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A typology of clean technology commercialization accelerators

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ABSTRACT

Accelerators are a type of incubation program that are concerned with attracting, supporting and developing new ventures. Although there is significant enthusiasm for accelerators and their potential benefits, there is limited research on how their core capabilities can vary. In response, we develop a typology of accelerator capabilities taking into account their strategy, governance, business model, operations and finance. To develop the typology we carried out a benchmark analysis of six clean energy commercialization accelerators (CECAs). From this we verified and illustrated the dimensions of our typology and identified four types of accelerator capabilities: *R&D focused*, *technology enabled*, *market enabled*, and *network enabled*. We then use a seventh accelerator case to illustrate how our typology can be used to describe, understand and prescribe appropriate capabilities for a CECA. We conclude our paper by explaining the research and practice implications of our research.

Introduction

An accelerator is a type of business incubation program that allows entrepreneurial teams and their ventures to connect with and access resources from investors and other important stakeholders. While accelerators, such as Y-Combinator in the USA, have caught the attention of media and policy makers by funding and supporting hundreds of successful digital start-ups, including Dropbox and Reddit, there has been surprisingly little academic research on the accelerator phenomenon.

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In response, our paper focuses on two issues. First, like research on related phenomenon such as incubators (Peters et al., 2004; Mian, 1994) and university research parks (Link and Link, 2003), we examine how accelerators can vary in terms of their capabilities and the associated value they provide to their start-ups. This knowledge is important for understanding how to appropriately design and manage accelerators so as to effectively help start-ups. Second, most of the reporting on the accelerator phenomenon has concentrated on start-ups concerned with digital media. Thus, we know very little about the other types of accelerators that support ventures that seek to commercialize products and services in areas such as advanced materials, biotechnology, and clean energy.

To address these issues we build on prior research (see Malek et al., 2012) to analyze and classify the capabilities of accelerators focused on supporting ventures that develop, demonstrate and commercialize clean energy technologies. We call these clean energy commercialization accelerators (CECAs). CECAs aim to attract, accommodate and nurture clean technology ventures (Malek et al., 2012). These ventures are established to develop and commercialize technologies linked to distributed power generators, photovoltaic solar panels, wind turbines, fuel cells, and energy storage systems, environmental consulting, pollution, and water treatment (SDTC, 2011). As a major sector in the clean technology industry, green technology has attracted considerable private investment in 2010 (CleanEdge, 2012). Since then the amount of investment globally has continued to grow. For example, South Korea's government allocated $85 billion to clean-tech investments, and China announced plans to invest up to $660 billion toward its clean-energy industry over the next ten years (CleanEdge, 2011, 2012, 2013; NRC-IFCI, 2011).

With this background, the core opportunity and motivation for our paper is that there is a dearth of research on accelerators in general, and more specifically on accelerators which support ventures outside of the digital media sector. Focusing on CECAs, the aim of our paper is develop a typological framework that provides a theoretical basis to describe and explain how accelerator reality can vary. The typology can be used by those who setup, fund and operate accelerator programs to better understand and develop appropriate strategies and practices. It can also be used by researchers to examine how the determinants and diversity of accelerator capabilities might lead to different entrepreneurial and innovation outcomes.

The rest of our paper unfolds as follows. In Section 2 "Theoretical background and industry context" we provide a primer on the concept of accelerators, and contrast them with incubators. In Section 3 "Method and data", we outline our benchmarking method and the nature of the data we collected from six CECAs. In Section 4 "Benchmarking findings" we present our benchmarking findings describing how each CECA varies according to certain dimensions that help reveal how CECAs vary in terms of their goals and how they are managed. We then compile the dimensions to present a parsimonious typology of CECA capabilities. In Section 5 "Typology illustration: the case of Clean Technology Commercialization Gateway (CTCG)", we illustrate the typology by applying it to a seventh case accelerator so as to exemplify the dimensions of the typology and their role in determining the *modus operandi* of an accelerator.

Theoretical background and industry context

In this section, we further introduce and define the concept of an accelerator. We then review the research on accelerators to highlight their role as important mechanisms for technology commercialization. As we focus on CECAs, we introduce the clean energy technology sector in Canada (which is home to half the cases in our paper) and explain the role of accelerators in this country, and elsewhere, in helping ventures commercialize their technologies.

