

# **Innovation intermediaries accelerating environmental sustainability transitions**

Travis Gliedt, Christina E. Hoicka, Nathan Jackson

2018

Faculty of Social Sciences

Faculty Publications

© 2018 Gliedt et al. This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 License:

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Original citation:

Gliedt, T., Hoicka, C. E., & Jackson, N. (2018). Innovation intermediaries accelerating environmental sustainability transitions. *Journal of Cleaner Production*, 174, 1247–1261. <https://doi.org/10.1016/j.jclepro.2017.11.054>

---

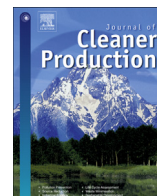
Downloaded from UVicSpace Research & Learning Repository

dspace.library.uvic.ca



**University  
of Victoria**

Libraries



## Review

# Innovation intermediaries accelerating environmental sustainability transitions



Travis Gliedt <sup>a, \*</sup>, Christina E. Hoicka <sup>b</sup>, Nathan Jackson <sup>a</sup>

<sup>a</sup> Department of Geography and Environmental Sustainability, College of Atmospheric and Geographic Sciences, University of Oklahoma, USA

<sup>b</sup> Roberts' Centre for Canadian Studies, Faculty of Environmental Studies, York University, Canada

## ARTICLE INFO

## Article history:

Received 8 February 2017

Received in revised form

7 November 2017

Accepted 8 November 2017

Available online 10 November 2017

Handling Editor: Cecilia Maria Villas Bôas de Almeida

## Keywords:

Policy entrepreneurship

Champion

Green economic development

Incubator

Institutional uncertainty

## ABSTRACT

Institutions in the United States are undergoing modifications that present direct challenges for the environment and society and may result in institutional uncertainty and instability. This article explores whether innovation intermediaries can be employed as a key component of a strategy to create a window of opportunity for green job creation, infrastructure changes, and technological innovation in response to these types of institutional modifications. Based on a systematic literature review, this article outlines a framework that combines institutional modifications with technological innovation and infrastructure development as part of an economic development strategy. Important findings are that connections between innovation intermediaries, such as incubator and accelerator centers, niche actors, such as green champions, and regime actors, such as policy entrepreneurs, show potential to contribute to a green economic development strategy but require further examination for the specific roles played by policy entrepreneurs to help create the conditions for scaling niche experiments and simultaneously disrupting the regime. The key contribution is in defining the role of sustainability-oriented innovation intermediaries at linking local, state and business actions in order to scale-up and influence green economic development in a politically feasible manner during times of institutional uncertainty and instability.

© 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Contents

1. Intermediaries within sustainability transitions .....	1248
1.1. Innovation intermediaries contribute to green economic development in the United States .....	1248
2. Method: A systematic review on innovation intermediaries in sustainability transitions .....	1249
3. Results .....	1250
3.1. Innovation intermediaries support green innovation and economic development .....	1253
3.2. Sustainability innovation intermediaries facilitating cross-level interactions .....	1254
4. Discussion .....	1255
4.1. Green niche actors: entrepreneurs and champions .....	1255
4.2. Green regime actors: policy entrepreneurs .....	1256
4.3. Niche and regime actors contribute to policy change frameworks .....	1256
4.4. An intermediary driven green economic development framework .....	1257
5. Conclusion .....	1259
Acknowledgements .....	1259
References .....	1259

\* Corresponding author.

E-mail address: [tgliedt@ou.edu](mailto:tgliedt@ou.edu) (T. Gliedt).

## 1. Intermediaries within sustainability transitions

Green innovation is the central tenet of sustainability transitions theory and practice; the process of green innovation and the diffusion of green technologies creates jobs and economic development benefits. For more than two decades, sustainability transitions theorists and practitioners have been developing a framework called the multi-level perspective (MLP) that outlines pathways for using innovation to change the infrastructure and institutions of society (Loorbach et al., 2017). The MLP focuses on innovation and development strategies that help to transform the cultural, institutional, social, political, market, industry, infrastructure, technology, and science ‘subsystems of society’ that are locked-in and characterize the dominant socio-technical regime (Smith et al., 2010). Transitions are often based on the negotiation of different stakeholders within a policy arena (Loorbach and Rotmans, 2010). In this way, change in socio-technical systems is dependent on functions performed by actors at various points in time.

The MLP “distinguishes between three analytical levels with increasing temporal stability: niche (flexible and fluid), regime (semi-stable) and landscape (slow societal processes that provide the context for regime stability or change)” (Fischer and Newig, 2016, p. 3). Kivimaa and Kern (2016) explain that “transitions come about through interactions between ... landscape (macro-economic and macro-political trends, significant environmental changes, demographic trends, etc.), regime (the deep structure of the socio-technical system involving alignment between technologies, infrastructure, institutions, practices, behavioral patterns, markets, industry structures, etc.), and niches (spaces where various technical, social and organizational innovations are created and tested” (p. 206). The challenge is to capitalize on external pressures during windows of opportunity to allow niche experiments to scale-up and change the regime (Wittmayer et al., 2017). According to Fischer and Newig (2016), the key capitalizers are the niche and regime actors, and intermediaries:

- *Niche actors* “focus on knowledge development and diffusion, articulation of visions, entrepreneurial activities, market formation, guidance of search activities, mobilization of resources, creation of legitimacy, and overcoming of resistance to change” (p. 13).
- *Regime actors* are “supporters of transition by forming powerful coalitions to push through a reform agenda that fits incumbent regimes interest, or opponents of transition by downplaying the need for transformation” (p. 13).
- *Intermediaries* are defined by the roles that they play, including “providing and distributing necessary information, services, mediation, connecting niche-level activities with regime-level institutions, and diffusing new technologies and practices through the regional level” (p. 14).

Critiques of the MLP include that it is a ‘post-political’ economic model that does not incorporate political or democratic processes, but rather, brings selected actors together to build consensus on a long-term strategic plan as part of a transition arena (Kenis et al., 2016). Furthermore, the MLP does not make power, conflict and decision-making ‘visible and contestable’ as it treats the political landscape as neutral, and it does not incorporate citizens except as consumers (Kenis et al., 2016). This paper outlines how, *precisely because it is post-political*, the MLP is advantageous and offers direction to local and regional actors in creating green economic development as a politically feasible strategy during times of institutional uncertainty.

Although innovation intermediaries can operate with support from the federal government (Kivimaa, 2014), during times of political and institutional uncertainty, a key advantage of innovation intermediaries is that they can be established by local or state level governments or the private sector to operate independent of the federal government. Innovation intermediaries can be developed as public, private, or non-profit organizations (McCauley and Stephens, 2012), sometimes involving support from universities (Hayter and Link, 2015; Kivimaa et al., 2017a), and can become the center of triple helix innovation systems (Barrie et al., 2017). Incubator and accelerator centers acting as innovation intermediaries (Blankenship et al., 2009; Ceschin, 2014; Hayter and Link, 2015) often form the core of university research parks, proof-of-concept centers, regional clusters, and municipal economic development strategies. Incubator and accelerator centers lead to thousands of direct and indirect jobs, and hundreds of millions of dollars of local economic impacts (New York Incubator, 2016).

Innovation intermediaries can contribute directly to green entrepreneurship (Gast et al., 2017), and indirectly to other green jobs strategies focusing on attracting (Bowen et al., 2013), retaining (Abdelkafi and Täuscher, 2016), and expanding (Inglesi-Lotz, 2016) firms in dominant industries that help scale-up niche experiments as part of sustainability transitions. This includes coordinating interactions and collaborations between business (Maas et al., 2016), municipal (Fenton et al., 2015) and state (Ray and Grannis, 2015) leaders focused on developing sustainability solutions as part of green economic development strategies when the federal government withdraws support from programs related to sustainability and innovation.

### 1.1. Innovation intermediaries contribute to green economic development in the United States

Evidence suggests that during the final years of the Obama administration, the United States was undergoing a sustainability transition with significant reductions in GHG emissions occurring simultaneously to positive economic growth rates (Obama, 2017). The sustainability transition was led by federal policy changes, which helped create millions of green jobs (BLS, 2012). More than 2.5 million Americans work in the clean tech sub-segment of green jobs (Ecotech Institute, 2016), which are part of a broader 4.5 million sustainability jobs that the Environmental Defense Fund estimates exist in the United States (Gessesse et al., 2017). Many sustainability jobs were created in part by innovation intermediaries within green clusters, which specialize in water technology innovation (Milwaukee), energy services and wind (Albany), battery technology, green architecture and construction services (Atlanta), electric vehicle technology (Kansas City), energy efficient products, fuel cells and solar PV (San Jose), and air and water purification technology, solar PV and solar thermal (Phoenix) (Muro et al., 2011).

Important outcomes of green economic development include breaking the ceiling on green jobs in rural America (Greene and Geisken, 2013; Pender et al., 2014), replicating eco-zones and policy transformations like in Portland, Oregon (Allen and Potiowsky, 2008), returning manufacturing to the rust belt like the SolarCity 1-GW Solar Factory in Buffalo, NY (Mullaney, 2015), and transforming the automotive (Penna and Geels, 2015; Wesseling et al., 2015) and aircraft industries (Slayton and Spinardi, 2016) to more sustainable performance. Many studies demonstrate the socio-economic benefits of green jobs in the United States (Elliott and Lindley, 2017; Hess and Mai, 2015; Wei et al., 2010; Yi, 2014), and various metrics show the contribution to green economic

**Table 1**  
Literature Review Framework: # of Articles and h-index value for each Boolean Keyword Combination.

Primary Keywords	Secondary Keywords	Tertiary Keywords									
		Incubator	Accelerator	Entrepreneur	Champion	Policy Entrepreneur	Transition	Niche	Regime	United States	
Innovation Intermediary 956; h = 47	Sustainability 343; h = 32	59; h = 10	28; h = 5	90; h = 11	33; h = 5	2; h = 1	158; h = 24	91; h = 14	65; h = 13	97; h = 12	
	Environmental Sustainability 38; h = 7	10; h = 4	8; h = 4	10; h = 3	5; h = 4	0; h = 0	23; h = 5	12; h = 4	13; h = 5	14; h = 5	
	Economic Development 333; h = 30	74; h = 12	27; h = 6	102; h = 12	23; h = 7	1; h = 0	153; h = 19	71; h = 11	72; h = 7	126; h = 14	
	Socio-technical 85; h = 14	8; h = 2	5; h = 1	19; h = 5	6; h = 1	1; h = 1	56; h = 12	39; h = 8	27; h = 6	15; h = 3	
	Sustainability AND Economic Development 139; h = 18	36; h = 8	16; h = 3	52; h = 7	14; h = 5	1; h = 0	78; h = 12	49; h = 9	33; h = 5	64; h = 9	
	Sustainability AND Socio-technical 54; h = 9	6; h = 2	5; h = 1	12; h = 2	5; h = 1	1; h = 1	44; h = 8	33; h = 7	24; h = 5	12; h = 3	
	Environmental Sustainability AND Economic Development 16; h = 4	3; h = 1	3; h = 1	6; h = 3	2; h = 2	0; h = 0	10; h = 3	7; h = 2	7; h = 2	9; h = 4	
	Environmental Sustainability AND Socio-technical 11; h = 2	1; h = 0	3; h = 1	2; h = 0	0; h = 0	0; h = 0	9; h = 2	7; h = 2	6; h = 2	2; h = 0	
	Economic Development AND Socio-technical 29; h = 6	3; h = 2	3; h = 1	5; h = 2	1; h = 0	0; h = 0	20; h = 4	17; h = 4	11; h = 2	8; h = 2	

Note: searches conducted June 24, 2017 include all publications available to that date. This table includes duplicates to reflect the comprehensive keyword combinations. For example, “innovation intermediary” AND “sustainability” leads to 343 publications, which also includes all 139 “innovation intermediary” AND “sustainability” AND “economic development” publications. Additionally, the tertiary searches contain overlaps to the extent that a publication contains multiple tertiary keywords. For example, the 20 publications that contain “innovation intermediary” AND “economic development” AND “socio-technical” AND “transition” overlap with other tertiary keyword search categories e.g. niche, regime. The duplicates were removed during the analysis process.

development (Chapple et al., 2011; Garrett-Peltier, 2017; Sooriyaarachchi et al., 2015).

