optimal level (Baron et al., 2012). The negative consequences of optimism seem to be especially pronounced in the context of vast entrepreneurial experience, high industry dynamism, and high levels of entrepreneurial improvisation, the deliberate extemporaneous execution of novel action. Prior research often focuses on individuals' dispositional optimism, sustainability innovation, and financial performance (Jabbour et al., 2015; Przychodzen and Wojciech Przychodzen, 2015; Tseng and Bui, 2017). Some of the disadvantages of optimism may, for example, lead to hubris, or an over-confidence in the current solutions. Constructive management in this area avoids all the pitfalls of optimism, which may be especially applicable to entrepreneurs because entrepreneurs, on average, tend to be more optimistic than the general population (Åstebro et al., 2007; Cassar, 2010). When industry optimism becomes detached from organizational reality it is likely to have harmful consequences.

In this study, instead of general optimism, we present qualitative interview evidence about *industry outlook* optimism and industry pessimism, which to our knowledge has never been analyzed in renewable energy research before. More specifically, our study sheds light on the strategic mindsets that may go hand in hand with managers', inventors', and other stakeholders' industry outlook optimism and pessimism. In turn, we suggest how this divergence may stall progress toward commercialization.

We will later return to the practical implications of conflicting outlooks —some good, others bad—after presenting our findings. First, in the next section, we describe our study context, the aviation biofuel industry.

2.2. Industry context: aviation biofuels

In a globally interconnected world, aviation is a crucial mode of transportation, which is especially important for shipping high-value, time-sensitive, or perishable goods. Aviation generates millions of jobs and contributes billions to annual global Gross Domestic Product (Air Transport Action Group, 2016). However, aviation also produces significant negative externalities as it is estimated to emit between 2% and 3% of global carbon dioxide (CO_2) (Anslow, 2008; Intergovernmental Panel on Climate Change, 1999). These industry total emissions are almost equivalent to those of the world's sixth-largest CO_2-emitting country, Japan (USA Environmental Protection Agency, 2016). Clearly, this problem has become an important issue for commercial airlines.

In response to various pressures, the airline industry has made commitments to three key targets to reduce its carbon footprint. The industry has achieved a 1.5% annual fuel efficiency by 2010 by improving its capital stock and optimizing fleet management and flight logistics (International Civil Aviation Organization, 2010). Two further targets remain: CO_2-neutral growth by 2020 and 50% reduction in net CO_2 over 2005 levels by 2050 (ICAO, 2016). Achieving these targets will be challenging because more than 95% of airlines' CO_2 emissions come from the combustion of fossil fuels in jet engines (Qantas Airways Ltd, 2015). Thus, to meet the last two targets, airlines need an alternative, more sustainable fuel.

So-called "drop-in" aviation biofuels, which reduce CO_2 emissions by 80% compared to fossil fuels (Fairley, 2011), can power aircraft without any modification to jet engines. To be considered sustainable, the International Air Transport Association (IATA) stipulates that aviation biofuels must produce less net lifecycle CO_2 emissions compared to fossil fuels, avoid competition for water and food resources required for human consumption, and avoid deforestation and biodiversity loss (International Air Transport Association, 2010). Currently, no biofuels provides such a sustainable solution, and there are serious questions about the ecological sustainability of biofuels, such as habitat loss, biodiversity loss, and excessive water use (Burritt and Schaltegger, 2012).

Aviation biofuels were pioneered in 2008 when Richard Branson sponsored a Virgin Atlantic flight between Heathrow (London, UK) and Amsterdam (Netherlands) powered by biofuels made from Brazilian babassu nuts and coconuts (Virgin Atlantic, 2008). "This pioneering