A primer on accelerators

To understand what an accelerator is, it is useful to understand how they relate and differ from a business incubator. Incubators are any sort of environment designed to support start-up organizations (see Peters et al., 2004). While accelerators are a relatively recent phenomenon, incubators have been around for over fifty years. It is widely recognized that the first business incubator was the Batavia Industrial Center in New York, which opened in 1959 (Lewis et al., 2011). A central feature of incubators is that they provide a physical space for entrepreneurs and their new ventures to set-up. By joining an incubator, new ventures limit their overhead costs by accessing and sharing the costs of office facility resources (Clarysse et al., 2005). This notion of resource sharing has since evolved to include accessing development and networking services for enhancing the growth and performance of the ventures (Peters et al., 2004).

Accelerators are related, but distinct from incubators. Originally focused on start-ups in the digital media sector, the genesis of accelerators was driven by private investors who sought to develop and benefit from new ventures in this sector. While accelerators have expanded to support ventures in a range of industries including biotechnology, wireless and telecommunication, digital media, and internet, they are different from incubators in terms of a number of features. Drawing upon policy reports that examine the phenomenon of accelerators (Miller and Bound, 2011); we suggest that while accelerators are similar to traditional business incubators in that they seek to attract and nurture new ventures; they are also distinct in five major ways. First, entrepreneurial teams must compete to be selected to join an accelerator. Much like applying to study at top tier universities, the process of applying to be part of a leading accelerator can be highly competitive, with very low acceptance rates. Second, accelerators will typically accept and nurture a much greater number of start-up teams than a typical incubator. Third, accelerators typically take some equity in the start-ups in exchange for providing capital and development services. Fourth, the accelerator development experience is much more rapid and intensive than that offered by an incubator. The accelerator program duration is typically short (e.g., three to four months for digital media and internet ventures) as opposed to that for an incubator. Fifth, the start-up teams that join an accelerator are expected to interact and network with other teams to support each other.

Canadian clean technology sector

One of the motivations for developing a typology of accelerators focused on clean technologies is that the authors are located in Canada, a country that is using accelerator programs to help foster a viable industry in this technological area. Thus, we provide an introduction to some of the industry conditions that policy makers, investors and entrepreneurs believe necessitate the use of accelerators.

Canada is home to ventures with competitive advantages in energy management and sustainable transportation in global value chains of the clean technology sector (SDTC, 2011). While the global market for clean energy is estimated to reach $325 billion worldwide by 2020 (Parker, 2009), reports suggest that Canada's share of this global clean technology market could reach $35 billion annually and be supplied by an industry of 6000 firms and 250,000 employees (CleanEdge, 2012). Technology innovation, however, remains a major hurdle for commercialization of clean technologies, putting Canada behind other developed countries (SDTC, 2011; CBC, 2013).

Demonstration is an important success factor for clean energy commercialization; it show cases the utility of a technology and its ability to be scaled up or be applied in a new manner (CleanEdge, 2011; SDTC, 2011; PikeResearch, 2011; Zhu et al., 2012). Demonstration projects allow validation and promotion of clean energy technologies and the required supply and distribution networks. However, setting up a demonstration project is challenging for ventures with small or no experience in this activity. Forming consortia to enhance the project-funding process is of vital importance to the success of large-scale demonstration projects (Schaefer and Guhr, 2011; NRC-IFCI, 2010). These demonstration projects can attract government funds and establish local market opportunities for clean technology ventures. Alternatively, demonstration projects may accelerate the consumers' early adoption process, as there is often reluctance by the majority of potential investors and customers to invest in emerging technologies, such as clean technology. As a result, Canadian ventures are increasingly dependent upon foreign markets as their key growth driver. But domestic markets must also be seen as a key enabler for exports (SDTC, 2011). Consequently, accelerators are considered to be an appropriate and important mechanism for helping clean technology ventures to develop, demonstrate and commercialize their technologies for a domestic market. We now explain how this logic for using accelerators to nurture a clean technology industry is linked to the genesis and use of clean energy commercialization accelerators (CECAs).

Clean energy commercialization accelerators (CECAs)