The election of President Trump in 2016 initiated processes to weaken federal regulations and programs that had supported the sustainability transition and green economic development. Rapid policy changes at the federal-level, such as reducing the budget of the Environmental Protection Agency (EPA), and executive orders to remove regulations on the coal industry, highlight how institutional uncertainty can threaten to interrupt sustainability transitions. This type of instability can also disrupt sustainability transitions in other jurisdictions. For example, between 2006 and 2015, the Conservative government in Canada steadily removed federal-level policies and institutions that supported sustainability, leaving provinces and municipalities to lead the way on climate change, sustainability and environmental protection. Therefore, it is important to explore how the MLP can be adapted with the inclusion of innovation intermediaries to create opportunities for green economic development in the context of uncertain political and institutional environments.

Understanding how to simultaneously scale-up niche experiments and weaken or alter subsystems of the regime is vital for accelerating sustainability transitions (Grin et al., 2010). It is therefore important to learn more about the roles of actors, like intermediaries, that connect individuals to societal structures in multi-level sustainability transitions (Wittmayer et al., 2017). Research on innovation intermediaries is critically needed to help address gaps in understanding how actors in the MLP can collaborate to protect niches, scale-up niche experiments, and act as change agents within the subsystems of the regime (Smith et al., 2010). This paper seeks to examine how innovation intermediaries interact with other important actors identified by the MLP, the niche actors and regime actors, to contribute to a sustainability transition.

## 2. Method: A systematic review on innovation intermediaries in sustainability transitions

This paper employs a systematic literature review as a method

to better understand how innovation intermediaries can interact with *niche actors* (e.g., green entrepreneurs and champions) and *regime actors* (e.g., policy entrepreneurs) to contribute to green economic development during times of political and institutional uncertainty. In particular, this paper assesses the extent to which niche actors, regime actors, and innovation intermediaries can link local, state and business actions at the niche level, while scaling-up experiments and encouraging cross-level interactions to influence change from the niche to the regime. The systematic literature review followed a similar process to those outlined in Boehm and Thomas (2013) and Gast et al. (2017), and was conducted to search for academic publications (papers, articles and books) that focus on innovation intermediaries in relation to sustainability transitions and green economic development. The method outlined by Boehm and Thomas (2013) framed the systematic literature review based on three types of questions: “review protocol: what is the research question and scope?; search strategy: how to identify relevant literature?; documentation and analysis: what can we learn from a rigorous analysis of the literature?” (p. 247). Therefore, the following research question was formulated to guide the review: *what is the state of knowledge about how innovation intermediaries can contribute to green economic development as part of sustainability transitions, particularly during a time of political and institutional uncertainty?* To focus the research and provide further clarity, three research objectives have been defined: 1) to understand how innovation intermediaries can be sustainability-oriented in theory and practice; 2) to examine how niche and regime actors and intermediaries contribute to cross-level interactions between niche experiments and regime subsystems; and 3) to clarify whether these intermediaries have been studied in the United States, which is currently experiencing political and institutional uncertainty.

The Google Scholar searches were conducted using Publish or Perish academic software (Harzing, 2007), which allows for the calculation of the h-index for each group of publications. The h-index is a combined measure of the number of publications (productivity) and the number of citations that each group of articles received (impact). Google Scholar was chosen because it includes

up to four times more publications and between 4.5 and 14 times more citations in the social sciences and humanities as either the Web of Science or Scopus (Harzing and Alakangas, 2016). The aforementioned study also found that Google Scholar includes additional books and articles that are not available in Web of Science or Scopus (Harzing and Alakangas, 2016). To test this, the keywords “innovation intermediary” and “environmental sustainability” were entered into Web of Science and six publications were returned, far less than Google Scholar; only one was relevant, and it was previously identified in the Google Scholar search.

A series of Boolean keyword combination searches within Google Scholar was used to first quantify the innovation intermediary literature related to sustainability, environmental sustainability, economic development, and socio-technical systems (Table 1), and second to narrow down the number of publications directly related to innovation intermediaries that focus on encouraging environmental sustainability transitions (Table 2). When looking at Table 1, the first two columns reflect primary and secondary search terms/phrases. The remaining columns represent tertiary search terms/phrases that were added to the primary and secondary search terms/phrases in order to capture innovation intermediary articles focused on niche and regime actors and sustainability transitions. The tertiary keywords include incubator, accelerator, United States, transition, niche, regime, champion, and policy entrepreneur. For example, combining “innovation intermediary” AND “socio-technical” AND “environmental sustainability” AND “transition” provided nine publications. Alternatively, combining “innovation intermediary” AND “economic development” AND “environmental sustainability” AND “regime” yielded seven publications.

The broader coverage of Google Scholar (Harzing and Alakangas, 2016) meant that additional refining was required to remove unrelated and unimportant search results. This involved removing duplicates, excluding publications that mentioned the secondary and tertiary keywords only in the reference lists, excluding non-English publications, and reading each publication to evaluate the extent that it focused on sustainability transitions and green technology innovation. Finally, publications were excluded that did not help to answer the research question, and in particular, did not focus on any of 1) sustainability-oriented innovation intermediary roles, including those that integrate sustainability principles or goals into their operations, 2) niche to regime functions of intermediaries, or 3) regime to niche functions of intermediaries.

Limitations of Google Scholar discussed by Sassmannshausen and Volkmann (2016) were found in this study. For example, the number of “innovation intermediary” publications that are directly relevant to our searches on environmental sustainability transitions and green technology innovation in the United States is less than what Google Scholar returns. The number of publications that contained the keyword combinations displayed in Table 1 significantly oversampled the actual number of publications and one reason is the propensity for results from reference lists. Of the 38 publications that contained “innovation intermediary” and “environmental sustainability”, only seven included both terms in the text, abstract or title, and focused directly on innovation intermediaries that aimed to foster sustainability transitions. The remainder were either duplicates (e.g., working papers by the same author as a journal article), were focused on agriculture in developing countries, contained only an indirect mention of environmental sustainability in the literature review, or were theses or dissertations that did not focus directly on innovation intermediaries or environmental sustainability. Two results were in books of abstracts that included “innovation intermediary” in one abstract and “environmental sustainability” in another.

### 3. Results

Between January 1, 1996 and June 24, 2017, 956 papers, articles or books in Google Scholar contained the exact phrase “innovation intermediary” (Table 1). Of these, 36 percent (343 with an h-index of 32) also contained “sustainability” and were therefore selected for analysis to understand the state of the literature about sustainability-oriented innovation intermediaries. After reviewing the 343 sustainability publications, many focused on financial sustainability of the intermediaries rather than on the environmental sustainability performance of the intermediary or the green innovations created with the help of the intermediary, and these and other similar publications were excluded from the analysis.<sup>1</sup> Therefore, the main finding related to the first research objective is that only a small proportion of the literature about innovation intermediaries is about sustainability-oriented innovation intermediaries. Another finding related to the third research objective, and shown in Table 1, was that few studies about innovation intermediaries focused on environmental sustainability in the United States, confirming a previous result in Kanda et al. (2014).

Related to the second research objective, it was found that few of the studies that examine how innovation intermediaries interact with niche actors (e.g., champions, entrepreneurs) and regime actors (e.g., policy entrepreneurs) to help create cross-level change (niche to regime and regime to niche) also incorporated concepts of environmental sustainability. The frequency of publications containing the phrase “innovation intermediary” peaked at 137 in 2013 (Fig. 1), and a small number focus on key niche and regime actors (e.g., champions and incubators). Two articles were found that contained both “innovation intermediary” and “policy entrepreneur” (Kivisaari et al., 2009; Wang and Wang, 2016), although further analysis revealed that neither directly related to sustainability. While 333 studies focus on innovation intermediaries within the standard economic development literature (Table 1), only a few recent studies have incorporated considerations for environmental sustainability (Fig. 2). For example, only 10 innovation intermediary publications contained “environmental sustainability” and “entrepreneur”, compared to 102 that contained “economic development” and “entrepreneur” (Table 1).

It was found that there is a clear separation in the literature between studies that focus on socio-technical systems change (as related to “sustainability”), and those that focus on innovation (as related to “economic development”) (Table 1). Less than one percent (16) of the 956 “innovation intermediary” publications contained both “economic development” and “environmental sustainability”. Searching for “innovation intermediary” AND “socio-technical” AND “economic development” AND “incubator” found three publications. The combination of “innovation intermediary” AND “environmental sustainability” AND “transition” found 23 publications. Regarding the third research objective, less than 20 percent of the 85 “innovation intermediary” publications with the term “socio-technical” also contained the phrase “United States”, but most of these were only in the reference lists or indirectly mentioning the United States.<sup>2</sup> Despite 97 publications containing the keyword combinations “innovation intermediary” AND “sustainability” AND “United States” (14 that contained “environmental sustainability”), none directly related to innovation intermediaries aiming to accelerate sustainability transitions in the

<sup>1</sup> Gascó (2017) and Mohalajeng and Kroon (2016), for example, contained “sustainability” but in reference to *sustaining the intermediary operations and innovation as a measure of business sustainability* and was removed.

<sup>2</sup> For example, Van Heyningen (2016) mentioned “United States” once in a passing reference to Silicon Valley in the literature review.

