Resource Mobilisation along Innovation Paths

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Abstract

The purpose of this paper is to investigate the innovation paths of an organisation within the renewable energy sector. An in-depth single case study methodology was used to analyse the events along each path and to consider resource mobilisation and re-configuration around these events. The paper categorises the innovation paths into technical, hybrid and commercialisation, introduces a more detailed typology of events and finds that lock-in events influence the convergence towards future paths. Research implications include the development of a new category of innovation path which may be closely link to the "context-in-use" (Håkansson et al. 2009) of the innovation, and the finding that co-occurrence of events across paths in the same time period influences the convergence of paths towards a focal aim. Practical implication highlights the multifaceted role of government within the business network which requires the focal organisation to consider its interactions with these diverse organisations.

Keywords: Innovation trajectory, innovation and commercialization paths, events, lock-in effect, renewable energy

Article type: Competitive Paper

INTRODUCTION

Research exchange between actors is important within new product development processes (Chou & Zolkewski 2012). Yet, research into resource exchange highlights that innovation processes can be considered chaotic (Van de Van et al. 2008) or complex (Purchase et al. 2014) particularly in the early stages. This research considers innovation processes through resource exchange and adaption during innovation events and the linking of innovation events through time. In particular, we are investigating how the resources, exchanged during innovation processes via different events, influence future innovation paths.

Events are interconnected through innovation trajectories (Jenkins & Floyd 2001) or paths (Thrane et al. 2010). This research incorporates the notion of multiple paths occurring over sequential and co-occurring time periods. Three different categories of paths emerged in the research: technical, commercialisation and hybrid. The contribution of a hybrid path category is based on the mobilisation of different resources quantities when compared to the previous two path types, thus extending research into innovation paths previously conducted by Thrane et al., (2010). A hybrid innovation path mobilises knowledge, financial and social capital to approximately similar strength, combing the resource mobilization characteristics of both commercialisation and technical paths.

The following research questions are developed:

1. How does resource mobilisation influence innovation paths?
2. How does the co-occurrence of events along multiple innovation paths influence future possible paths?

The remainder of this article is structured as follows: The next section presents the literature review in resource mobilisation, event categorisation and time, followed by a description of the innovation paths. These concepts are then linked together to highlight how they each contribute to innovation processes. The following Methodology and Data section presents the methodology adopted for the study and description of the case data. The final section presents the results, findings and implications for theory and practice, as well as ideas for furthering the research.

LITERATURE REVIEW

RESOURCE EXCHANGE WITHIN INNOVATION PROCESSES

The mobilisation and re-configuration of resources within the innovation process is unique to each innovation (Lichtenstein & Brush 2001) and encourages creative processes leading to innovation emergence (Andriani 2011). While the types of resources used within innovation processes varies according to the case context (Lichtenstein & Brush 2001) this research categorises resources into three broad categories: financial capital, social capital and knowledge, similar to Gupta and Govindarajan (1991). We further separate knowledge into exploratory and exploitative knowledge given the different innovation paths that emerge (Thrane et al. 2010).

Resources change through interaction processes: e.g. financial capital can be used to develop knowledge resource and social capital and vice versa. Other examples include exploitative knowledge and social capital successfully deployed leading to the accumulation of financial capital in the terms of sales (Ostendorf et al. 2014). Resource exchange varies over the lifetime of the innovation process and is not linear (Van de Van et al 2008). In particular, ambidextrous innovation processes require the deployment of different types of knowledge resources (exploitative/ exploratory) either concurrently or sequentially with the proportion of the different types varying over time (Lin et al. 2013; Simsek et al. 2009).

Another important aspect of resource mobilisation is the timing of the exchange processes relative to other resource exchanges occurring within the same time period (Purchase et al. 2014; Land et al. 2012). Resource exchange processes are embedded within a resource exchange constellation where innovation emerges from the bottom-up behaviours of individual exchange processes. For innovation to emerge these resource exchange processes need to re-inforce each other. For example financial resources exchanged with exploratory knowledge have a strong association with the number of innovations developed (Land et al. 2012). Or the exchange of financial resources with both exploratory and exploitative knowledge within the same time period (e.g. ambidextrous innovation) leads to successful innovation networks (Purchase et al. 2014).

INNOVATION PROCESSES

Mobilisation of resources occurs through innovation processes. Innovation processes recombine heterogeneous resources towards the development of new products or services

(Andriani 2011; Arthur 2009). In particular, Arthur (2009) describes innovation processes as recombining existing technologies into different configurations to develop new solutions to problems where some novelty has been produced. Andrini (2011, p. 464) extends this definition further to also include the "discovery of new applications for existing technologies".

Focusing on innovation processes allows investigation of how past events may influence future events and/or paths thus, incorporating a temporal dimension into the research (Medlin 2004). Therefore, processual research considers changes over time (Purchase et al., 2008) and can incorporate complexity approaches and thinking during the analysis.

Innovation processes have also been considered in stages (e.g. Vohora et al. 2004; Ndonzuau et al. 2002; Gabrielsson & Gabrielsson 2013; Ostendorf et al. 2014), though there is no consensus between the number of stages of development, on the activities done within each stage, or on the inclusion of feedback and resources used. For example, when considering university spin-off organisations, Ndonzuau et al. (2002), developed four stages: business idea generation; new venture project selection; organisational launch; and strengthening economic value. Vohora et al. (2004) instead described five stages: research phase; opportunity framing phase; pre-organisational phase; re-orientation phase and sustainable return phase. These stages models have been criticised for being too linear in their perspectives (McCarthy et al. 2006; Andriani 2011). The notion of innovation stages has been used in this research where the focal case was split into two stages closely corresponding to the opportunity framing phase and pre-organisational phase (Vohora et al. 2004) or the business idea generation and new venture project selection stages (Ndonzuau et al. 2002).

For this research, innovation processes are made up of events occurring through time in which resources are recombined towards the development of novel ideas. This approach is similar to Van de Van et al. (2008) who investigated the development of innovations through the different events and interactions undertaken by the focal organisation's push towards product development.

INNOVATION EVENTS

Events are defined as "temporally specific outcomes of performed acts by actors" (Hedaa Törnoos 2008, p. 324) and require the mobilisation of resources during the performance of the event (Chou & Zolkiewski 2012). Van de van et al. (2008) investigates innovation through

analysis of the events that occur during innovation processes and highlights that different categories of events contribute to innovation: learning events, administrative events, leadership events etc.

Resource exchange varies over different life stage within innovation processes (Clarysee & Moray 2004; Gabrielsson & Gabrielsson 2013) with important events occurring between the stages. These events have been termed: critical junctures (Vohora et al. 2004); episodes (Ostendorf et al. 2014); event categories (Van de Van et al. 2008) and milestone events (Chou & Zolkiewski 2012).

Previous research has tended to focus on the most important events, while Halinen et al. (2013) indicates that concentrating on just the important events may miss critical network processes. Therefore, they indicate that research should include critical, related and background events to encompass a broader understanding of network dynamics. This research incorporates these ideas and codes the innovation events into critical, related and background events.

Also event occurring in multiple paths within the same time period is another aspect which needs to be considered. Previous research highlights that co-occurring events influence future paths (Purchase et al. 2014b) while Araujo and Harrison (2002) indicate that lock-in events reinforce paths towards particular aims.