Many clean technology ventures are science-based businesses (Pisano, 2010), and thus face long delays and uncertain paths in taking inventions to commercialization (Maine and Garnsey, 2006; Maine et al., 2012). Unlike the biotechnology sector, where a more established relationship exists between a venture's R&D potential, the market for the technology, and the amount of wealth created by the venture (Deeds, 2001), the clean technology sector is younger and more uncertain. As an emerging industry, it can be characterized as being ''high-velocity'' with rapid and discontinuous change in technology, competitors, demand and regulations (Eisenhardt, 1989). Such shifting conditions make it difficult for entrepreneurs to track, make sense of, and adaptively pursue opportunities (McCarthy et al., 2010). Also, clean technologies are built using both established and new technologies and this means that innovative business models, careful market-adoption strategies, and favorable government policies are all highly important (Johnson and Suskewicz, 2009). Furthermore, with limited economic value placed on the reduction of emissions, ''barriers for commercialization are particularly significant for mass-scale commercialization'' (Malek et al., 2012, p. 837). Thus, the cost per unit of clean energy, along with user requirements in terms of durability and reliability (i.e., operations risk) are significant hurdles compared to conventional energy technologies (Touhill et al., 2008; Faems et al., 2012). Consequently, the process of commercializing clean energy technology involves significant operational risk that increases as the technology risk diminishes along the same commercialization path (see Fig. 1).

Faced with such start-up conditions, accelerators, in addition to providing incubation, offer an important technology commercialization role (SDTC, 2011; Touhill et al., 2008). This has led to the emergence of clean energy commercialization accelerators (CECAs) to attract and support early stage ventures by facilitating large-scale demonstration projects (Ulhøi, 1997). CECAs are intended to shorten the time-to-market of new clean energy technologies by facilitating R&D capabilities and accelerating the design-to-demonstration cycle. Moreover, CECAs often offer shared business support services to help reduce the administrative, procurement, and regulatory or legal process times

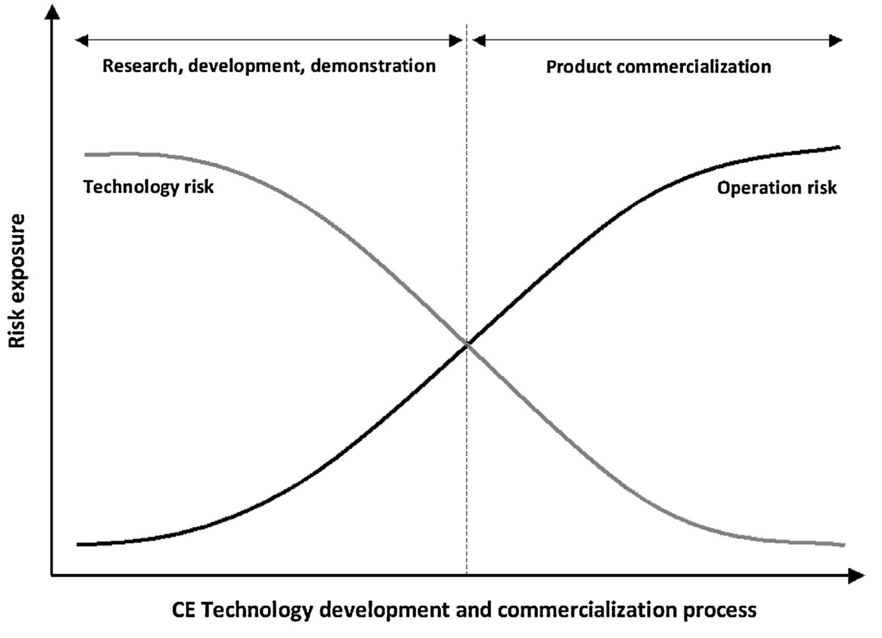

Fig. 1. The risk profile of clean energy (CE) technology commercialization process, adapted from SDTC (2010).

associated with commercialization. It is also common for CECAs to connect entrepreneurs to investors who provide seed capital to help facilitate the "lean demonstration" or "early market penetration process" (Malek et al., 2012; NRC-IFCI, 2010).

Currently, the CECAs in Canada are typically non-profit entities. Some offer business development support to negotiate with major energy suppliers and power utilities for potential joint demonstration projects and access the extended distribution channels. Others leverage on R&D and deployment capabilities of their industry partners, by playing the role of a trusted third party validator to service end users (NRC-IFCI, 2010; NRC-IRAP, 2011; Malek et al., 2012). In sum, CECAs provide an industry specific accelerator program that focuses on helping start-up ventures develop, demonstrate and eventually commercialize their clean energy products.

Method and data

We used case benchmarking analysis to develop our typology of CECAs. This involved reviewing and selecting CECAs from the Canadian federal government and provincial government databases of clean technology accelerators. We were also able to consult with industry policy makers and entrepreneurs as one of the authors has ten years' experience of working in clean energy R&D. The benchmarking resulted in the identification and analysis of six non-profit CECAs: four in Canada, one in the US, and one in Europe. With this number of CECAs, we did not seek to develop rich case studies for inductive theory building. Instead, we sought multiple sources of case data to help identify, describe and tentatively validate the elements and logic of our typological framework (see McCarthy and Gordon, 2011). We first examined how each CECA varied in terms of their organizational, operational, strategic, and financial characteristics. From this analysis we explain how variations in these characteristics can be configured to produce a viable and theoretically interesting typology of CECA capabilities.