**Table 2**  
Innovation intermediary studies that focus on sustainability transitions and cross-level interactions.

Authors	Country	Secondary Keywords Contained	Tertiary Keywords Contained	Niche to Regime Functions	Regime to Niche Functions	Integrating Sustainability Principles/Goals	Sustainability-Oriented Innovation Intermediary Roles from Each Study
McCauley and Stephens (2012)	United States	Socio-technical; sustainability; economic development	Transition; niche; regime	Yes	Yes	Yes	<ul style="list-style-type: none"> <li>• Intermediary created specifically to support a sustainability transition (e.g., an energy and economic transition)</li> <li>• Created green jobs, increased energy efficiency and renewable energy, reduced emissions</li> <li>• Supported sustainability transitions research</li> <li>• Helped integrate actors from niche (entrepreneurs, university leadership) and regime (state and city government)</li> <li>• Helped brand city as a sustainability leader to attract sustainability-oriented investments, businesses, human capital</li> </ul>
Klewitz et al. (2012)	Germany	Sustainability	Niche; entrepreneur	Yes	Yes	Yes	<ul style="list-style-type: none"> <li>• Assisted SMEs in sustainability innovation focusing on 'ecoprofit' (a combination of economic and environmental performance)</li> <li>• Helped SMEs locate/use external knowledge, and develop internal resources (e.g., time, financial, human) for sustainability innovation</li> </ul>
Abbate and Coppolino (2012)	Open Innovation	Sustainability	none	Yes		Yes	<ul style="list-style-type: none"> <li>• Encouraged companies to follow the triple-bottom-line</li> <li>• Required sustainability criteria/performance of tenants</li> </ul>
Klerkx and Aarts (2013)	the Netherlands, China	Sustainability	Champion; entrepreneur	Yes	Yes		<ul style="list-style-type: none"> <li>• Acted as champions facilitating connections beyond the firm's network</li> <li>• Connected innovation processes to value chains and policy-making arenas</li> </ul>
Kivimaa (2014)	Finland	Socio-technical; environmental sustainability; sustainability	Entrepreneur; niche; regime	Yes	Yes	Yes	<ul style="list-style-type: none"> <li>• Encouraged strategy development, business investment, job creation</li> <li>• Communicated pathways for technology and sustainability</li> <li>• Built social networks by gatekeeping/aligning interests</li> <li>• Managed financial and human capital</li> <li>• Developed learning processes with knowledge gathering, processing, generation</li> <li>• Carried out policy/regime renewal functions</li> <li>• Helped cities use emission targets</li> <li>• Facilitated energy innovation</li> <li>• Helped with research/training/knowledge transfer</li> <li>• Carried out innovation management to help policy makers/researchers understand energy R&amp;D</li> <li>• Coordinated capacity building with PhD programs in energy transitions</li> <li>• Built networks for international researchers</li> <li>• Developed strategic partnerships between industry and universities</li> <li>• An overarching intermediary (the Low Carbon Innovation Coordination Group) coordinated other intermediaries</li> </ul>
Hannon et al. (2014)	United Kingdom	Sustainability	Transition; niche; entrepreneur	Yes	Yes		<ul style="list-style-type: none"> <li>• A public support incubator developed clean tech cluster</li> <li>• Provided networking/bridging functions, and financing mechanisms</li> <li>• Engaged external actors with expertise in environmental impact assessment and eco-design to incorporate sustainability into energy innovation</li> </ul>
Kanda et al. (2014)	Sweden	Environmental sustainability; sustainability	Entrepreneur; transition	Yes		Yes	<ul style="list-style-type: none"> <li>• Offered workshops, consultancies, conferences, incubation programs, government and international projects</li> <li>• Supported financing, networking, awareness raising, technology/knowledge transfer, innovation management</li> <li>• Sustainability driven by proactive individuals within intermediaries, company policies, company needs</li> <li>• Worked to reach companies with a sustainability message</li> <li>• Integrated social impact, allowed reassessments during the support process, adapted existing tools to specific needs of companies</li> </ul>
Küçüksayrac et al. (2015)	The Netherlands, The United Kingdom, Turkey	Sustainability	Incubator; entrepreneur	Yes		Yes	<ul style="list-style-type: none"> <li>• A new type of intermediary focused on radical innovation in sustainability</li> <li>• Helped forecasting and road mapping, information gathering/disseminating about green tech innovation</li> <li>• Helped firms prototype/test/commercialize green tech</li> <li>• Used networks, partnerships and meeting arenas to encourage innovation</li> <li>• Mobilized resources (e.g., technical competence, human and financial capital)</li> <li>• Branded the green tech sector</li> <li>• Collaborated to promote learning and competence sharing</li> <li>• Supported green innovations in technology, service, product, process</li> </ul>
Kanda et al. (2015)	Sweden, Germany	Environmental sustainability; sustainability	Incubator; entrepreneur; transition; niche; regime	Yes		Yes	<ul style="list-style-type: none"> <li>• Supported green innovations in technology, service, product, process</li> </ul>

(continued on next page)

Table 2 (continued)

Authors	Country	Secondary Keywords Contained	Tertiary Keywords Contained	Niche to Regime Functions	Regime to Niche Functions	Integrating Sustainability Principles/Goals	Sustainability-Oriented Innovation Intermediary Roles from Each Study
Mattes et al. (2015)	Germany	Socio-technical; sustainability	Transition; niche; regime	Yes	Yes		<ul style="list-style-type: none"> <li>• A new intermediary subsystem added to MLP aimed at encouraging innovation and transitions</li> <li>• Intermediary subsystem included labor unions, chambers of commerce, network connectors, and enabling organizations, which acted as key connectors between the other subsystems to accelerate niche experiments and regime changes</li> </ul>
Bank and Kanda (2016)	Germany, Finland, Sweden	Sustainability	Incubator; accelerator; entrepreneur; niche	Yes		Yes	<ul style="list-style-type: none"> <li>• Selected tenants by requiring sustainability focus areas (e.g., sustainable IT, green building, solar and wind energy, energy storage, energy efficiency, smart grid)</li> <li>• Sustainability support needed for a start-up idea found in the team or recruited from outside</li> </ul>
Polzin et al. (2016)	Germany	Sustainability	Entrepreneur; transition; niche	Yes	Yes		<ul style="list-style-type: none"> <li>• Helped overcome financial, regulatory, cooperative, and technological barriers to eco-innovation</li> <li>• Direct techniques for overcoming financial barriers included connecting entrepreneurs to financial mechanisms (e.g., subsidies, grants, tax credits, angel investors, venture capitalists)</li> <li>• Indirect techniques for overcoming financial barriers included changing the finance environment by supporting science, technology, innovation policy, developing strategic research partnerships, mobilizing private finance from banks</li> <li>• Helped address financial barriers related to capital intensity, scalability, infrastructure, lock-ins, regulatory risk, policy coordination failures</li> <li>• Translated/mediated between market and non-market actors to support market creation</li> <li>• Central and guiding organizations within green clusters</li> <li>• Enabled innovation networks</li> <li>• Transferred knowledge between different clusters</li> <li>• Built credibility and trust in sustainability for clusters</li> <li>• Institutional gatekeepers</li> <li>• Lowered transaction costs for and drove innovation of energy services</li> <li>• Policies were needed to support intermediaries for radical innovation</li> <li>• Reduced risk for clients and acted as gatekeepers/enablers of market opportunities in priority sectors</li> <li>• Connected actors, mobilized joint innovation, solved conflicts of interest, stimulated innovation</li> <li>• Developed capacity for a network for collective innovation</li> <li>• Addressed conflict in a creative way to use it as a resource to leverage exploration</li> <li>• Integrated sustainability into innovation support functions</li> <li>• Co-created and engrained sustainability principles into business plans</li> <li>• Required a portion of the project deliver sustainability benefits</li> <li>• Incorporated environmental management and reporting from the intermediary and its occupants</li> <li>• Used life cycle analysis or other sustainability metrics to evaluate projects and proposals</li> <li>• Supported niche empowering processes</li> <li>• Facilitated restructuring of incumbent institutional frameworks, which can then influence transition opportunities</li> <li>• Contributed to climate experiments: aggregated lessons and knowledge from multiple sites; introduced new practices to shift away from existing practices; influenced changes beyond the experiments</li> <li>• Sustainability experiments co-funded by intermediary and municipalities, companies and research organizations</li> <li>• National intermediary promoted innovation, provided funding for companies</li> <li>• International intermediary funded sustainability experiments</li> <li>• Measured sustainability performance of experiments, as well as their effect on technology improvement, behavioral change and system change</li> <li>• Provided protective spaces for transitioning to a circular economy</li> <li>• Identified synergies between innovation systems, intermediaries, and strategic niche management</li> <li>• Intermediaries at center of triple helix (government, industry, university) may be more effective at creating and scaling radical innovations</li> </ul>
McLennan et al. (2016)	Australia	Environmental sustainability	Champion; entrepreneur		Yes		
Nolden et al. (2016)	United Kingdom	Sustainability	none	Yes	Yes		
Agogu�e et al. (2017)	France	Sustainability; environmental sustainability	Incubator; accelerator; champion; entrepreneur	Yes			
Kivimaa et al. (2017a)	Finland	Environmental sustainability; sustainability; economic development	Entrepreneur; transition; niche	Yes		Yes	
Bush et al. (2017)	United Kingdom	Socio-technical; sustainability	Transition; niche; regime	Yes	Yes		
Matschoss and Heiskanen (2017)	Finland	Socio-technical; sustainability; economic development	Transition; niche; regime	Yes			
Antikainen et al. (2017)	Finland	Sustainability; environmental sustainability; socio-technical	Transition; niche; regime; entrepreneur		Yes	Yes	
Barrie et al. (2017)	Scotland	Socio-technical; sustainability	Transition; niche; regime; champion	Yes			

United States, and only one publication added from an additional search examined a sustainability transitions intermediary in the United States (McCauley and Stephens, 2012).

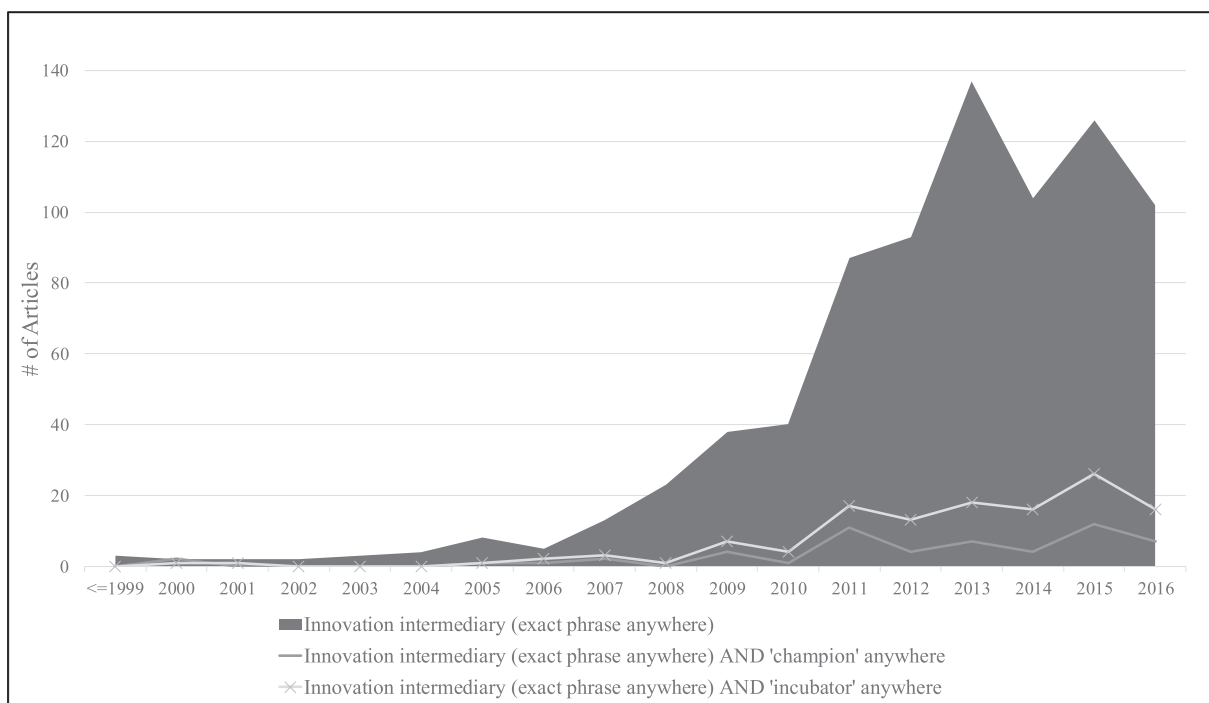
The twenty publications that were selected for analysis in Table 2 include thirteen publications that contain the phrase “innovation intermediary” (Abbate and Coppolino, 2012; Agogué et al., 2017; Antikainen et al., 2017; Barrie et al., 2017; Hannon et al., 2014; Kanda et al., 2015; Kivimaa, 2014; Kivimaa et al., 2017a; Klerkx and Aarts, 2013; Klewitz et al., 2012; Matschoss and Heiskanen, 2017; McLennan et al., 2016; Polzin et al., 2016) and seven that did not contain the exact phrase “innovation intermediary”, but were found by searching for “intermediaries” that relate to “sustainability” (Bank and Kanda, 2016; Bush et al., 2017; Kanda et al., 2014; Küçüksayraç et al., 2015; Mattes et al., 2015; McCauley and Stephens, 2012; Nolden et al., 2016). The remainder of the results and discussion focus largely on the articles presented in Table 2.