TIME

Past events influence possible future events (Chou & Zolkiewski 2012) and therefore incorporating time is an important component of this research. Rather than focusing on chronological time we will be considering event time (Orlikowski &Yates 2002), particularly for investigating resource exchange within critical innovation events where the stages categorisation was split according to event time (the decision to focus on the innovation).

Both event time and chronological time are used in the development of the paths. Chronological time is used to consider which events co-occur in the same time period and event time is used for considering which events from the data collection process to include within the path analysis. For example interviewees discussed important innovation processes through event time as they outline events with the greatest impact, which the researchers then triangulated with the secondary data to analyse the co-occurrence of the events within chronological time.

METHODOLOGY AND DATA

A single case study was conducted into the development of a product innovation within a private research and development (R&D) organisation in the renewable energy sector in Australia. This method is considered suitable as it allows the researcher to explore in detail the emergence of the innovation through multiple perspectives and gain rich insights on novel phenomena and the process of capital raising by the focal organisation, which was unique (Yin 2009).

The case is a company developing a wave energy device that is targeted at the sustainable electricity market. This case is unusual because the company followed a different growth strategy from other private innovation companies in that they did not solely rely on venture capitalist funding during the early stages, but rather listed the small innovation company on the Australian Stock Exchange (ASX) to raise capital. The ASX allows companies to list for extremely small amounts of capital and is a capital funding process which is commonly used in Perth, Western Australia, within the resources sector and fairly unique to the ASX. This capital raising process has meant that the company needed to meet the reporting requirements of the ASX and Australian Securities and Investment Commission (ASIC). These reporting requirements can be onerous for small companies, thus, there is a large amount of secondary data was available from the ASX and the company website. The ASX transparency requirements also mean that innovation processes have been open to public scrutiny over their lifetime and consequently influencing the innovation processes, especially in relation to governance structures.

Data consisted of both face-to-face interviews and publically available secondary data such as newspaper articles, grant information, blogging sites and websites. The organisation listed on the Australian Stock Exchange (ASX) in 2003 and under the reporting standards an Australian listed company has to make announcements to the ASX whenever a major change or development occurred. These announcements, over the last 12 years, were extensively used in the analysis, similar to Bairstow and Young (2012). Table 1 gives details of the interviewees, their current position and a brief description of their involvement.

Table 1 Interviewee Details

	Current Position	Involvement
Interview A (2007 - present)	Chief Operating Officer (COO)	Originally employed as a Business Development Manager and has since been promoted to COO
Interview B (2005 - present)	Managing Director and Board Member	Originally employed as Manager of Innovation and Technology and has since been promoted to MD
Interview C (Intermittently 1995 – present)	Private Investor and Board Member	Originally managing investment through a venture capital fund in 1995; then through an energy company 2002 – 2004; then as a private investor and lastly board member due to experience in the industry
Interview D (intermittently 2002 - present)	Board Member	Originally managing investment of an energy company 2002 – 2004; board member due to experience in the industry

Interviewees were asked to give their story around the development of the innovation, relationships developed, resources required and the strategic and business model changes undertaken during the time period. All interviews were transcribed and sent back to interviewees for comment.

CASE DESCRIPTION

The company emerged from diversified private organisations to focus on the development of wave energy devices for electrical power generation. The original companies were involved in other sustainability technologies, mining exploration, development of technology for the rural industry and marine technologies (including recreational devices). It was the combination of the inventor's enthusiasm for the marine environment and previous ideas within the rural sector that lead to the development of the wave energy device. Yet, it took a number of years before the organisation focused on wave energy for electrical power generation. Focus began in the mid-2000's and towards 2007/8, they were exclusively focused on wave energy opportunities. The event analysis tells the story of the organisation since 1975 to present. The company has currently installed devices in Australia and France and there are currently a number of other opportunities under investigation (as can be seen in the Event Paths tables in Appendix B).

The analysis was split into two life stages of the organisation: processes occurring prior to the decision to focus on the current technology, and processes occurring post focal innovation

decision. Given the number and diversity of processes occurring within each life stage, innovation paths were developed.

Data Analysis

Data analysis consisted of two steps: (1) analysis of interviews and documentary data through Leximancer (Smith & Humphreys 2006); and (2) analysis of innovation processes through an event-based approach (Halinen et al. 2013). Results from both steps were then compared to determine if the 'stories' aligned and then merged to portray a richer description. The results of the Leximancer analysis assisted in the interpretation of the events developed for the second step, in that concepts that emerged related to events were considered critical events, thus helping with their classification.

RESULTS

Leximancer Analysis and Results

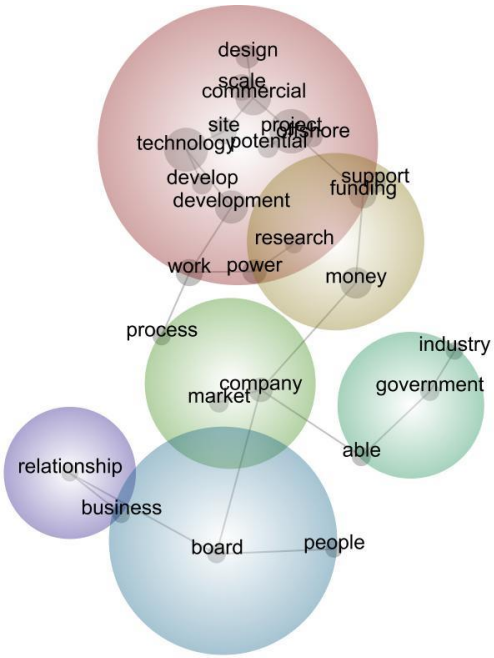
Interviews and documentary data (in particular the ASX announcements) were analysed using the Leximancer software to construct a semantic map of multiple actor perceptions of how the innovation developed. Leximancer has been used as a qualitative data analysis tools on a number of projects (e.g. Munksgaard & Medlin 2014) and uses a learning algorithm to develop clusters of related concepts, which are grouped into themes to derive a semantic network (Smith & Humphreys 2006). This approach is expected to reduce coder biased, hence improving reliability (Penn-Edwards 2010). However, the researcher controls a number of parameters (e.g., number of themes and concepts) that are included in the analysis based on the research questions and richness of information available for analysis. The researcher is still involved in the interpretation of the data. Leximancer develops a hierarchy of themes and concepts, which are displayed on the semantic map for visual interpretation (Leximancer Manual 2011).

The Leximancer analysis considers how the data perceived changes occurring over time. Table 2 gives the five most connected themes, their related concepts, and descriptions. Theme connectedness (%) is also shown, highlighting the dominating themes. Figure 1 highlights the semantic map output from the Leximancer analysis. The strongest connected themes are indicated in hot colours (e.g. red), and then decrease in strength to the cool colours for the weaker themes (e.g. blue).