The benchmarking analysis was performed by examining publically available data on each CECA (e.g., web site information and reports), conducting interviews with CECA managers and tenant entrepreneurs, and visiting and touring the CECAs (Malek et al., 2012, p. 838). Respondents were asked to confirm that their organization was a CECA, provide background information and an account of its specific focus area of clean technology. We also assessed the number of partnerships each CECA had with government agencies, suppliers and potential customers, and examined the social and economic benefits that accelerators and their ventures provide. This is important for understanding the role of public representatives in the governance approach, which plays a significant role in determining the extent of public–private partnerships in the organizational operation and business model. It also helps us to understand the nature of the activities [service-oriented or facilitator (incubator, cluster and networking enabler)], which dictates the required level of capital investment.

Benchmarking findings

In this section of our paper we present the findings of our benchmark analysis. Specifically we introduce a comparative table that shows the capability dimensions (strategy, governance, business model, operations and financing) and performance measures (number of ventures and their impact on communities) for each CECA we studied (see Table 1). We then discuss how these capabilities vary and link to different performance measures for the CECAs.

Governance

The governance approaches employed by the CECAs in our study generally follow some form of the policy governance model developed by the consultant John Carver (Carver, 2006). Applied to CECAs, this model of governance is designed to empower CECA directors to fulfil the goals and obligations of the accelerators. With this focus however, it has been suggested that the Carver governance model can afford excessive or unnecessary control power to the executive director (Bradshaw et al., 2007). More specifically, one of the respondents in our study indicated that this level of control can create a

Table 1
Capability dimensions and performance measures for benchmarked clean energy commercialization accelerators (CECAs).

		Clean energy commercialization accelerators					
		CTSI	Bloom	MaRS	EBC	ECO	URIP
Capability dimension	Strategy	Specialized on Clean-Tech	Public–private partnership Specialized on Clean-Tech	Public–private partnership	Specialized on Clean Energy	Specialized on Clean-Tech	Public–private partnership
	Governance	Policy-Representative model	Policy-Representative model	Policy-Entrepreneurial model	Policy-Entrepreneurial model	Representative or hybrid model	Policy-Representative model
	Business model	Market linkage mode Partnership model	Technical services model Market linkage model Partnership model	Technical services model Partnership model Incubation model Market linkage model	Market linkage model Incubation model Partnership model	Partnership model Market linkage model	Incubation model Technical services model
	Operations	Customer focused	Customer focused	Customer focused Incubation focused Licensing focused	Incubation focused Licensing focused	Customer focused	Incubation focused Licensing focused
	Financing	Government grant Service or Membership fees	Public–private fund Technical service fees	Public–private fund Incubation fee Technical Services fees	Incubation fee Public–private fund	Government grant Public–private fund Membership fee	Government grant Public–private fund
	Number of member ventures/ communities	>100	Less than 20	>70	>150	>50	Less than10
Performance	Impact on community, member ventures	High	High	Medium	Low	High	Low

disconnect between the CECA president and board members which in turn can erode board control and accountability.

In order to implement a suitable governance model for non-profit commercialization accelerators it is important to distinguish governance function from an accelerator's interpretive perspective (e.g., codes, standard and regulations) and political perspective (e.g., regional or federal clean energy policy). It has been suggested that existing governance models of non-profits can be classified in terms of the *Policy Governance* model, the *Entrepreneurial* model, the *Representative Board* model, the *Emergent Cellular* model, and hybrids of these models (Bradshaw et al., 2007). Fig. 2 summarizes these governance models and maps some of the benchmarked organizations. The horizontal axis of this framework characterizes how the governance approach of the organization is ''flexible'' with 'low' being little intention to change or being open to change and 'high' being able to innovate new ways of working. The changes are often motivated by increasing efficiency or bringing about fundamental social changes (Bradshaw et al., 2007). The vertical axis characterizes the extent of the governance function to work in a network of member organizations. Low generality equals a distributed and interdependent balance of power, whereas high generality refers to governance approaches with centralized, top-down power structures (Bradshaw et al., 2007).