### 3.1. Innovation intermediaries support green innovation and economic development

The sustainability-oriented innovation intermediaries that focus on green innovation can be defined as “organizations that assist firms in the eco-innovation process by providing external impulse, motivation, advice and other specific support often by acting as an agent or broker between two or more parties” (Kanda et al., 2015, p 3). The systematic literature review revealed several pathways by which innovation intermediaries can encourage sustainability. Based on Kilelu et al. (2011), Hannon et al. (2014) identified a set of key functions of energy innovation intermediaries in the United Kingdom. The functions included *demand articulation* (scanning for information/opportunities, foresight through strategic planning, diagnosis through needs/knowledge gap assessment), *network building* (gate keeping through filtering/selecting collaborators,

match making through forming partnerships/market connections), *capacity building* (organizational development through incubation/support services, training and competence building through management/technical skills/certifications), *innovation process management* (mediating and arbitrating), *knowledge brokering* (matching knowledge demand and supply), and *institutional support* (boundary work between science and practice, institutional change through advocacy, regulation change, and attitudes/practices change). In the context of sustainability-oriented innovation intermediaries, one or more actors within the intermediary would focus on incorporating sustainability principles into these functions in order to encourage and support the creation of businesses and technologies that can act as niche experiments and/or change the regime subsystems.

There are other pathways by which intermediaries can encourage sustainability. For example, some incubators influenced sustainability via the landlord-tenant relationship by requiring tenants to demonstrate specific climate adaptation or mitigation performance, as well as broader environmental, social, economic and governance criteria (Abbate and Coppolino, 2012). In other cases, incubators required prospective tenants to fulfill sustainability focus areas (e.g., sustainable IT, green building, solar and wind energy, energy storage, energy efficiency, smart grid) (Bank and Kanda, 2016). Bank and Kanda (2016) case studies in Germany, Finland and Sweden outlined the process by which incubators can influence sustainability entrepreneurship through the mechanism of tenant selection by requiring prospective tenants to incorporate sustainability metrics into business plans and goals. Bank and Kanda (2016) found that some incubators did not fill enough spots and needed to weaken the sustainability criteria to attract more tenants, while other incubators had more applicants than spots and therefore could be more selective regarding the merits of the sustainability ideas. The challenge for incubators attempting to contribute to sustainability is how to gradually



Note: An additional 57 “innovation intermediary” publications during the first six months of 2017 were also included in Table 1.

**Fig. 1.** Innovation Intermediary Literature Search (<December 31, 2016). Note: An additional 57 “innovation intermediary” publications during the first six months of 2017 were also included in Table 1.

influence the incorporation of sustainability principles into the non-sustainability tenant's business plans as they move from incubator to accelerator and eventually graduate to their own office space and growth model.

Kivimaa et al. (2017a) found that a university innovation intermediary incubator in Finland did not 'operationally integrate sustainability' into the intermediation process. Rather, entrepreneurs creating and scaling businesses within that incubator incorporated sustainability on an individual basis. Recommendations for co-creating sustainability with the help of university intermediaries included having a sustainability expert, coordinator, or team to work with the intermediary and its entrepreneurs to ingrain sustainability principles into projects and business plans, using sustainability objectives for the intermediary like requiring a portion of the projects deliver sustainability benefits, requiring environmental management and reporting to the university from the incubator and its occupants, and using lifecycle analysis or other sustainability metrics to evaluate projects and proposals.

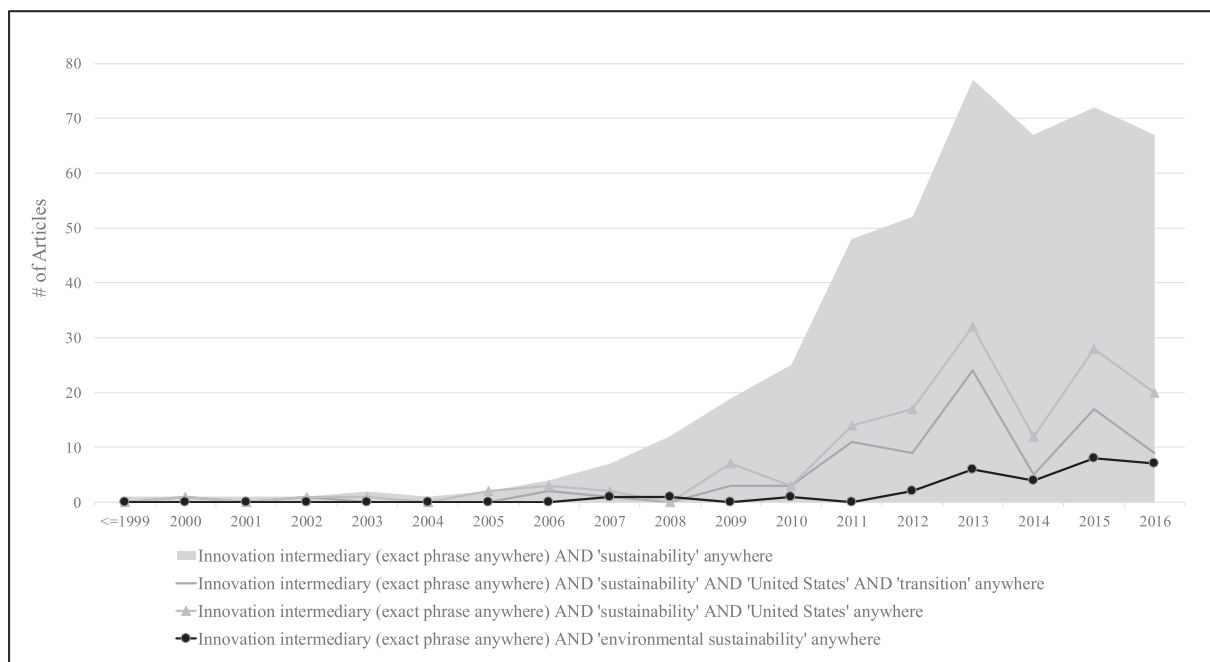
The literature findings indicate that few studies focus directly on sustainability-oriented innovation and intermediaries in the United States. One exception is McCauley and Stephens (2012), which examined the green energy transition in central Massachusetts. Worcester, a city that was impacted by regional economic challenges, a reduction in property values, and declining municipal tax revenues, began the process of creating a sustainable energy cluster in 2008. They followed an integrated approach that included politicians, universities, businesses, citizen groups, and activists. The goal was to capitalize on the interrelated problems of economic and energy system transformation. To accelerate this process, an intermediary organization called the Institute for Energy and Sustainability was created. The mission was to help create green jobs, increase energy efficiency, reduce GHG emissions, make Worcester known as a leader in sustainability, and support sustainability science research. The intermediary organization used various strategies to accomplish their mission, including labeling the region as a green business destination, helping save and expand green

businesses through tax incentives, supporting university research, organizing labor market training and outreach for energy efficiency, and following a market-based cluster development strategy (McCauley and Stephens, 2012, p. 220).

McCauley and Stephens (2012) describe how the State of Massachusetts received hundreds of millions of dollars from the American Recovery and Reinvestment Act (ARRA) of 2009 for the development of sustainable energy companies and state-level solar projects. The intermediary helped capitalize on this window of opportunity provided by the ARRA by coordinating action from local and state governments, universities and private businesses. Clean energy became the 10th largest state-industry with over 60 clean energy businesses that were part of the cluster. Worcester supported this strategy by changing various municipal laws to accelerate the transition to sustainable energy options, including easing the siting requirements for renewable energy projects, accelerating the permitting process for clean energy companies, and adopting an enhanced energy efficiency building code. As part of the cluster, creative financing options became available and new types of partnerships were developed for energy projects. The learning and network benefits of the cluster helped attract further investment, green workers and greener companies to the region (McCauley and Stephens, 2012).

### 3.2. Sustainability innovation intermediaries facilitating cross-level interactions

An important finding from the systematic literature review about how sustainability-oriented innovation intermediaries facilitate cross-level interactions is that two processes contribute to the creation and survival of innovations: (1) niche to regime interactions, and (2) regime to niche interactions. Many of the roles of sustainability-oriented innovation intermediaries summarized in Table 2 aim to help expand niche activities to the regime and/or draw upon the regime to support niche development and protection.



Note: an additional 27 publications containing "innovation intermediary" AND "sustainability" from the first six months of 2017 were also included in Table 1.

Fig. 2. Innovation Intermediary and Sustainability Literature Search (<December 31, 2016). Note: an additional 27 publications containing "innovation intermediary" AND "sustainability" from the first six months of 2017 were also included in Table 1.

Kivimaa (2014) identifies three techniques employed by innovation intermediaries to contribute to *niche development*. First, they help *articulate expectations and visions*, including the application and commercialization of technologies and the advancement of sustainability objectives. Second, they help *build social networks* by carrying out roles such as gatekeeping and brokering, configuring and aligning interests, managing and finding financial resources, and identifying and managing human capital skills. Third, they *instigate learning processes*, including knowledge gathering, processing, generation, and combination. Learning processes are also related to the assessment, evaluation, piloting, and prototyping of technology, and investment decisions in emerging businesses. Additional processes focus on communication, education, training, advice, support, and learning-by-doing. Bush et al. (2017) expanded upon Kivimaa (2014) framework by adding intermediary activities that facilitate *empowering processes* to encourage broader diffusion of the technology innovation and the corresponding transformation of the regime. These activities include *embedding a new regime* with new standards/rules, *consulting on policy development* as a means of influencing opinion and policy direction, and *working to encourage policy change* through communication and implementation strategies. Although these activities fall within the skillset of policy entrepreneurs as regime actors, policy entrepreneurs were not discussed in the Bush et al. (2017) study suggesting a need for synthesizing these two areas of literature.