Table 2 Leximancer Theme Results

Theme/ connectedness	Concepts	Descriptions
Project 100%	project, commercial, site, scale, design, potential	• Commercialisation of other technologies • Commercial deployment of wave energy device through projects at various sites • Commercial activities at various mineral sands sites • Technical development of the various technologies as part of commercialisation • The technologies being commercialised are those with potential
Technology 80%	technology, development, work, power	• Various types of work performed to develop wave energy device and other technologies • The people and influences that affect wave energy device development and other technologies • Technologies are aimed at power market
Money 42%	money, funding, support	• Money issues related to innovation development • Acquiring money for innovation development • Money supports technology and projects
Company 19%		• Companies involved in early stage of the commercialisation effort • Company as a listed company • People in the company • Involvement in other technologies, include the wave energy device • Suppliers/Partners/Investors that deal with the company
Government 13%		• Government as a background influence – government provides funding, support/non-support for renewable energy • Getting funds from government - money received from government, importance of funds to projects, and conditions of getting funds • Working with government – challenges and attempts to influence government

Figure 1: Leximancer Semantic Map



The Leximancer analysis indicated a number of important findings which are incorporated with the event analysis later in the paper:

- The company focused on the commercialisation of the wave energy device and other technologies which they believed to have potential. Eventually, it focused solely on the wave energy device. The focus was not just on the single device but also on various versions of the device.
- Commercialisation effort is aimed at power energy market which is controlled by government. So government is both a customer (energy market) and the provider of grant monies which makes the relationship with government multifaceted. Therefore, business development efforts need to consider resources from both sales and grant funds.
- Acquiring money to support the technology and projects is an important part of commercialisation. This finding is not new and reinforces other research on the importance of mobilising financial resources during innovation development. In this case grant funds were critical to development projects and that if government grant funds were not available, the company would not pursue opportunities with those countries.
- Technology and project development are closely related. Each project needs to be designed and devices adapted around the natural environment for project installation. As the natural environment is different for every installation it is difficult to separate device innovation from project installation. Therefore, context of the natural environment plays an important influence on innovation path development. Consequently separating technical and commercialisation paths may be difficult and a hybrid path concept is developed for this case. More detail is provided in the discussion section.

- Commercialisation involves many different companies – not just the effort of a sole company. This finding highlights the importance of the large variety of organisations involved in the innovation's development, including suppliers who worked selectively with them to develop components, knowing there will be limited short term return; government as both critical funding source (grant funds) and customer (natural environment sovereign issues); communities in which installation is to occur; and competitors within the electrical generation market including non-renewable and renewable technology providers.
- Government support influences the commercialisation path. This finding highlights that government influences how innovation develops, through being both customers and grant fund provider. Therefore, interaction with government s (both domestic and international) is an important component in managing innovation paths in this industry.

CRITICAL EVENT AND DECISION ANALYSIS RESULTS

This methodological approach is based on Halinen et al. (2013) where events and decisions were coded along an event time line to develop a case history. Step 1 involved initial event coding broadly developed from the following categories: innovation processes; organisational changes; resource re-configurations and actor interactions. This was undertaken based on the documentary evidence which is available from public sources, particularly ASX announcements.

Through this exercise, it is observed that events formed paths relating to decisions influencing each path. Step 2 maps out these paths, which are presented in Appendix B. The events surrounding the paths are coded into three categories: critical, related, and background (Halinen et al. 2013). Critical events were coded using three criteria: (1) interviewees (who were involved in innovation processes for that time period) mentioned the event as important; (2) the event emerged in the concepts of the Leximancer analysis; and (3) it radically changed the innovation development (following the definition proposed by Van de Van et al. 2008, p. 73). For instance, in Path 2-3 (as shown in Appendix B2), the various funding awarded from government are identified as critical events because: (1) the importance of government funding for the commencement and progress of projects was mentioned in the interview:

"Whether [the specific project being discussed] comes to fruition… depends on how successful we are in getting some government grant funding". (Managing Director and Board member)

(2) Funding from the government has been identified as an important concept within the "Money" theme in Leximancer result, and (3) the failure of acquiring government funding has led the company to abandon some of its projects.

Related events were coded as having a direct influence on critical events, while events having an indirect influence were coded as background events. For instance, in Path 2-3, events like "Search for commercial opportunities" and "Design and construct desalination plant" are identified as related events because they either directly lead to or result from the critical events of receiving government funding. The background events, for instance, "Australia's government announced new climate change initiative" are identified as events that shape the environment in which critical events occur. Table 3 summarises the number of event categories for the paths for each stage.

Table 3 Event Coding

Stage/Path	No. Critical Events	No. Related Events	No. Background Events	Lock-in Events[1]
1-1 Obtaining full ownership of technology	5	13	22	1
1-2 Initial technical development	5	14	12	1
1-3 Initial commercialisation	13	14	12	2
2-1 Continued technical development	7	31	12	1
2-2 Continued commercialisation	9	30	15	1
2-3 Initial commercial project	6	16	11	4

Decisions that influence the paths were coded according to whether they displayed "lock-in" characteristics along that particular path – in other words, the possible path in future time is constrained by previous decisions. In Path 2-3 example, the events with "lock-in" characteristics are the various grant funds awarded by government which enable the project to proceed. Although the same decision can occur across multiple paths, the "lock-in" effect may be unique to one path and not another. For example, securing the southern hemisphere (SH) license is a "lock-in" event for path 1-3 and a critical event in path 1-1. See Appendix B for details.

[1] These refer to total number of unique events with lock-in characteristics at each stage.

In Step 3, each path was categorised as either technical, hybrid or commercialisation based on the types of events occurring along the path, as shown in Table 4. Each path was investigated in more detail, with a particular focus on the overall resource mobilisation. Resources were categorised into finance; knowledge (exploratory/exploitative) and social capital (SC) (Purchase et al. 2014). For each event, resources were coded into low (1), medium (2) or high (3), as shown in Appendix A. Table 4 shows a summary of the results. Figures 2 and 3 summarise the results separately for technical, hybrid and commercialisation paths. Exploratory and exploitative knowledge were summed together for Table 4, for ease of visualisation in Figures 2 and 3.

Table 4 Summary of Resource Mobilisation in Innovation Paths

Stage - Path	Lock-in Event/(s)	Path Category	Knowledge Resources	Financial Resources	Social Capital
1-1 Obtaining full ownership of technology	Develop and test prototype	Hybrid	24	25	25
1-2 Initial technical development	Develop and test prototype	Technical	39	25	24
1-3 Initial commercialisation	Secure SH license & AIM-listed company formed to commercialise innovation	Commercialisation	19	37	49
2-1 Continued technical development	Achieve milestones for ver 3 test	Hybrid	48	42	64
2-2 Continued commercialisation	Acquire 100% of IP	Commercialisation	25	41	64
2-3 Initial commercial project	4 grants awarded to the total of $AUD 29 mill	Commercialisation	13	28	49