Strategy

By connecting to vendors, integrators, utilities, end users, and regulatory bodies in the clean energy industry, CECAs take a business strategy in which they provide a "cross industry community" service to promote clean energy technology development, profitable commercialization, and global integration of sustainable industry practices. CECAs are enabling the transformation of businesses, governments and society toward a more sustainable local and global economy. Organizations of such kind (e.g., CTSI) are a matchmaker between communities or clean energy integrators, technology vendors, and public or private R&D centers (CTSI, 2011).

Several factors are involved in defining and employing appropriate strategies for CECAs. The level of public–private partnership and extent of capital investment are among key factors that drive the strategy of CECAs. MaRS for example with its high initial capital investment, has established an

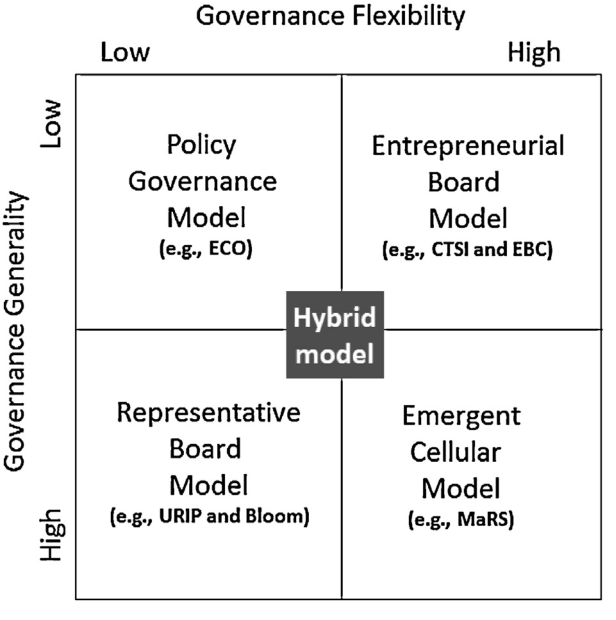

Fig. 2. Governance models for CECAs, adapted from Bradshaw et al. (2007).

effective process to review, research, support, and help transform disclosures from member institutions into marketable products and processes. Building upon a strong public–private partnership, Bloom works in close collaboration with leading organizations in the public and private sectors to ''drive positive changes through the application of sustainable processes, practices and technologies that maximize resource efficiencies, enhance competitiveness, reduce environmental and social impact, and mitigate risk'' (Bloom, 2011, pp. 1).

Considering that clean energy can be characterized by different industry or technology specialisms it was surprising that the majority of the CECAs in our analysis had little to no specialization strategy. Of those that specialized (CTSI and EBC), EBC was among the leaders in terms of capital raised and jobs created. This suggests a positive link between degree of specialization and resulting economic growth. However, other facilities with no specialization also were successful in promoting growth, suggesting that there may be other influential factors as well.

Operations

The financial model and operations dimensions of a CECA are inter-related. The finances determine the resources and capabilities available to fulfil commercialization goals, as well the extent to which a CECA will fund and take equity in its new ventures. The major operational activities of a CECA can include technology evaluation, testing, integration, and maintenance (collectively referred to as ''technology services''). CECAs also support entrepreneurs and their ventures by providing network linkages, business model and development advice, and training services. Other activities related to the provision of incubation resources such as physical space, building maintenance, and lab technicians if applicable, do not require day-to-day communications with entrepreneurs, but are still central operational issues. The overall CECA strategy dictates the type and variation of these activities. For example, clean technology ventures with a high R&D intensity will typically focus on business model development and commercialization channels, and thus offer expertise and support in these areas. Based on our benchmarking analysis and as shown in Table 1, we classify the operational activities of CECAs as: *customer focused*, *incubation focused*, or *licensing focused*. Our benchmark analysis suggests that depending upon their business model and strategy, some CECAs (i.e., MaRS and EBC) can simultaneously employ more than one of these operational dimensions.

Financing

As shown in Table 1 we found that CECAs draw their finances primarily from the government and public sector grants, venture capital funds, and revenue from facility and equipment rental fees and project-related services such as technology and market analysis and training. The CTSI and Bloom CECAs, for example, rely significantly on large public *government grants* and *public-private funds*, which are then organized into a ''community fund'' to provide an aggregate level of funding that exceeds that normally offered by individual sources alone. The financial process and the resources adopted by URIPs, MaRS, and EBC, are partly or fully managed by public–private funds to develop and capture value from ventures, which is similar to what research on technology incubators has found (see Clarysse et al., 2005). In contrast, ECO, secures and uses financial supports from government grants to establish a center of excellence in clean energy so as to help foster a clean energy technology cluster in the region.