Based on findings from case studies, Mattes et al. (2015) built upon the MLP by adding a new intermediary subsystem specifically aimed at encouraging innovation and socio-technical transitions. Mattes et al. (2015) argue that local energy development can be driven by the interactions between the scientific subsystem (e.g., science and education), the political subsystem (e.g., political parties and actors), the public administration subsystem (e.g., municipal and regional administration), the industrial subsystem (e.g., companies compete or cooperate), the financial subsystem (e.g., funding, venture capital, banks), and the civil society subsystem (e.g., NGOs, mobilized citizens). The *intermediary subsystem* (e.g., labor unions, chambers of commerce, network connectors, new enabling organizations) acts as a key connector between the other subsystems to encourage and accelerate the creation of niche experiments as well as changes to the regime. The co-evolving nature of these regime subsystems and actors that connect the niche to regime are critical for sustainability transitions. Mattes et al. (2015) suggests that “change may be triggered, pushed or hindered by either subsystem, and the interaction between them increases the necessity to coordinate” (p. 257). Therefore, depending on the country, state, or city, sustainability professionals could instigate a transition by mobilizing change from within any of these subsystems; however, it is more likely that a transition will successfully break through and change the regime if coordination occurs between more than one subsystem. For example, competition within the industry and scientific subsystems can drive research and development and innovation, but policy innovation within the political subsystem can help to coordinate and accelerate those innovation processes. Mattes et al. (2015) found that *new* intermediary organizations were created to encourage and coordinate transitions of the energy system toward sustainability in some cases, while *existing* organizations acted as intermediaries including the chamber of commerce and business networks in other cases. The intermediaries helped to bridge gaps between different cultural norms and between the industrial and administration subsystem actors. The intermediaries were also able to help overcome bottlenecks like legal challenges and administrative red tape.

Klewitz et al. (2012) suggest that innovation intermediaries may be able to strengthen a small and medium sized business' ability to

absorb and use new information to create sustainability innovations. The intermediary can provide support to businesses via knowledge gathering, processing, testing, validation and training capacity. The intermediary can also help evaluate the effectiveness of sustainability innovations over time. Klewitz et al. (2012) suggests that a *complex intermediary* combining public (local government agency) and private (environmental consultancy) organizations within the regime can act as an external stimulus to get businesses to start thinking about sustainability experiments. This represents a *regime to niche* function where the intermediary influences and supports sustainability innovation.

#### 4. Discussion

While the studies in Table 2 provide insight into the research question, an important finding of the systematic literature review is that there is not yet a definitive understanding of the functions performed by niche and regime actors that specifically support the intermediaries in encouraging cross-level interactions in sustainability transitions. Despite the lack of literature with this specific focus, two established areas of literature can directly address the second objective, to clarify how niche and regime actors and intermediaries contribute to cross-level interactions between niche experiments and regime subsystems. The first area is studies that focus on *green niche actors*, such as entrepreneurs and champions, in order to identify specific functions that they could perform to support innovation intermediaries to influence regime change. The second area is studies that focus on *green regime actors*, such as policy entrepreneurs, in order to identify specific functions that they could perform to support innovation intermediaries to influence regime change.

##### 4.1. Green niche actors: entrepreneurs and champions

This section considers the literature that examines how green niche actors can help innovation intermediaries scale-up and link sustainability behavior to broader system changes as part of a green economic development strategy. Innovation intermediaries can complement the roles and functions of green niche actors (entrepreneurs and champions) by providing collaborations that cross levels within an innovation system (Klerkx and Aarts, 2013). Champions who work within organizations, including intermediaries, encourage pro-environmental behavior through various techniques: scanning the external environment for solutions, gathering support, using persuasive and business-focused communication strategies, and building coalitions (Gliedt et al., 2010; Swaffield and Bell, 2012).

Experiments for sustainability transitions, which are carried out by entrepreneurs at the niche level, are “inclusive, practice-based and challenge-led initiatives ... designed to promote system innovation through social learning under conditions of uncertainty” (Sengers et al., 2016, p. 1). Sustainability transition experiments can help diversify economies in times of institutional instability, and can include encouragement of green entrepreneurship (Kern et al., 2015; Raven et al., 2016; Sengers and Raven, 2015), strategic niche management (Kemp et al., 1998; Kivimaa, 2014), niche experiments (Sengers et al., 2016), and societal problem-solving experiments (Kivimaa et al., 2017b). Innovation intermediaries also nurture new green technologies and support niche actors like green entrepreneurs by providing *niche shielding strategies*, defined as the financial and resource support that can protect innovations from market forces by reducing transaction costs in the early stages of development (Huijben et al., 2016). Niche shielding can influence how competitive a new green technology is once it expands, as well as the level of risk that entrepreneurs are

willing and able to take in the innovation creation and diffusion process (Huijben et al., 2016).

Kivimaa et al. (2017b) reviewed the literature on experiments in climate governance that can contribute to multi-level sustainability transitions and identified various *outputs and outcomes*, including changes to discourse, technology, built environment or infrastructure, policy and institutional change, new markets, or new consumer or citizen practices. For example, in the case of *technology* changes, *outputs* included the creation of new solar PV applications, new technology solutions for energy efficiency, and new types of meters, while *outcomes* included the broader learning processes for how to apply and adopt successful experiments as new energy systems. In the case of *infrastructure*, *outputs* included temporary changes to land use planning to encourage green buildings and developments, while *outcomes* included learning how to make broader changes to infrastructure with sustainability benefits. With respect to *policy and institutional* change, *outputs* included new district planning practices for green construction, renovation, transportation, as well as incorporating additional actors into policy-making, while *outcomes* included the creation of a new political space and governance rules and practices, which have the potential for supporting further experiments at the regime and niche levels (Kivimaa et al., 2017b).

In summary, innovation intermediaries can help niche actors scale-up sustainability transition experiments through technology diffusion for broader market acceptance, while also relying on regime actors like policy entrepreneurs to help create political and institutional space for regime subsystem changes.

#### 4.2. Green regime actors: policy entrepreneurs

One finding of the systematic literature review was that no studies directly linked how policy entrepreneurs as regime actors supported sustainability-oriented innovation intermediaries in facilitating cross-level interactions. This section considers the literature about the functions of policy entrepreneurs that could help innovation intermediaries create the conditions for sustainability transitions experiments to scale-up and encourage cross-level change and green economic development. The literature about policy entrepreneurs describes that they can play important roles in linking organizations and institutions within green innovation systems by working to influence policy changes that are supportive of innovation intermediaries (Pahl-Wostl, 2015).

Policy entrepreneurs can help innovation intermediaries connect across levels with the help of partnerships (Frantzeskaki et al., 2014), gatekeepers within networks (Breschi and Lenzi, 2015), boundary spanners (Smink et al., 2015), and cluster champions (McLennan et al., 2016). Kalafatis et al. (2015) suggest that policy entrepreneurs can act as knowledge brokers (e.g., between science and policy makers) and boundary spanners to connect with innovation intermediaries. Knowledge brokers can have *direct* impacts on policy creation by linking a problem with solutions, and *indirect* impacts by changing the ideas flowing within the policy-making context. Boundary spanners “play a key translating and bridging role between informal networks on the one hand and formal decision-making structures and policy processes on the other hand” (Edelenbos and van Meerkerk, 2015, p. 27). Klewitz (2015) identified different boundary spanners that helped businesses develop learning capabilities in sustainability-oriented innovation networks.

Policy entrepreneurs have helped guide sustainability transitions in the water sector (Huiteima and Meijerink, 2010), municipal climate change adaptation (Kalafatis et al., 2015), municipal policy changes related to fracking (Arnold et al., 2017), the renewable energy policy arena (Rowlands, 2007), and to transportation

biofuels (Palmer, 2015). Kalafatis et al. (2015) examined how Toledo, Ohio adopted a climate change adaptation plan despite political opposition from its mayor. They described key roles played by policy entrepreneurs at developing decision support partnerships, raising issue awareness, reclassifying existing conditions into something more politically appealing, framing the problem and potential solutions, and working to align the problem, solution and political streams during windows of opportunity. Kalafatis et al. (2015) described a boundary chain, the National Oceanic and Atmospheric Administration’s (NOAA) Regional Integrated Sciences and Assessment (RISA) program, which is important for linking climate and sustainability problems and solutions across governance scales. *Boundary chains* can be leveraged by policy entrepreneurs at the state and city level to gain support for local initiatives. The absence of leadership from the mayor instigated policy entrepreneurs and municipal staff to form strategic partnerships through boundary chains, which helped to mainstream climate change policy by connecting it with existing efforts like stormwater management (Kalafatis et al., 2015). Boundary organizations can themselves be a form of intermediary that can facilitate knowledge transfer and mobilize resources to encourage technology and institutional innovation.

Therefore, policy entrepreneurs as regime actors have a set of skills that help identify opportunities for making institutional changes. These skills, when coordinated with the help of innovation intermediaries, could be critical for changing conditions to allow green niche actors to create innovations and foster green economic development.

#### 4.3. Niche and regime actors contribute to policy change frameworks

The systematic literature search revealed that little research has examined how intermediaries overlap and connect the niche and regime (see Table 2 for examples), or more specifically, how innovation intermediaries can use their influence in these relationships to contribute to radical system-changing technological and institutional innovations. One tool that would be critical to achieve this is called a *policy mix*, which links niche creation and regime change policies to encourage infrastructure and institutional innovation and sustainability transitions (Kivimaa and Kern, 2016). Kivimaa and Kern (2016, p. 208) argue that it is important to identify the *innovation system functions* that contribute to the creation of niche innovations, which can be executed by niche actors and innovation intermediaries. The functions include knowledge creation, development and diffusion; establishing market niches; entrepreneurial experimentation; resource mobilization; support from key groups; and influence on the direction of search. These functions are enhanced by the following *policy instruments* that can be supported by regime actors (policy entrepreneurs) (Kivimaa and Kern, 2016, p. 208): innovation pathways (e.g., knowledge creation/diffusion through networks); market-based policies (e.g., feed-in tariffs, eco-labelling); entrepreneurship support (e.g., advice systems for start-ups, low-interest loans, venture capital); research and development funding and deployment subsidies; education, training, and labor-market policies; and public procurement to support new technologies.

Green niche actors operating within innovation intermediaries as well as regime actors are each critical to the creation and use of policy mixes for sustainability transitions. If a collection of policies that are well coordinated are able to both encourage the creation and diffusion of new technologies and contribute to the weakening of the existing institutional regime, green economic development benefits may be amplified and transitions may be accelerated.