Figure 2: Resource Mobilisation for Technical and Hybrid Paths

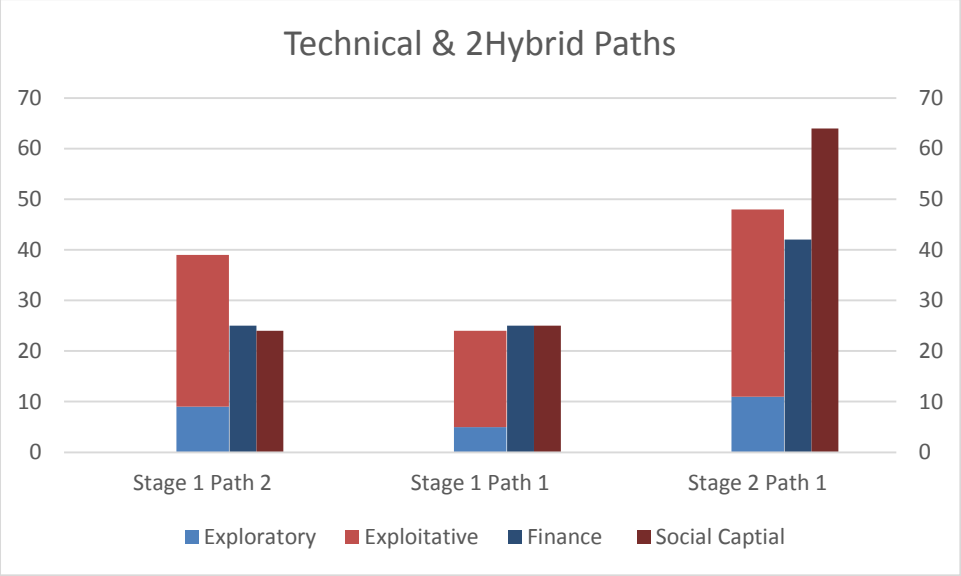
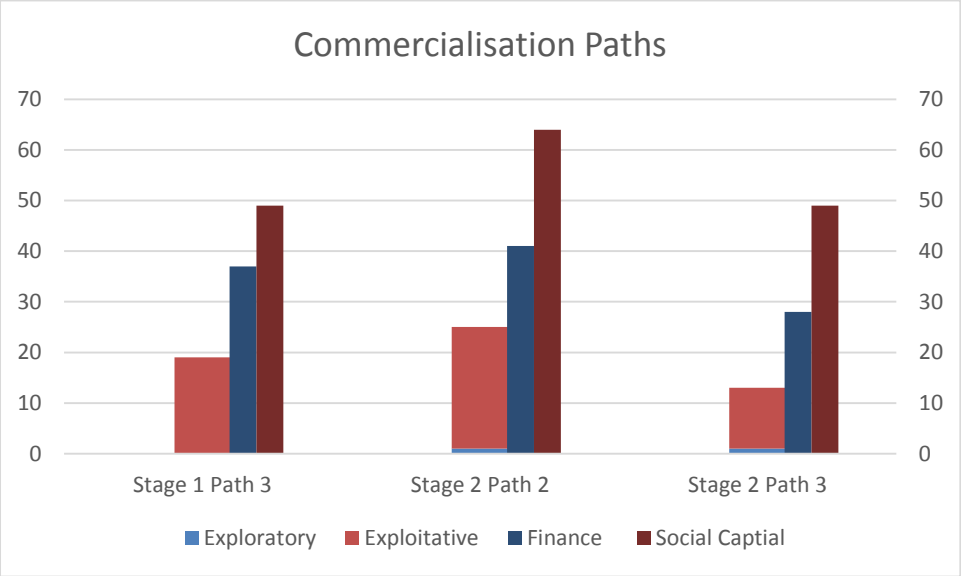


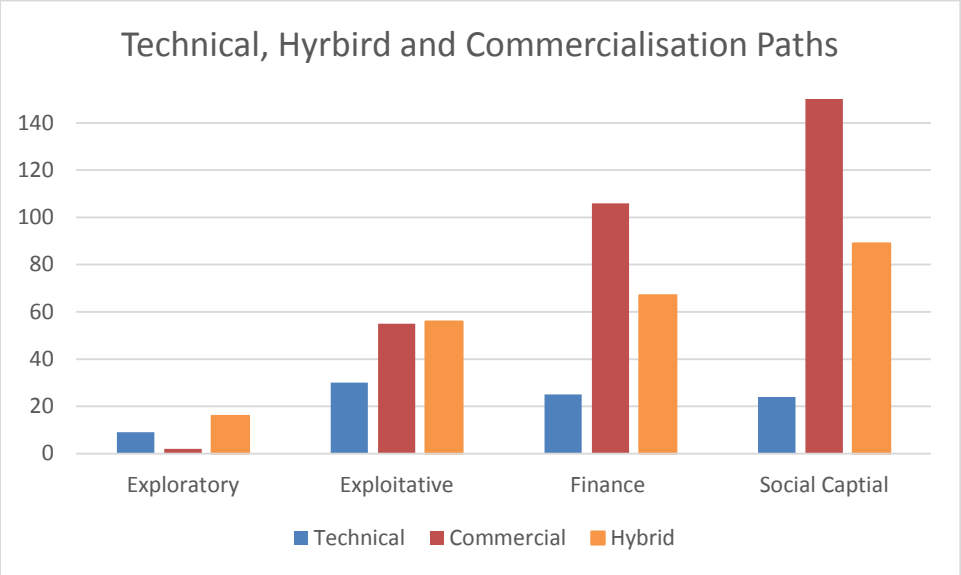
Figure 3: Resource Mobilisation for Commercialisation Paths



As Figures 2 and 3 illustrate, the number of commercialisation paths is higher than the number of technical or hybrid paths. This highlights the importance of commercialisation along an innovation trajectory. The figures also show that in the technical path, exploitative and exploratory knowledge resources are dominant in relative terms (compared to the total resources) whereas exploratory knowledge is not mobilised to a great extent along the commercialisation paths. Instead, in the commercialisation paths, social capital is particularly important. The graph also indicates that the hybrid path mobilises knowledge, finance and social capital to about the same extent, rather than distinct differences as per the other path categories.

Figure 4 provides a comparison of the summation of resource mobilisation for all technical, hybrid and commercialisation innovation paths: i.e. overall trajectories.

Figure 4: Summated Resource Mobilisation for Technical, Hybrid and Commercialisation Paths



The results highlight the importance of social capital and finance resources within the commercialisation paths and the importance of the commercialisation paths within the development of this innovation. The hybrid path contributes to existing research within paths as it highlights the equal importance of all resource combinations and the innovation context influencing the types of paths that emerge.

Step 4 considers the events that occur along the paths and investigates the commonality of events within similar time periods. The findings, indicated in Table 5, emphasise the influence of common events across the different paths and how this influence future possible paths that may emerge. Path numbering, previous given in Table 4, and event coding indicates how an event has been coded across the different paths. Common events occurring across all three paths in each stage were not included in the count for those events occurring across two paths only.

Table 5: Common Events

Common Paths	No. of common events: Event coding				Total Unique Events
	critical and 2 related	critical and related	all related	all critical	
1-1, 1-2, 1-3	**5**				5
1-1, 1-2		**1**	2		3
1-1, 1-3		**4**	2		6
1-2, 1-3		**4**			4
2-1, 2-2, 2-3	**3**		1		4
2-1, 2-2		**3**	8		11
2-1, 2-3		**5**	1	1	7
2-2, 2-3			2		2

The tally suggests that although there are more total unique common events in Stage 2 (24) than Stage 1 (18), the number of common events that were coded critical (bold) were much higher for Stage 1 (e.g. 14) than for Stage 2 (e.g. 11). These findings indicate that before the decision to commercialise the focal innovation was made, there were a number of critical events occurring across multiple paths that were converging towards this important decision.

DISCUSSION

Research Question 1: How does resource mobilisation influence innovation paths?

The first major contribution from the findings above is the inclusion of the hybrid innovation path. Previously, Thrane et al. (2010) highlighted two paths: innovation and technical, while Purchase et al. (2014b) also incorporated two paths: commercialisation and technical. This case found another path, hybrid, which is described as a path which requires technical development around the project in which the innovation is to be embedded (i.e. commercialisation processes).

In the context of this particular case, the innovation needs adaptation for each environment in which the energy device is embedded. Therefore, there is an extensive requirement for technical development during the project implementation process (commercialisation phase). Much of the previous research focuses on innovations which can be replicated as “use” can be

consistently applied to many situations. For example, Ostendorf et al. (2014) highlight the development of a quick drying masonry paint for which its "context in use" (Håkansson et al. 2009) is consistent.