Business model

The commercialization of clean technology products or services involves a range of opportunities, challenges, and risks, all of which are highly uncertain (SDTC, 2011). *Start-up capital* is of vital importance for the creation and growth of clean technology ventures (SDTC, 2011). Moreover, the sustainability of the ventures is relies on acquiring a number of clients to which the venture offers its services.

Drawing upon existing business model frameworks for accelerators (SDTC, 2011) and using the collected benchmarking data, four different types of business model are identified: the *incubation model*, the *technical services model*, the *market linkage model*, the *partnership model*. As these CECA

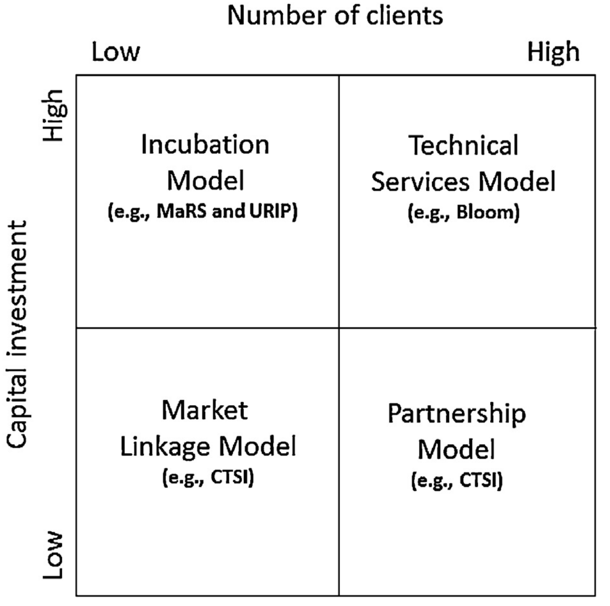

Fig. 3. Business models for CECAs.

business models vary in terms of how many client entrepreneurs they seek to support, and the amount of capital investment they provide to clients, they can be classified and presented accordingly (see Fig. 3).

The *incubation model* which provides entrepreneurs and new ventures with office space and financial services in return for a rental fee or member fee, which is generally offered at below-market rates. The *technical services model* provides the technical expertise and resources clean energy ventures need to demonstrate market readiness of their technologies. Clean energy ventures require on-going technical services such as testing and validating of their technologies before they can be installed or demonstrated to the potential clients in a specific site location. Commercialization centers that are adapting this business model either own testing facilities and provide the technical support services in house or utilize facilities available in their member organizations that can provide the services with lower rate based on number of services used per year. The *market linkage model* involves a clean technology club or membership program that includes advisors, corporate and community partner. This business model focuses on expanding the existing market or establishing new markets for demonstration and deployment of emerging clean energy technologies that are developed by member ventures. The fourth business model is the *partnership model*, where CECAs establish business relationships for their clean technology ventures. These include partnerships between ventures and R&D laboratories and technology testing facilities in return for sharing profits or joint execution of pilot or demonstration projects in return for sharing long-term earnings. On various operational capacity bases, the partners are sharing the risk of technology development, capital investment, and potential rewards that result in successful development, demonstration or deployment of the technologies, none of which could be achieved by the existing organizations alone.

A typology of CECA capabilities

Typologies are useful for thinking about and describing how any type of organizational phenomenon can vary. One of the key characteristics of a valuable typology is that it focuses on and aggregates dimensions of organizational reality in a way that results in a framework that is parsimonious and elegant (McCarthy et al., 2000; McCarthy, 2005). This aggregation and the resulting

Table 2
A typology of CECA capabilities.

Types of CECA capabilities	Dimensions
R&D focused	Strategy: public–private partnership Governance: policy model, technical services model Business model: Incubation model, technical services model Operation: Incubation focused, licensing focused Financing: Large public (government) grant, public–private fund, VC fund
Technology enabled	Strategy: public–private partnership, specialization Governance: policy-representative model Business model: technical Service model, market linkage model, partnership model Operation: customer focused Finance: public–private fund, Technical services fees
Market enabled	Strategy: specialization Governance: policy-representative model Business model: market linkage model, partnership model Operation: customer focused Finance: government grant, Services or membership fees
Network enabled	Strategy: public–private partnership, specialization Governance: representative or hybrid model Business model: partnership model, Market linkage model Operation: customer focused Finance: government grant, membership fee

typology (see Table 2) are presented in this section of our paper. We use the dimensions identified in our benchmarking analysis (i.e., strategy, governance, business model, operations, and financing) to show how the benchmarked accelerators can be classified in terms of four types of CECA capabilities: *R&D focused*, *technology enabled*, *market enabled*, and *network enabled* (see Table 2).