4.4. An intermediary driven green economic development framework

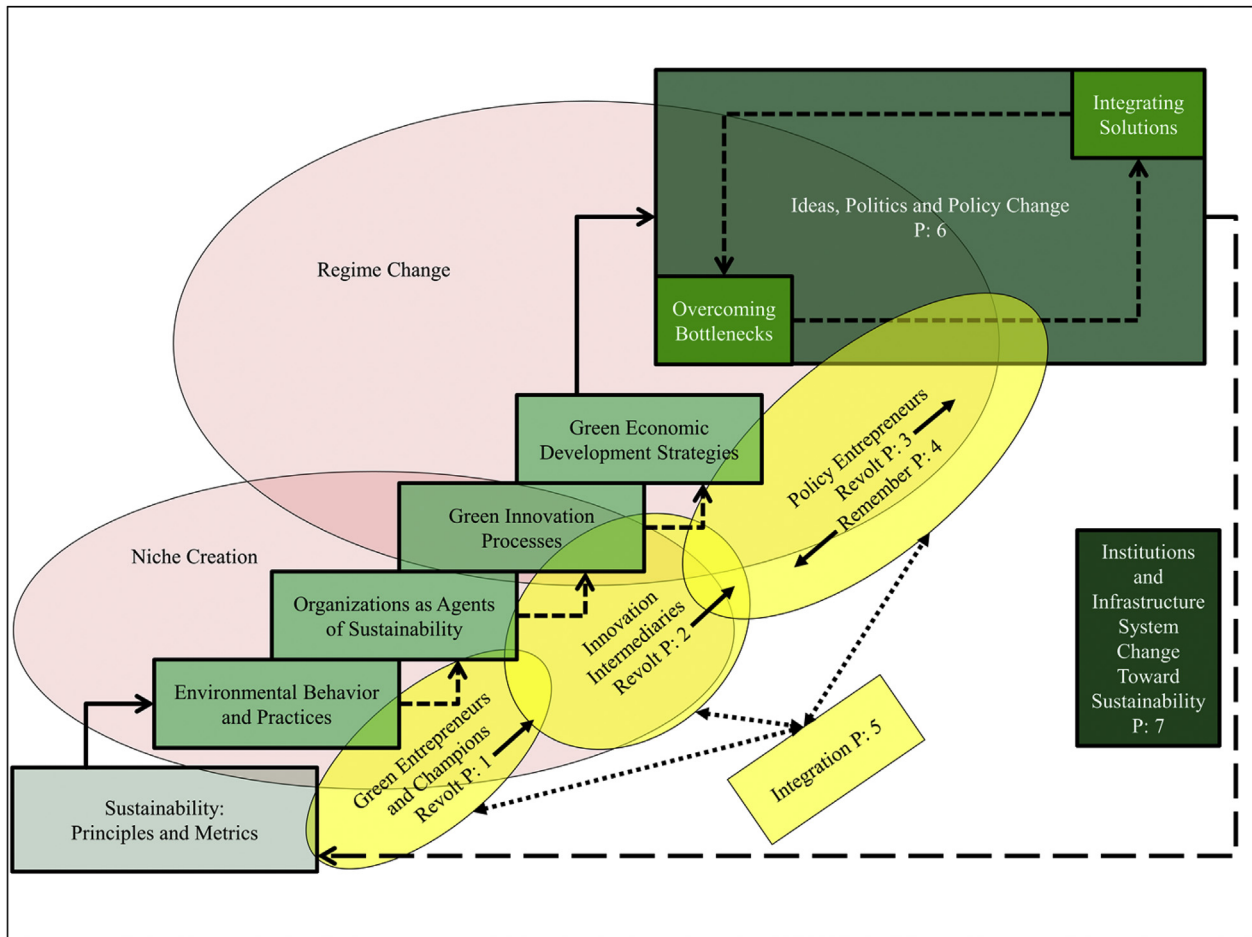
This paper examined how sustainability-oriented innovation intermediaries can help to create the conditions to accelerate the timeframe of a sustainability transition by fostering more openings for innovations to break through from the niche to the regime level. The objective of this section is to create a framework that synthesizes the findings from the systematic literature review (section 3), and from sections 4.1 and 4.2, and 4.3, to describe how innovation intermediaries can connect with green niche actors (entrepreneurs and champions) and regime actors (policy entrepreneurs) to develop and protect niches, create policies to change the regime, and support strategies for technology and infrastructure investment to create green jobs.

The MLP can help understand how individual or organizational actions can ripple outward to affect system change (Fischer and Newig, 2016; Rauschmayer et al., 2015). One challenge for employing the MLP in practice is to outline strategies and pathways for how change and persistence can occur in the same system (Berkes and Ross, 2016). The *revolt process*, that is, the drive for change from niches to encourage regime change, and the *remember process*, in which the regime characteristics demonstrate resilience to guide subsystem change (Benson and Garmestani, 2011), provide

insight into how cross-level interactions can both foster changes and stabilize the overall system.

The proposed framework for green economic development is illustrated in Fig. 3 and highlights the role of innovation intermediaries at linking niche level goals, behavior, and practices, to regime level policy changes and green innovation systems. The framework contains techniques (outlined in Fig. 4) for niche actors (entrepreneurs and champions) to help innovation intermediaries facilitate the *revolt* process, and for regime actors (policy entrepreneurs) to both help the innovation intermediaries contribute to the *revolt* process, and to draw upon system memory to stabilize the system as part of the *remember* process. Innovation intermediaries contribute to revolt and remember mechanisms and influence regime change functions, and Kivimaa and Kern (2016 p. 208) identify four *policy instruments* that can support this: (1) control policies to put pressure on the regime and create a level playing field; (2) changes in regime rules to create windows of opportunity; (3) reduced support for the dominant regime technologies; and (4) changes in social networks and replacement of key actors.

The framework also highlights future research propositions designed to address the gaps uncovered by the systematic literature review by drawing on the findings presented in sections 4.1, 4.2 and 4.3 about how niche and regime actors could support



Note: Propositions are labeled as P: 1, P: 2... etc.

Fig. 3. Framework for Green Economic Development: Intermediaries as Agents for Accelerating Sustainability Transitions. Note: Propositions are labeled as P: 1, P: 2 ... etc. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

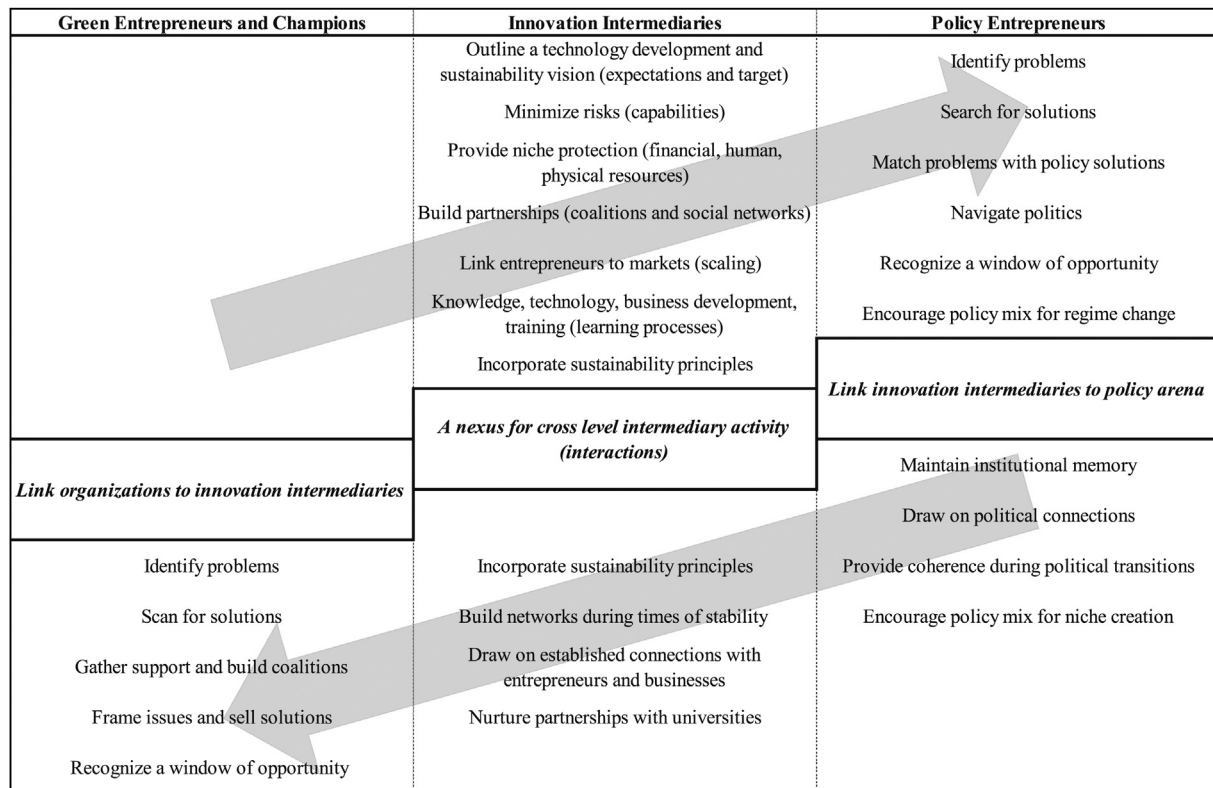


Fig. 4. Techniques for revolt (niche to regime) and remember (regime to niche) cross-level interactions.

innovation intermediaries. In the framework, niche actors (entrepreneurs and champions) amplify individual behavior to drive change in organizations that operate within innovation intermediaries. Intermediaries integrate technology, social and institutional entrepreneurship as niche experiments to drive broader green innovation processes. Regime actors (policy entrepreneurs) facilitate and accelerate green innovation and economic development by influencing changes in the institutional regime, including the creation of *policy mixes* that support green jobs strategies driven by intermediaries.

Innovation intermediaries connect the niche to the regime via organizational and institutional networks within and between clusters. As part of making socio-technical system change, the framework identifies how intermediaries work to overcome bottlenecks and gain support for integrated solutions that have economic and sustainability benefits, including improved environmental performance due to technology upgrades. The framework is based upon the following propositions.

**Proposition 1.** Technology entrepreneurs and champions (niche actors) instigate cross-level *revolts* by linking environmental behavior and sustainability goals to organizational change.

**Proposition 2.** Innovation intermediaries facilitate cross-level *revolts* by connecting organizations as agents of sustainability to green innovation systems.

**Proposition 3.** Policy entrepreneurs (regime actors) drive cross-level *revolts* by integrating entrepreneurial actions within innovation intermediaries to broader socio-technical system change.

**Proposition 4.** Policy entrepreneurs (regime actors) provide system memory and stability (*remember*) to the multi-level system during periods of rapid change and uncertainty.

**Proposition 5.** Innovation intermediaries *coordinate and integrate* their actions with technology entrepreneurs and champions, and policy entrepreneurs, to foster niche creation and regime change activities.

**Proposition 6.** Policy entrepreneurs (regime actors) work to overcome bottlenecks by *aligning* ideas and policy mixes with political trends to create *integrated solutions* during a window of opportunity.

**Proposition 7.** The extent that organizations as agents of sustainability, green innovation processes, and green economic development strategies, successfully transition the institutions and infrastructure of society to a more sustainable state is associated with the rate of change in propositions one through six.

The propositions offer pathways for future research on the relationships between innovation intermediaries, champions and policy entrepreneurs. Given their importance to institutional changes at the regime level that can support niche innovation and diffusion, future research should examine how policy entrepreneurs can contribute to *regime change functions* (Kivimaa and Kern, 2016) in coordination with niche actors and intermediaries. An important question for researchers and practitioners is to understand how policy entrepreneurs can influence the development of policy mixes that support innovation and green job creation, while guiding the direction of intermediaries, entrepreneurs and champions towards sustainability principles. Finally, comparative research can focus on how innovation intermediaries led by lower levels of government in the United States may differ from those around the world at supporting sustainability experiments and institutional changes. The framework can help guide theory and practice for the acceleration of rates of niche creation *and* regime change in order to foster green technology and infrastructure

development. Innovation intermediaries integrate across levels through their activities and interactions with niche actors (technology entrepreneurs and champions) and regime actors (policy entrepreneurs).