This finding emphases the importance of considering "context in use" during resource mobilisation in commercialisation processes, given it is not consistent for this application. The requirement for extensive technical development – even after the device itself if fairly stable – impacts not only on the mobilisation of context specific knowledge resources (in this case design to suit the natural environment) but also extensive financial resources and social capital to support added technical development.

Hybrid paths differs to technical paths in that the technical development is aimed at the unique natural environment while there are also strong commercialisation processes to achieve access to the site; and that grant funding to proceed with the research and profits through the sales of the technology occurs within the same path. This importance of "context-in-use" within this case supports the argument that different innovations require different resource exchange and therefore follow unique paths (Lichtenstein & Brush 2001).

Research Question 2: How does the co-occurrence of events along multiple innovation paths influence future possible paths?

The findings also highlight the difference made by co-occurrence of critical events across paths between the stages. The commonality of critical events across paths, rather than only related events, influences the innovation process towards a convergence of the innovation paths around innovation choices. Once the technology choice of focusing on this particular energy device had been made, the convergence around critical events decreased. Thus, indicating that when events are common across paths and are critical along one path, the innovation processes converge around these particular events.

IMPLICATIONS

Government plays an important multifaceted role in that they are the financiers (grant funding); customer (electrical power producer); and site owner (sovereignty issues around the natural environment). Therefore, the business relationships between the focal company and various government authorities requires different resource mobilisation processes and will also impact the different paths that emerge. One of the impacts of events that include government

authorities does result in lock-in events (paths 2-1 & 2-3) with some authorities and not with others. Therefore, relationship development will require consistent messages and social capital strategies, while at the same time evaluating possible lock-in events.

CONCLUSION

In conclusion this research investigates the types of resources mobilised along different innovation path categories. An important contribution is the development of a hybrid innovation path where knowledge, finance and social capital resources are equally mobilised. The limitations to these research findings is the uniqueness of this innovation which requires further adaptation and research for every implementation scenario, thus, emphasising the hybrid path category. Further research needs to investigate whether the hybrid path category develops for other innovation developments.

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APPENDIX A

Table 6: Resource allocations for Innovation Paths

Stage/Paths	Exploratory knowledge	Exploitative knowledge	Financial	Social Capital
1-1 Obtaining full ownership of technology				
Inventor conceived various inventions	3	0	0	0
First rename of the company	0	0	1	0
Decide to expand beyond mining to technologies	0	0	0	0
Investigate wave device	0	1	1	0
Acquired 50% of the wave device	0	2	1	3
Awarded $600,000 AusIndustry fund	0	0	1	1
Formed joint venture	0	1	2	3
Develop & test prototype	2	3	2	3
AIM-listed company formed to commercialise wave device	0	1	3	3
AIM-listed company acquired joint venture	0	3	2	3
Recruit Manager of Innovation &Tech	0	1	1	0
Decide to focus on clean energy	0	1	0	0
Separate mining activities	0	0	2	0
Secure SH license	0	3	3	2
Raised $5.75m from SP	0	0	2	1
Second rename of company	0	0	1	0
Acquire 100%IP	0	3	3	3
Restructures board	0	0	0	3
1-2 Initial technical development				
Inventor conceived various inventions	3	0	0	0
Initial desktop design	0	3	1	0
Investigate wave device	0	1	1	0
Perform wave tank testing	0	2	1	0
Acquired 50% of the wave device	0	2	1	3
Formed joint venture	0	1	2	3
Awarded $600,000 AusIndustry fund	0	0	1	1
Brainstorm on design	1	3	0	3
Assemble team & construct plan	0	0	1	2
Develop & test prototype	2	3	2	3
AIM-listed company acquired joint venture	0	3	2	3
Developed & tested ver 2	1	3	2	1
Refine ver 2 design	1	3	0	0
Raised $14.8m for innovation & tech	0	0	2	1
Sold AIM-listed company shares	0	0	2	0
Raised $1.18 from SPP & SP	0	1	2	2
Prelim design for demo project in Aus	0	2	0	0
Raised $5.75m	0	0	2	1
Developed ver 3	1	3	3	1
1-3 Initial commercialization				
Acquired 50% of the wave device	0	2	1	3
Awarded $600,000 AusIndustry fund	0	0	1	2
Formed joint venture	0	1	2	3
AIM-listed company formed to commercialise wave device	0	1	3	3
AIM-listed company to acquire joint venture	0	3	2	3
Secure SH license	0	3	3	2
Raised $14.8m for innovation & tech	0	0	2	1
Made proposal for demo in Aus	0	2	1	0