R&D focused CECAs are those that are characterized by a public–private partnership and are governed by the policy or representative governance model. They follow either an incubation focused, customer focused, or a licensing focused operation and seek for financing from large public grants, public–private funds, or direct capital investment from VCs.

Technology enabled CECAs adopt a public–private partnership as their core strategy. As a result, they generally implement a policy model or representative model as their governance. They are characterized by their customer focused operation and specialized business models in technical services, market linkage, and partnership activities. Technical service fees and public–private funds are the major source of financing for these CECAs.

Activity specialization (by focusing on specific clean energy sector or clean energy technology solution) is the main strategy in market enabled CECAs, where market linkage and partnership activities are considered as the core business models. With a policy representative governance model, they adopt a customer focused operation which is financed from government grants, service fees, or membership fees.

The core strategy of network enabled CECAs is to create joint partnerships with private clean energy technology vendors and public entities. This helps venture to adopt a customer focused operation with specialization in their network enabled services. They utilize representative or hybrid governance model, employ partnership or market linkage model as their business models and seek for financing from government grants and membership fees.

An appropriate performance matrix for CECAs should include data related to financial returns, quality and speed of project development and execution, and overall impacts on communities and relevant industry sector. In addition to these performance measures, exit rates and ability to attract foreign capital are also meaningful indicators for determining the quality of commercialization services provided by these ventures. For instance, exit rates are the total historical number of client exits in proportion to the total historical number of hosted client ventures. Young accelerators may experience lower exit rates due to the time required for young ventures to mature, and technology-focused incubators may have lower exit rates due to the time-consuming nature of product development. Foreign capital is an indicator of the incubators' potential for wealth contribution to the local economy. To gauge good CECA practice the differences and causal drivers between "outcome" and "performance" must be determined (Bergek and Norrman, 2008); that is it is important to understand the link between accelerators capabilities and their impact.

Typology illustration: the case of Clean Technology Commercialization Gateway (CTCG)

To illustrate the use of our typology, a further case study is presented and analyzed. We do this to help ensure that the typology dimensions and the resulting insights are concrete i.e., they adequately reflect and capture accelerator reality. Similar approaches have been used to illustrate conceptual frameworks dealing with external technology commercialization and the control of R&D organizations (McCarthy and Gordon, 2011).

The final illustrative case is CTCG, a not-for profit CECA in the province of British Columbia, Canada. It was formed to connect clean energy ventures with the energy needs of remote aboriginal communities in Canada. The aim is to attract, validate, integrate, and deploy emerging clean technologies to enhance the wellbeing of these communities. Using the typology dimensions in Table 2, we evaluate and prescribe appropriate capability dimensions for CTCG that fit their strategy, governance, business model, operations and financing. Additionally, performance metrics for CTCG are discussed.

Strategy

The core business strategy of CTCG is to focus initially on first-nation remote communities (e.g., the council of the Haida Nation) as the target market. Remote communities provide excellent platforms for emerging clean energy technologies that are mainly supplied by small businesses and early stage ventures. These ventures are not able to demonstrate and test their technology in local communities, municipalities, and end user domains due to rigid regulations and lack of available infrastructure. The CTCG's long-term business strategy is to provide services to BC remote communities and leverage that success to help connect SMEs and clean energy technology providers in BC and Canada to the global market to sell their viable and demonstrated clean energy technologies. By bringing together the technology suppliers and linking with other clean energy clusters, CTCG is a one-stop-shop to provide the expertise and support activities required for developing clean energy projects.

Governance

Given the scope and extent of the CTCG projects for its target community, a "representative board" model is the governance model that fits CTCG's objective, capital investment, and operation. This is because the clean energy supplier and community representatives on the board control over policy and decision-making process.

CTCG's initial Board of Directors formed with five core members; including two federal and provincial representatives, a president, and two representatives from private stakeholders in addition to advisory board members (CTCG, 2011). The board members at CTCG represent stakeholder organizations including provincial and federal governments and the executives of private clean energy ventures. Although the board is not large, there are other advisory board members that help facilitate communications between community end users, CTCG, and technology vendors. The board members and associated committees make decisions over the types and sizes of clean energy projects, the role of CTCG in those projects, as well as overseeing the operations of CTCG. Once established on the "representative board" model, CTCG can evolve its governance approach to an "emerging cellular" model depending on how much control and authority CTCG wishes to maintain. If having control is the predominant desire, a "representative board" model should be considered. In contrast, the "emerging cellular" model could serve as a more suitable governance approach in the long-term, where large clean energy projects need a strong network of member communities and require extended outsourcing to private clean energy technology vendors.