## 5. Conclusion

Based on a systematic literature review, this paper provides insight into the research question: what is the state of knowledge about how innovation intermediaries can contribute to green economic development as part of sustainability transitions, particularly during a time of political and institutional uncertainty? Three research objectives guided the research: 1) to understand how innovation intermediaries can be sustainability-oriented in theory and practice; 2) to examine how niche and regime actors and intermediaries contribute to cross-level interactions between niche experiments and regime subsystems; and 3) to clarify whether these intermediaries have been studied in the United States, which is currently experiencing political and institutional uncertainty. The resulting framework contributes to a gap in the literature for applying sustainability transitions theory outside of the European context (in this case the United States), as well as for understanding how transitions could occur in the absence of consistent top-down federal-level leadership and policy.

The framework outlines actions that can be taken by *business*, *municipal* and *state* leadership to support innovation intermediaries to drive a green economic development strategy that is resilient in the face of institutional instability. Sustainability-oriented innovation intermediaries can amplify green job creation strategies that include business attraction, business retention, business expansion, and entrepreneurship. Innovation intermediaries can be created by non-profit organizations, businesses, and/or local/state governments, and *therefore do not necessarily depend on federal funding or regulatory control*. As central actors within the proposed framework, innovation intermediaries help create green jobs by: (1) facilitating revolts from technology entrepreneurs and champions as part of niche experiments; (2) developing and shielding niches from market pressures and political/institutional uncertainty; (3) working with policy entrepreneurs to both promote system memory and stability (from regime to niche) and encourage regime change with the help of policy mixes; (4) helping boundary spanners cross-levels (niche to regime) in order to find new ways of creating policies and influencing change to the regime; (5) encouraging sustainability performance improvements of entrepreneurs and new ventures; and (6) influencing the development of targeted strategies for sustainability technology and infrastructure investment.

The systematic literature review and the framework highlight several findings that focus on the links between sustainability transitions theory and practice and on the integrated roles of actors within multi-level transitions during periods of institutional uncertainty. For example, the review revealed many functions of sustainability-oriented intermediaries to overcome barriers to transitions, create green jobs, accelerate regime subsystem change, and encourage niche experiments. Innovation intermediaries contribute to cross-level interactions by amplifying niche experiments through networks, partnerships, and boundary organizations. In some cases, intermediaries also acted as champions and coordinated other intermediaries within networks. Given that many sustainability-oriented innovation intermediaries work with or are funded by governments, fostering their connections to the policy-making process creates opportunities to weaken the regime. Innovation intermediaries can take on roles as policy entrepreneurs by searching, influencing and gathering support for interventions at the regime level that can support niche experiments.

Sustainability-oriented innovation intermediaries can be the nexus for learning processes that aim to make triple-bottom-line economic development (Hammer and Pivo, 2017) and the circular economy (Barrie et al., 2017) the norm rather than the exception.

The findings are subject to a series of limitations, which are similar to those identified by other systematic reviews including Gast et al. (2017). First, new articles are continually being published and therefore the analysis pertains only to the time period of the search. Additionally, all interpretations of the reviewed articles are subjective and based on the author's background and understandings. It is possible that other authors using the same set of keywords could arrive at different conclusions by identifying different themes and connections between the areas of literature reviewed in this article. The choice of keywords is also open to criticism, and while the authors purposefully selected a broad set of keywords and then narrowed them down to refine the search pool, other keyword combinations could have led to the inclusion of other articles and therefore different results.

## Acknowledgements

This research is being conducted as part of a project funded partially by an Insight Development Grant number 430-2015-00713 from the Social Sciences and Humanities Research Council of Canada. The authors would like to thank the anonymous peer reviewers for their insightful and detailed comments that greatly improved the manuscript. Financial support was provided by the Office of the Vice President for Research, the Office of the Provost, and the Department of Geography and Environmental Sustainability at the University of Oklahoma.

## References

- Abbate, T., Coppolino, R., 2012. Leading Sustainable Innovation: the Role of Innovation Intermediaries. Moving from the Crisis to Sustainability. *Emerging Issues in the International Context: Emerging Issues in the International Context*, pp. 189–198.
- Abdelkafi, N., Täuscher, K., 2016. Business models for sustainability from a system dynamics perspective. *Organ. Environ.* 29 (1), 74–96.
- Agogue, M., Agogue, M., Berthet, E., Berthet, E., Fredberg, T., Fredberg, T., Stoetzel, M., 2017. Explicating the role of innovation intermediaries in the “unknown”: a contingency approach. *J. Strategy Manag.* 10 (1), 19–39.
- Allen, J.H., Potiowsky, T., 2008. Portland's green building cluster economic trends and impacts. *Econ. Dev. Q.* 22 (4), 303–315.
- Antikainen, R., Alhola, K., Jääskeläinen, T., 2017. Experiments as a means towards sustainable societies—Lessons learnt and future outlooks from a Finnish perspective. *J. Clean. Prod.*
- Arnold, G., Nguyen Long, L.A., Gottlieb, M., 2017. Social networks and policy entrepreneurship: how relationships shape municipal decision making about high-volume hydraulic fracturing. *Pol. Stud. J.* 45 (3), 414–441.
- Bank, N., Kanda, W., 2016. Tenant recruitment and support processes in sustainability-profiled business incubators. *Industry High. Educ.* 30 (4), 267–277.
- Barrie, J., Zawdie, G., João, E., 2017. Leveraging triple helix and system intermediaries to enhance effectiveness of protected spaces and strategic niche management for transitioning to circular economy. *Int. J. Technol. Manag. Sustain. Dev.* 16 (1), 25–47.
- Benson, M.H., Garmestani, A.S., 2011. Embracing panarchy, building resilience and integrating adaptive management through a rebirth of the National Environmental Policy Act. *J. Environ. Manag.* 92 (5), 1420–1427.
- Berkes, F., Ross, H., 2016. Panarchy and community resilience: sustainability science and policy implications. *Environ. Sci. Pol.* 61, 185–193.
- Blankenship, H., Kulhavy, V., Lagneryd, J., 2009. Introducing strategic sustainable development in a business incubator. *Prog. Ind. Ecol. Int. J.* 6 (3), 243–264.
- BLS, 2012. Bureau of Labor Statistics. United States Department of Labor. Green Goods and Services Survey. Available at: <http://www.bls.gov/ggs/>.
- Boehm, M., Thomas, O., 2013. Looking beyond the rim of one's teacup: a multi-disciplinary literature review of product-service systems in information systems, business management, and engineering & design. *J. Clean. Prod.* 51, 245–260.
- Bowen, W.M., Park, S., Elvery, J.A., 2013. Empirical estimates of the influence of renewable energy portfolio standards on the green economies of states. *Econ. Dev. Q.* 27 (4), 338–351.
- Breschi, S., Lenzi, C., 2015. The role of external linkages and gatekeepers for the renewal and expansion of US cities' knowledge base, 1990–2004. *Reg. Stud.* 49