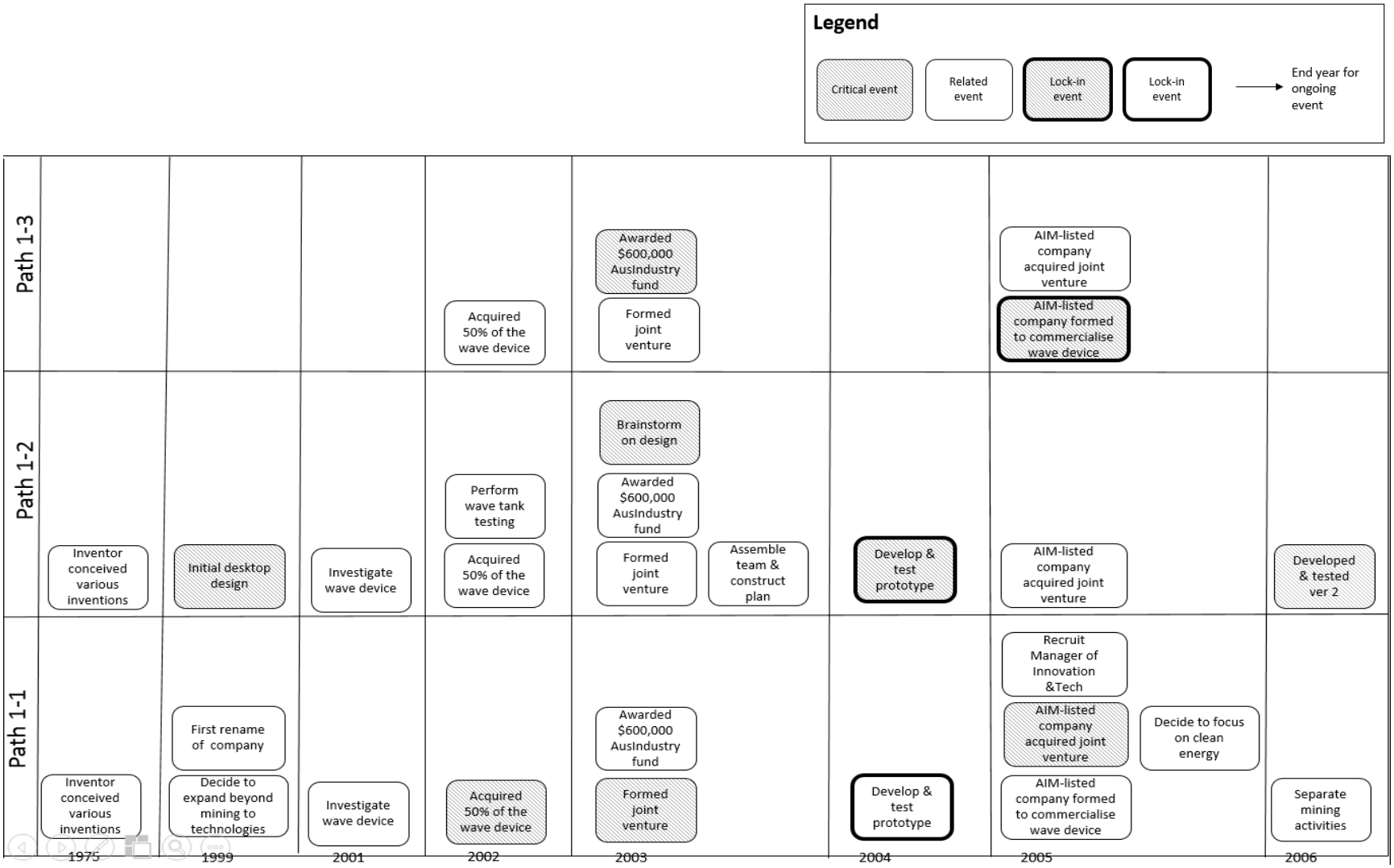
Search for commercial opportunities	0	0	0	0
Formed French partnership	0	1	2	2
Sold AIM-listed company shares	0	0	2	0
Raised $1.18m from SPP & SP	0	1	2	2
Raised $2.5m through PP	0	0	2	2
Formed Canadian subsidiary	0	0	1	2
Awarded CAD$2m Canadian project	0	0	2	2
Formed Bermuda partnership	0	0	1	1
Applied for Bermuda demo	0	2	1	0
Presented at conferences & seminars	0	0	1	2
Receive license to investigate various Aus sites	0	0	0	2
Entered discussion for desalination project	0	0	0	1
Raised $5.75m from SP	0	0	2	1
Acquire 100% IP	0	3	3	3
Restructures board	0	0	0	3
Second rename of company	0	0	1	0
Awarded £3m for French project	0	0	2	3
Signed MoU to investigate offshore site	0	0	0	3
Awarded $12.5 LEED fund	0	0	0	3
2-1 Continued technical development				
Developed ver 3	1	3	3	1
Raised money	0	0	3	3
- Raised $8.865m from SPP & SP	-	-	-	-
- Raised $6m from SPP	-	-	-	-
- Raised $4m from SP	-	-	-	-
- Raised $6m from SPP	-	-	-	-
- Raised $5.8 from govt & private	-	-	-	-
- Secure $16.3m funding	-	-	-	-
- Raised $9.5m from SPP PP	-	-	-	-
- Raised $9m from SPP &PP	-	-	-	-
Select offshore site for ver 3 test	0	0	0	2
Awarded $12.5 LEED fund	0	0	0	3
Achieve milestone for ver 3 test	0	3	0	2
Presented at conferences & seminars	0	2	1	1
Milestone payments from funding	0	0	3	0
Collaborate on French project	0	0	2	3
Developed ver 4	1	3	0	3
Developed ver 5	1	3	2	2
Deployment of ver 4 failed	0	0	1	0
Awarded $9.9m ARENA fund	0	0	0	3
Awarded $5.5m LEED fund	0	0	0	3
Select offshore site for commercial project	0	0	3	2
Design & construct commercial project	0	3	3	3
Received $2.26m R&D tax refund	0	0	2	0
Awarded $1.27m for desalination	0	0	0	3
Raised $4m from convertible notes	0	0	2	0
Partner to research device array	1	3	2	3
Continue tech development	0	0	0	0
Developed ver 6	1	3	0	2
Design & construct desalination plant	0	3	2	1
Secure $20m CFC loan	0	0	3	3
Select sites for ver 6	0	0	2	0
Awarded $11m fund for offshore site	0	0	0	3
Awarded UK site for ver 6	0	0	0	3
Awarded EU fund for ver 6	0	0	2	3
Collaborate on tidal & wave research	1	2	1	2
Partake in CSIRO study	1	2	2	2
Partner U. Adelaide for ver 6 research	1	3	0	2

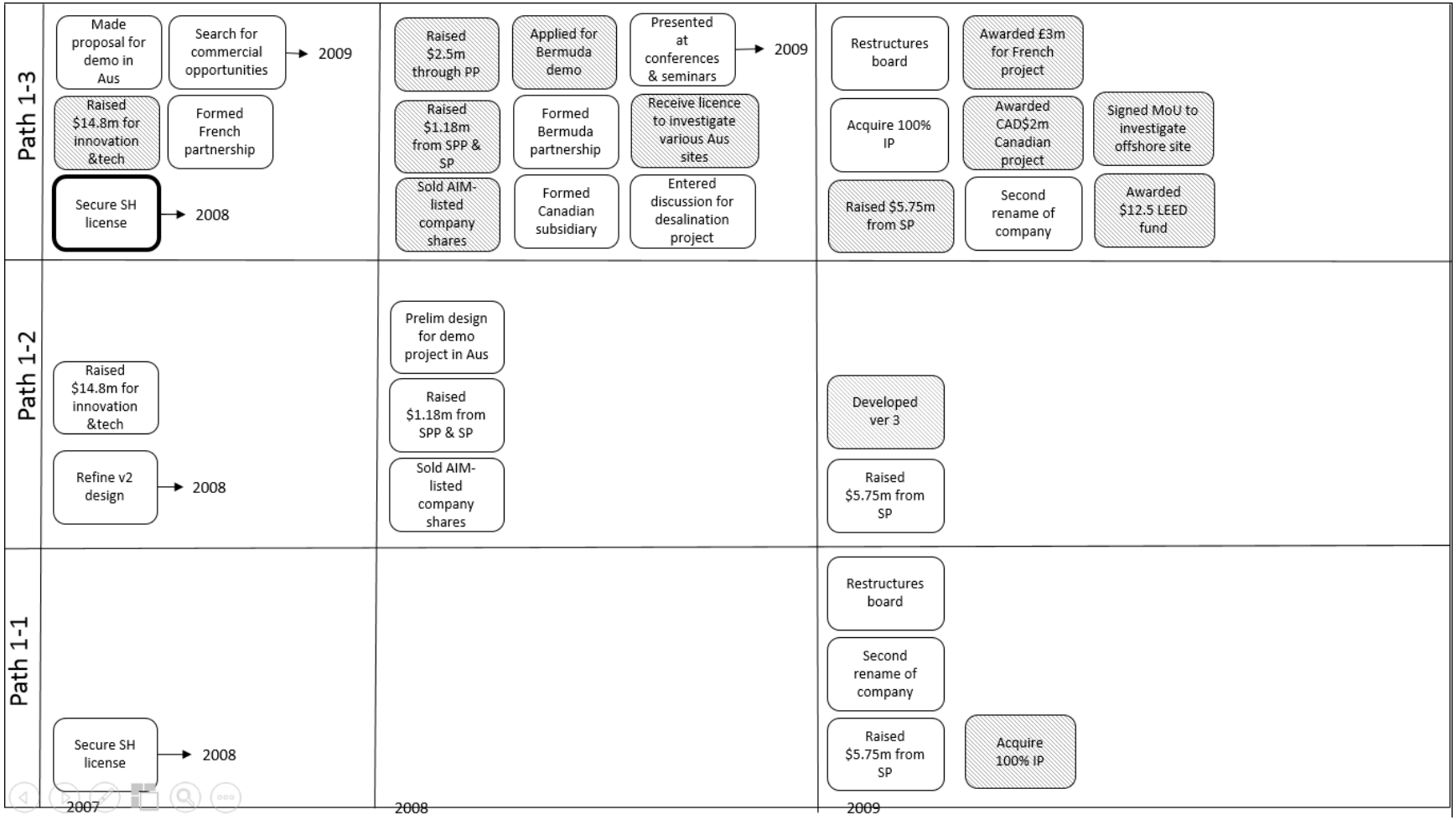
Collaborate to develop WavePOD	2	2	1	3
Partner SAMS for environmental research	1	2	2	3
2-2 Continued commercialization				
Acquire 100% IP	0	3	3	3
Raised money	0	0	3	3
- Raised $8.865m from SPP & SP	-	-	-	-
- Raised $6m from SPP	-	-	-	-
- Raised $4m from SP	-	-	-	-
- Raised $6m from SPP	-	-	-	-
- Raised $5.8m from govt & private	-	-	-	-
- Raised $9.5m from SPP & SP	-	-	-	-
Investigate Canadian site	0	3	2	2
Re-formed agreement with French partner	0	0	0	2
Bermuda demo selected	0	0	0	1
Search for commercial opportunities	0	0	0	0
Perform feasibility assessment at various site	0	3	2	2
Presented at conferences & seminars	0	2	1	1
Collaborate on French project	0	0	2	3
Signed agreement to develop Irish project	0	0	0	3
Formed Irish subsidiary	0	0	1	2
Awarded €74,000 for Irish project	0	0	2	3
Milestone payments from funding	0	0	3	0
Developed ver 4	1	3	0	3
Failure to secure Canadian funding	0	0	0	0
Establish Chilean subsidiary	0	0	1	2
Determine & investigate site in Ireland	0	3	2	2
Hosted various visitors	0	2	1	1
Deployment of ver 4 failed	0	0	1	0
Awarded $9.9m ARENA fund	0	0	0	3
Awarded $5.5m LEED fund	0	0	0	3
Secure $16.3m funding	0	0	3	2
Complete Bermuda site assessment	0	3	2	2
Awarded $1.27m from desalination	0	0	0	3
Received $2.26m R&D tax refund	0	0	2	0
Raised $4m from convertible notes	0	0	2	0
Formed UK subsidiary	0	0	1	2
Partner WCWI for research	0	2	0	2
Secure $20m CFC loan	0	0	3	3
Select sites for ver 6	0	0	2	0
Awarded EU fund for ver 6	0	0	0	3
Awarded UK site for ver 6	0	0	0	3
Awarded $11m fund for offshore site	0	0	0	3
Raised $9m from SPP & PP	0	0	2	2
2-3 Initial commercial project				
Awarded $12.5 LEED fund	0	0	0	3
Select offshore site for ver 3 test	0	0	0	2
Raised $8.86m from SPP & SP	0	0	2	3
Search for commercial opportunities	0	0	0	0
Achieve milestones for ver 3 test	0	3	0	2
Signed MoU to investigate offshore site	0	0	0	3
Milestone payments from funding	0	0	3	0
Raised $6.2m from SPP	0	0	2	1
Develop ver 5	1	3	2	2
Raised $4m from SP	0	0	2	3
Raised $6m from SPP	0	0	2	1
Secure $16.3m funding	0	0	3	2
Awarded $9.9m ARENA fund	0	0	0	3
Awarded $5.5m LEED fund	0	0	0	3