Business model

The most viable business model for CTCG is based on service-oriented activities, which include both *technical services* and *market linkage* models. The CTCG core business consists of contracts with private and public partners (communities and municipalities). The technical services model covers a variety of services from technology evaluation and clean energy assessment to project planning, coordination, resource management, implementation, execution, and managing clean energy projects for remote communities. The market linkage model primarily targets early stage clean energy ventures. This requires demonstration and government certification of their technology and relies on short- to long-term testing, demonstration, and integration by end users. The technical services model is generally more capital intensive than market linkage model, but can attract clients among service recipients from communities, early-stage, or established clean energy ventures. These two business models require relatively low capital investment and their success strongly depends on the size of projects and the role of CTCG in those projects.

Operation

A customer-focused activity is a highly viable operation model for CTCG. The organization works with first-nation communities to identify and develop clean energy strategies and models based on locally available resources. CTCG particularly provides tools and assessments to help them make decisions. CTCG also provides market services to clean energy technology companies to develop and deliver a solution to these community needs, and advises and supports them in identifying local communities' needs and in accessing global markets. The required resources and capabilities include engineers, scientists, and business and market analysts. All CTCG services and projects are focused on developing a sound understanding of the needs of customers and the market. Based on this understanding, CTCG develops collaborative partnerships with technology vendors, service providers and other relevant stakeholders, to design and deliver initiatives that meet the remote communities' expectations as well as the market performance expectations, and relevant government regulations and standards.

Financing

The financial source for the majority of CTCG's projects is public–private funds that are usually provided in form of "community funds". Other financial support is provided through project-related services such as technology and market services, market linkage and project management services. In the early stages of a project, the project manager performs a general assessment of the financial requirements of implementing the plan over the expected lifetime of the project, which could be fairly simple for smaller and shorter-term projects and more comprehensive for complicated projects. Budgeting and cash management are two important areas of financial management for CTCG. Special attention is given to the current and potential sources of income, the estimated costs of services and monitoring activities, and any projected financial resource gaps.

Fit with typology

In summary, CTCG has implemented a specialized business strategy by focusing on remote communities as the initial target market. The governance approach of CTCG can evolve from current *representative board* model to an *emerging cellular* model. A longer-term recommended business model for CTCG is to leverage their strategic partners (government and technology suppliers) to engage in large-scale *technical services* and *market linkage* services. Currently, CTCG finances its *customer-focused* operation from public–private funds that are usually provided in form of community funds. The latter impacts remote communities highly and could generate substantial project payoffs and positive cash flow to CTCG.

Conclusions

The aim of this paper was to develop a typology of clean energy commercialization accelerators (CECAs) that would help scholars and practitioners understand how the capabilities of these organizations can vary to suit different goals. We defined and differentiated accelerators from incubators and highlighted the need to better understand their practices and capabilities. We also revealed the opportunity to better understand the growing number of accelerators focused on attracting and developing clean technology ventures. To address these opportunities we conducted a benchmark analysis of six CECAs and used this information to develop a typology of accelerator capabilities. We believe this typology has at least three important implications for scholars and practitioners.

First, the typology provides a framework for CECA practitioners and researchers to describe what CECAs are and how they vary. Being able to define and label the organizational forms in an emerging industry (CECAs are an industry) is important for branding, directing and transforming an industry overtime. This descriptive contribution links to a second contribution, which is to be able to draw upon and develop theoretical explanations as to why these types of CECAs have arisen and exist. For example, explanations derived from resource-based theory (Barney, 1991) could highlight the importance of providing different bundles so as to help develop unique capabilities or differentiators for CECAs. Similarly, the concept of strategic group theory (Hunt, 1972; Porter, 1980) could be used to explain why CECAs evolve overtime to have different capabilities or combinations of capabilities. This is important because CECAs are an emerging industry in their own right, and strategic group mapping could help individual CECAs to differentiate competitive CECAs from partner CECAs, and indicate the changes needed to transition from one CECA capability to another, if required. Finally, our typology provides a theoretical framework to design and carry out empirical studies that test the contingency links between CECA capability and CECA outcomes. For example, researchers could examine the impact of different CECA capabilities in different contexts, and the link between CECA type coherence (i.e., how closely a CECA conforms to one of our capability types) and its impact. Ultimately, our typology could be used to develop and test predictions of which sets of CECA capabilities will be successful under a particular set of regional, technology and value chain circumstances.

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