- (5), 782–797.
- Bush, R.E., Bale, C.S., Powell, M., Gouldson, A., Taylor, P.G., Gale, W.F., 2017. The role of intermediaries in low carbon transitions—empowering innovations to unlock district heating in the UK. *J. Clean. Prod.* 148, 137–147.
- Ceschin, F., 2014. How the design of socio-technical experiments can enable radical changes for sustainability. *Int. J. Soc. 8* (3), 1–21.
- Chapple, K., Kroll, C., Lester, T.W., Montero, S., 2011. Innovation in the green economy: an extension of the regional innovation system model? *Econ. Dev. Q.* 25 (1), 5–25.
- Ecotech Institute, 2016. Clean Jobs Index. Available at: <https://www.ecotechinstitute.com/careers/clean-jobs-index>.
- Elliott, R.J., Lindley, J.K., 2017. Environmental jobs and growth in the United States. *Ecol. Econ.* 132, 232–244.
- Edelenbos, J., van Meerkerk, I., 2015. Connective capacity in water governance practices: the meaning of trust and boundary spanning for integrated performance. *Curr. Opin. Environ. Sustain.* 12, 25–29.
- Fenton, P., Gustafsson, S., Ivner, J., Palm, J., 2015. Sustainable energy and climate strategies: lessons from planning processes in five municipalities. *J. Clean. Prod.* 98, 213–221.
- Fischer, L.B., Newig, J., 2016. Importance of actors and agency in sustainability transitions: a systematic exploration of the literature. *Sustainability* 8 (5), 476.
- Frantzeskaki, N., Wittmayer, J., Loorbach, D., 2014. The role of partnerships in 'realising' urban sustainability in Rotterdam's City Ports Area, The Netherlands. *J. Clean. Prod.* 65, 406–417.
- Garrett-Peltier, H., 2017. Green versus brown: comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model. *Econ. Model.* 61, 439–447.
- Gascó, M., 2017. Living labs: implementing open innovation in the public sector. *Gov. Inf. Q.* 34 (1), 90–98.
- Gast, J., Gundolf, K., Cesinger, B., 2017. Doing business in a green way: A systematic review of the ecological sustainability entrepreneurship literature and future research directions. *J. Clean. Prod.* 147, 44–56.
- Gesseus, E., Grady, N., Whitehouse, K., Crowe, J., Delaney, L., Hanley, K., Marchyshyn, A., McKeon, N., 2017. Now Hiring: the Growth of America's Clean Energy and Sustainability Jobs. Environmental Defense Fund. Climate Corps. Meister Consultants Group.
- Gliedt, T., Berkhout, T., Parker, P., Doucet, J., 2010. Voluntary environmental decision making in firms: green electricity purchases and the role of champions. *Int. J. Bus. Environ.* 3 (3), 308–328.
- Greene, J.S., Geisken, M., 2013. Socioeconomic impacts of wind farm development: a case study of Weatherford, Oklahoma. *Energy Sustain. Soc.* 3 (1), 1–9.
- Grin, J., Rotmans, J., Schot, J., 2010. *Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*. Routledge.
- Hammer, J., Pivo, G., 2017. The triple bottom line and sustainable economic development theory and practice. *Econ. Dev. Q.* 31 (1), 25–36.
- Hannon, M., Skea, J., Rhodes, A., 2014. Facilitating and coordinating UK energy innovation through systemic innovation intermediaries. In: 5th International Conference Sustainability Transitions.
- Harzing, A.W., 2007. Publish or Perish Academic Software, Version: 5.24.1 (3 December 2016) available from: <http://www.harzing.com/pop.htm>.
- Harzing, A.W., Alakangas, S., 2016. Google scholar, Scopus and the Web of science: a longitudinal and cross-disciplinary comparison. *Scientometrics* 106 (2), 787–804.
- Hayter, C.S., Link, A.N., 2015. On the economic impact of university proof of concept centers. *J. Technol. Transf.* 40 (1), 178–183.
- Hess, D.J., Mai, Q.D., 2015. The convergence of economic development and energy-transition policies in state-government plans in the United States. *Sustain. Sci. Pract. Pol.* 11 (1), 5–20.
- Huijben, J.C.C.M., Verbong, G.P.J., Podoyntsyna, K.S., 2016. Mainstreaming solar: stretching the regulatory regime through business model innovation. *Environ. Innov. Soc. Transitions* 20, 1–15.
- Huitema, D., Meijerink, S., 2010. Realizing water transitions: the role of policy entrepreneurs in water policy change. *Ecol. Soc.* 15 (2), 26.
- Inglesi-Lotz, R., 2016. The impact of renewable energy consumption to economic growth: a panel data application. *Energy Econ.* 53, 58–63.
- Kalafatis, S.E., Grace, A., Gibbons, E., 2015. Making climate science accessible in Toledo: the linked boundary chain approach. *Clim. Risk Manag.* 9, 30–40.
- Kanda, W., Hjelm, O., Bienkowska, D., 2014. Boosting eco-innovation: the role of public support organizations. In: ISPIIM Conference Proceedings (P. 1). The International Society for Professional Innovation Management (ISPIIM).
- Kanda, W., Clausen, J., Hjelm, O., Bienkowska, D., 2015. Functions of intermediaries in eco-innovation: a study of business development organizations and cluster initiatives in a Swedish and a German region. In: *Global Cleaner Production and Sustainable Consumption Conference*, 1–4 November, Sitges-Barcelona, Spain.
- Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technol. Analysis Strategic Manag.* 10 (2), 175–195.
- Kenis, A., Bono, F., Mathijs, E., 2016. Unravelling the (post-) political in transition management: interrogating pathways towards sustainable change. *J. Environ. Pol. Plan.* 18 (5), 568–584.
- Kern, F., Verhees, B., Raven, R., Smith, A., 2015. Empowering sustainable niches: comparing UK and Dutch offshore wind developments. *Technol. Forecast. Soc. Change* 100, 344–355.
- Kilelu, C.W., Klerkx, L., Leeuwis, C., Hall, A., 2011. Beyond knowledge brokering: an exploratory study on innovation intermediaries in an evolving smallholder agricultural system in Kenya. *Knowl. Manag. Dev. J.* 7 (1), 84–108.
- Kivimaa, P., 2014. Government-affiliated intermediary organisations as actors in system-level transitions. *Res. Pol.* 43 (8), 1370–1380.
- Kivimaa, P., Kern, F., 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Res. Pol.* 45 (1), 205–217.
- Kivimaa, P., Boon, W., Antikainen, R., 2017a. Commercialising university inventions for sustainability—a case study of (non-) intermediating 'cleantech' at Aalto University. *Sci. Public Pol.* 44 (5), 631–644.
- Kivimaa, P., Hilden, M., Huitema, D., Jordan, A., Newig, J., 2017b. Experiments in climate governance—a systematic review of research on energy and built environment transitions. *J. Clean. Prod.* 169, 17–29.
- Kivisaari, S., Kokkinen, L., Lehto, J., Saari, E., 2009. Management of System Innovation in Welfare and Health Sector. Lessons Learned from Two Case Studies, (Tech. Rep. No. 2504). Espoo, Finland: Technical Research Centre of Finland.
- Klerkx, L., Aarts, N., 2013. The interaction of multiple champions in orchestrating innovation networks: conflicts and complementarities. *Technovation* 33 (6), 193–210.
- Klewitz, J., 2015. Grazing, exploring and networking for sustainability-oriented innovations in learning-action networks: an SME perspective. *Innov. Eur. J. Soc. Sci. Res.* 1–28.
- Klewitz, J., Zeyen, A., Hansen, E.G., 2012. Intermediaries driving eco-innovation in SMEs: a qualitative investigation. *Eur. J. Innov. Manag.* 15 (4), 442–467.
- Küçüksayraç, E., Keskin, D., Brezet, H., 2015. Intermediaries and innovation support in the design for sustainability field: cases from The Netherlands, Turkey and the United Kingdom. *J. Clean. Prod.* 101, 38–48.
- Loorbach, D., Rotmans, J., 2010. The practice of transition management: examples and lessons from four distinct cases. *Futures* 42 (3), 237–246.
- Loorbach, D., Frantzeskaki, N., Avelino, F., 2017. Sustainability transitions research: transforming science and practice for societal change. *Annu. Rev. Environ. Resour.* 42.
- Maas, K., Schaltegger, S., Crutzen, N., 2016. Advancing the integration of corporate sustainability measurement, management and reporting. *J. Clean. Prod.* 133, 859–862.
- Matschoss, K., Heiskanen, E., 2017. Making it experimental in several ways: the work of intermediaries in raising the ambition level in local climate initiatives. *J. Clean. Prod.* 169, 85–93.
- Mattes, J., Huber, A., Koehrsen, J., 2015. Energy transitions in small-scale regions—What we can learn from a regional innovation systems perspective. *Energy Policy* 78, 255–264.
- McCauley, S.M., Stephens, J.C., 2012. Green energy clusters and socio-technical transitions: analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA. *Sustain. Sci.* 7 (2), 213–225.
- McLennan, C.J., Becken, S., Watt, M., 2016. Learning through a cluster approach: lessons from the implementation of six Australian tourism business sustainability programs. *J. Clean. Prod.* 111, 348–357.
- Mohalajeng, L.E., Kroon, J., 2016. Innovation through accelerators: a case for open innovation. *South. Afr. J. Entrepreneursh. Small Bus. Manag.* 8 (1), 1–9.
- Mullaney, T., 2015. Elon Musk's Biggest Challenge yet: Recharging Buffalo, NY. SolarCity's New Factory Is Linchpin of a \$1 Billion Plan to Bring Back a Third of Nickel City's Lost Manufacturing Jobs. Available at: <http://www.cnbc.com/2015/06/11/elon-musks-biggest-challenge-yet-recharging-buffalo-ny.html>.
- Muro, M., Rothwell, J., Saha, D., 2011. *Sizing the Clean Economy: a National and Regional Jobs Assessment*. The Brookings Institution. Metropolitan Policy Program. Battelle Technology Partnership Practice. Available at: [https://www.brookings.edu/wp-content/uploads/2016/06/0713\\_clean\\_economy.pdf](https://www.brookings.edu/wp-content/uploads/2016/06/0713_clean_economy.pdf).
- New York Incubator, 2016. New York University Tandon Labs. Available at: <http://engineering.nyu.edu/business/future-labs>.
- Nolden, C., Sorrell, S., Polzin, F., 2016. Catalysing the energy service market: the role of intermediaries. *Energy Pol.* 98, 420–430.
- Obama, B., 2017. The irreversible momentum of clean energy. *Science* 355 (6321), 126–129. [10.1126/science.aam6284](https://doi.org/10.1126/science.aam6284).
- Pahl-Wostl, C., 2015. The role of institutions, actors and social networks in societal change. In: *Water Governance in the Face of Global Change*. Springer International Publishing, pp. 51–83.
- Palmer, J.R., 2015. How do policy entrepreneurs influence policy change? Framing and boundary work in EU transport biofuels policy. *Environ. Polit.* 24 (2), 270–287.
- Pender, J.L., Weber, J.G., Brown, J.P., 2014. Sustainable rural development and wealth creation five observations based on emerging energy opportunities. *Econ. Dev. Q.* 28 (1), 73–86.
- Penna, C.C., Geels, F.W., 2015. Climate change and the slow reorientation of the American car industry (1979–2012): an application and extension of the Dialectic Issue LifeCycle (DILC) model. *Res. Pol.* 44 (5), 1029–1048.
- Polzin, F., von Flotow, P., Klerkx, L., 2016. Addressing barriers to eco-innovation: exploring the finance mobilisation functions of institutional innovation intermediaries. *Technol. Forecast. Soc. Change* 103, 34–46.
- Rauschmayer, F., Bauler, T., Schöpke, N., 2015. Towards a thick understanding of sustainability transitions—linking transition management, capabilities and social practices. *Ecol. Econ.* 109, 211–221.
- Raven, R., Kern, F., Verhees, B., Smith, A., 2016. Niche construction and empowerment through socio-political work. A meta-analysis of six low-carbon technology cases. *Environ. Innov. Soc. Transitions* 18, 164–180.
- Ray, A.D., Grannis, J., 2015. From planning to action: implementation of state climate change adaptation plans. *Mich. J. Sustain.* 3.
- Rowlands, I.H., 2007. The development of renewable electricity policy in the

- province of Ontario: the influence of ideas and timing. *Rev. Pol. Res.* 24 (3), 185–207.
- Sassmannshausen, S.P., Volkmann, C., 2016. The Scientometrics of social entrepreneurship and its establishment as an academic field. *J. Small Bus. Manag.* <https://doi.org/10.1111/jsbm.12254>.
- Sengers, F., Raven, R., 2015. Toward a spatial perspective on niche development: the case of Bus Rapid Transit. *Environ. Innov. Soc. Transitions* 17, 166–182.
- Sengers, F., Wieczorek, A.J., Raven, R., 2016. Experimenting for sustainability transitions: a systematic literature review. *Technol. Forecast. Soc. Change.* <https://doi.org/10.1016/j.techfore.2016.08.031>.
- Slayton, R., Spinardi, G., 2016. Radical innovation in scaling up: boeing's Dreamliner and the challenge of socio-technical transitions. *Technovation* 47, 47–58.
- Smink, M., Negro, S.O., Niesten, E., Hekkert, M.P., 2015. How mismatching institutional logics hinder niche–regime interaction and how boundary spanners intervene. *Technol. Forecast. Soc. Change* 100, 225–237.
- Smith, A., Voß, J.P., Grin, J., 2010. Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. *Res. Pol.* 39 (4), 435–448.
- Sooriyaarachchi, T.M., Tsai, I.T., El Khatib, S., Farid, A.M., Mezher, T., 2015. Job creation potentials and skill requirements in, PV, CSP, wind, water-to-energy and energy efficiency value chains. *Renew. Sustain. Energy Rev.* 52, 653–668.
- Swaffield, J., Bell, D., 2012. Can 'climate champions' save the planet? A critical reflection on neoliberal social change. *Environ. Polit.* 21 (2), 248–267.
- Van Heyningen, J.P., 2016. An Innovation Systems Approach to Sustainability Transitions: Analysing Socio-cognitive Institutions in Austrian and South African Cases (Doctoral Dissertation, Stellenbosch: Stellenbosch University).
- Wang, C., Wang, L., 2016. Unfolding policies for innovation intermediaries in China: a discourse network analysis. *Sci. Public Pol.* 44 (3), 354–368.
- Wei, M., Patadia, S., Kammen, D.M., 2010. Putting renewable and energy efficiency to work: how many jobs can the clean energy industry generate in the US? *Energy Pol.* 38, 919–931.
- Wesseling, J.H., Niesten, E.M.M.I., Faber, J., Hekkert, M.P., 2015. Business strategies of incumbents in the market for electric vehicles: opportunities and incentives for sustainable innovation. *Bus. Strategy Environ.* 24 (6), 518–531.
- Wittmayer, J.M., Avelino, F., van Steenberghe, F., Loorbach, D., 2017. Actor roles in transition: insights from sociological perspectives. *Environ. Innov. Soc. Transitions* 24, 45–56.
- Yi, H., 2014. Green businesses in a clean energy economy: analyzing drivers of green business growth in US states. *Energy* 68, 922–929.