Raised $5.8m from govt & private	0	0	2	3
Select offshore site for commercial project	0	0	3	2
Signed supply & grid connection agreement for offshore site	0	0	0	3
Design & construct commercial project	0	3	3	3
Awarded $1.27m for desalination	0	0	0	3
Raised $9.5m from SPP & PP	0	0	2	3
Formed support agreement for desalination	0	0	0	3
Design & construct desalination plant	0	3	2	1

APPENDIX B1

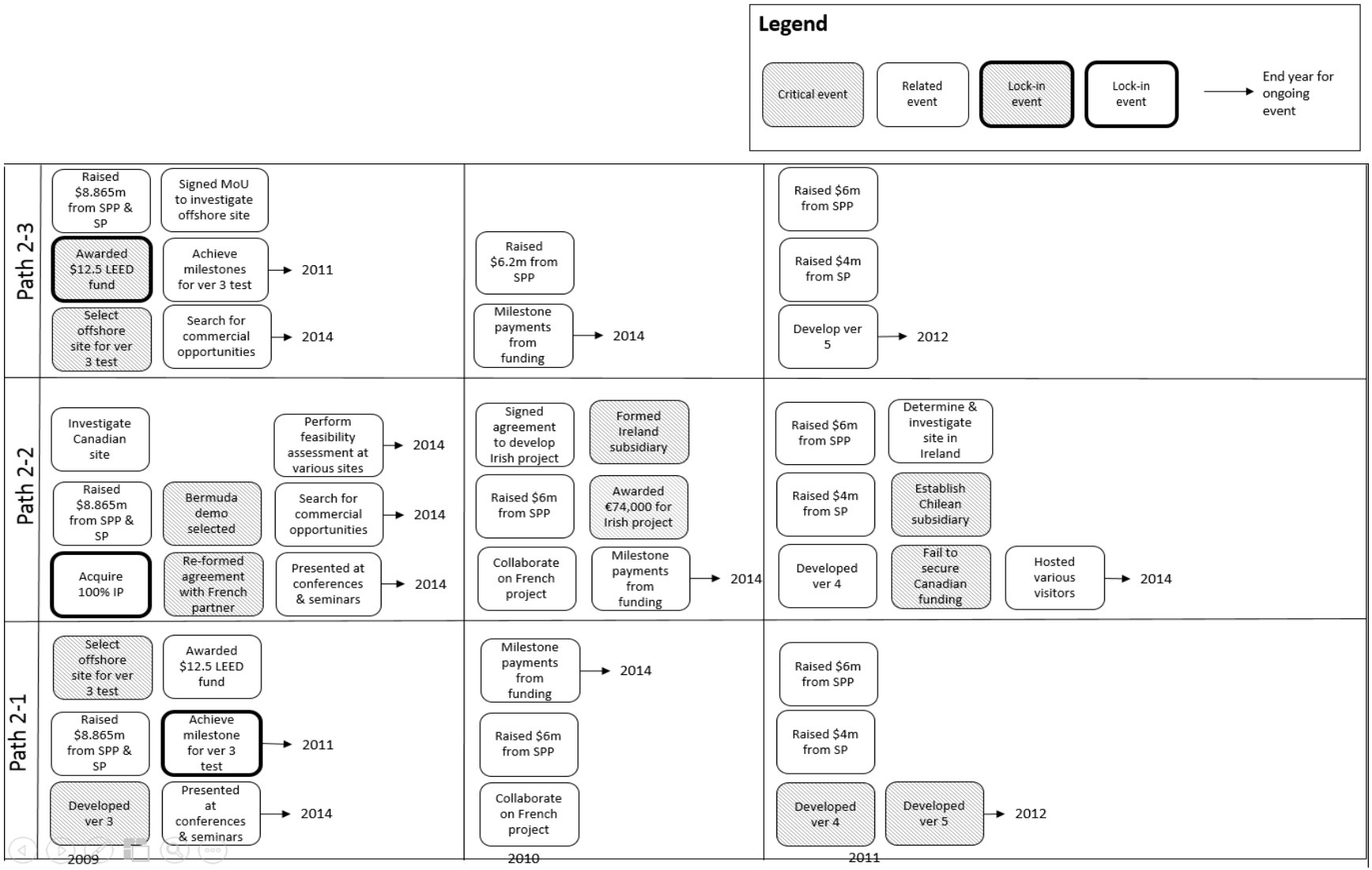
Figure 5: Event Paths for Stage 1 (1975 – 2009)

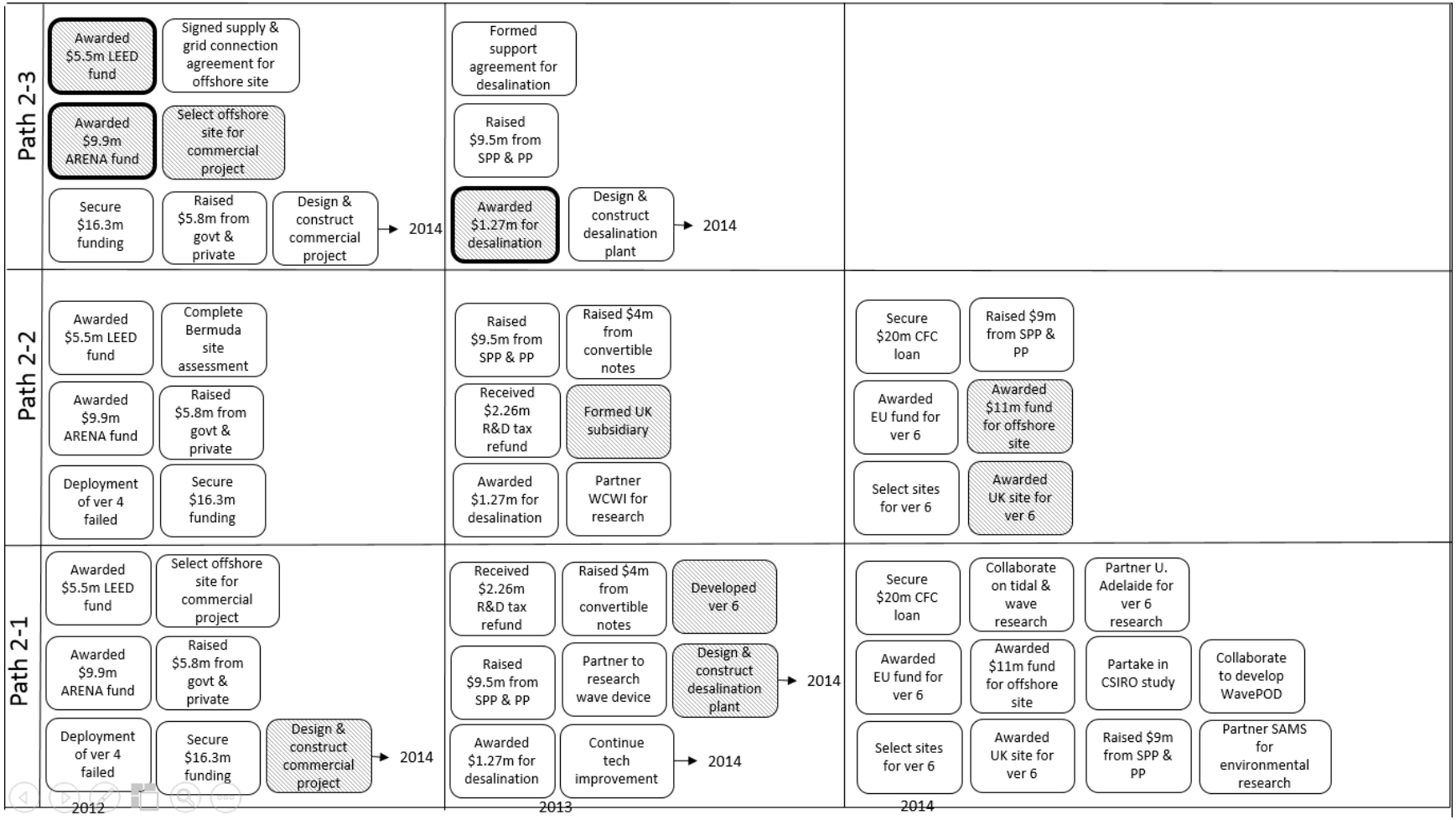



Path 1-3
Made proposal for demo in Aus
Search for commercial opportunities
2009
Raised $14.8m for innovation &tech
Formed French partnership
Secure SH license
2008
Raised $2.5m through PP
Applied for Bermuda demo
Presented at conferences & seminars
2009
Raised $1.18m from SPP & SP
Formed Bermuda partnership
Receive licence to investigate various Aus sites
Sold AIM-listed company shares
Formed Canadian subsidiary
Entered discussion for desalination project
Restructures board
Awarded £3m for French project
Acquire 100% IP
Awarded CAD$2m Canadian project
Signed MoU to investigate offshore site
Raised $5.75m from SP
Second rename of company
Awarded $12.5 LEED fund
Path 1-2
Raised $14.8m for innovation &tech
Refine v2 design
2008
Prelim design for demo project in Aus
Raised $1.18m from SPP & SP
Sold AIM-listed company shares
Developed ver 3
Raised $5.75m from SP
Path 1-1
Secure SH license
2008
Restructures board
Second rename of company
Raised $5.75m from SP
Acquire 100% IP
2007
2008
2009

APPENDIX B2

Figure 6: Event Paths for Stage 2 (2009 – 2014)




Path 2-3
Awarded $5.5m LEED fund
Signed supply & grid connection agreement for offshore site
Awarded $9.9m ARENA fund
Select offshore site for commercial project
Secure $16.3m funding
Raised $5.8m from govt & private
Design & construct commercial project
2014
Formed support agreement for desalination
Raised $9.5m from SPP & PP
Awarded $1.27m for desalination
Design & construct desalination plant
2014
Path 2-2
Awarded $5.5m LEED fund
Complete Bermuda site assessment
Awarded $9.9m ARENA fund
Raised $5.8m from govt & private
Deployment of ver 4 failed
Secure $16.3m funding
Raised $9.5m from SPP & PP
Raised $4m from convertible notes
Received $2.26m R&D tax refund
Formed UK subsidiary
Awarded $1.27m for desalination
Partner WCWI for research
Secure $20m CFC loan
Raised $9m from SPP & PP
Awarded EU fund for ver 6
Awarded $11m fund for offshore site
Select sites for ver 6
Awarded UK site for ver 6
Path 2-1
Awarded $5.5m LEED fund
Select offshore site for commercial project
Awarded $9.9m ARENA fund
Raised $5.8m from govt & private
Deployment of ver 4 failed
Secure $16.3m funding
Design & construct commercial project
2014
Received $2.26m R&D tax refund
Raised $4m from convertible notes
Developed ver 6
Raised $9.5m from SPP & PP
Partner to research wave device
Design & construct desalination plant
2014
Awarded $1.27m for desalination
Continue tech improvement
2014
Secure $20m CFC loan
Collaborate on tidal & wave research
Partner U. Adelaide for ver 6 research
Awarded EU fund for ver 6
Awarded $11m fund for offshore site
Partake in CSIRO study
Collaborate to develop WavePOD
Select sites for ver 6
Awarded UK site for ver 6
Raised $9m from SPP & PP
Partner SAMS for environmental research
2012
2013
2014