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The Marine Renewable Energy Sector Early-Stage Supply Chain

Canada

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Executive Summary

Describing every aspect of a product's creation and delivery to market, a well-defined supply chain sheds light on the maturity, strengths, weaknesses and areas of opportunity open to a particular industry or market sector. Many renewable energy supply chain studies have been made over the years, with the UK and U.S. both recently issuing reports on marine renewable energy specifically.

This report breaks Canada's marine renewable energy supply chain down into 10 distinct segments: technology developers, manufacturers and suppliers, project developers, development services, supporting technology providers, engineering and construction, operations and maintenance, research and development, policy and industry support, and business services.

There are companies located in Canada that are active in each of these segments. That said, Canada's marine renewable energy sector is currently at the prototype stage, meaning most device developers are building working models of their technologies with the goal of deploying single units for learning and further refinement. Prototyping does not require a complete supply chain as it does not involve commercial multi-unit manufacturing.

A survey of sector proponents conducted for this report found that all agreed the most critical activity today is for the industry to learn, improve and create confidence in marine energy technologies through large-scale deployments. The scale is essential: to yield valid results, even demonstration projects have to match the scale of the marine environment itself. This, however, incurs effort and costs that are disproportionate to the level of activity, causing many companies in Canada to take a 'wait-and-see' approach.

The survey of sector proponents also identified areas of perceived Canadian strengths and weaknesses in the nascent supply chain. Areas of perceived strengths include: deep sea ports, marine construction, resource monitoring and analysis, environmental assessment, marine supplies, commercial diving and transport. Areas of perceived weakness include device manufacturing, engineering construction and foundations / anchoring experience.

Based on these and other observations, this report offers short- and medium-term visions for the marine energy sector's supply chain. In the near term, 2013-16, the aim is to see some of the country's current prototyping projects advance, through technological innovation and development, to pre-commercialization. Beyond 2016, the goal would be to convert those pre-commercial enterprises into a commercial industry. Canada's experience and expertise in other sectors can be used to accelerate the marine renewable energy industry's journey toward commercialization, with several areas identified as potential outlets for knowledge, skill and technology transfer including drilling technologies and maintenance systems for the offshore oil and gas industry.

Overall, the marine renewable energy sector's development needs to be centered on a solid vision that industry, governments and the public can embrace. A strategic roadmap is considered to be critical to providing an emerging supply chain with a tangible picture of the opportunity within which they should engage.

Introduction

A well-defined supply chain sheds light on the maturity, strengths, weaknesses and areas of opportunity open to a particular industry or sector. This report looks at the supply chain for Canada's marine renewable energy sector, its current stage of progress, and what industry feels is required next—offering a vision for the future in both the near (2013-16) and longer terms (after 2016).

Marine renewable energy remains at an early stage of development in Canada and around the world today. Its supply chain is still taking shape. But if the country is to take advantage of its abundant marine energy resources and not miss the current opportunity to take a leadership position in the development of the sector, that supply chain must be fleshed out and actively engaged—first to support large-scale prototyping and demonstration projects, and soon after to move through pre-commercialization to commercial success.

The Canadian marine renewable energy industry, has over a dozen technology developers working on different concepts to convert energy from wave, in-stream tidal and river currents,

This early stage supply chain review identifies the segments of the marine renewable energy sector supply chain, surveys proponents for their insight into the strengths and weaknesses of Canada's existing capabilities to support the sector and identifies opportunities for knowledge, skills and technology transfer.

The intent of this early-stage supply chain review—a collaborative effort between Natural Resources Canada (NRCan) nd Natural Power—is to provide an overview of the supply chain for marine renewable energy in Canada and identify gaps in today's supply chain as well as opportunities to address them and requirements for the future as the industry continues to grow. Funding for this report was provided by NRCan and Industry Canada.

The marine energy supply chain at a glance

A supply chain encompasses all aspects of how a product is delivered to the end user: its design, the sourcing of its components, and the manufacturing and distribution of the finished goods [1]. Due to the emerging nature of the marine renewable energy sector many other elements—research and development, technology design, policy and regulatory development, supporting services, project development and broader business services—must also be considered to be part of the industry's supply chain.

Numerous supply chain studies have been completed for the marine renewable energy sector to date, most recently in the United Kingdom [2] and the United States [3]. In Canada, efforts are being made to further develop the wind energy supply chain, with key references being Industry Canada's *The Study of Supply Chain Capabilities in the Canadian Wind Power Industry* [4] and the Ontario Ministry of Economic Development and Trade's *Directory of Ontario Wind Energy Manufacturers and Suppliers* [5].

Although some of the above-mentioned resources focus on wind, they are highly relevant to the marine renewable energy context as well due to a number of commonalities between the two technology areas: the electricity market; the technical and manufacturing expertise applicable to both sectors; the international nature of the industries with key strengths and capabilities originating in the UK and Europe; and the shared objectives of building strong domestic industries.

Segments of the supply chain

In preparing this document, supply chain segmentation approaches from various reports were analyzed to form a list of 10 key segments (see Table 1 below). Canada currently has at least a dozen companies providing services or products in each of these segments. (See Appendix A for a supply chain-based overview of a hypothetical marine renewable energy project as well as for additional insight into the broader requirements for commercial project development and operation.)

Table 1: Supply chain segmentation

Supply Chain Segment	Description
Technology developers	Marine energy conversion device innovators, designers and developers.
Manufacturers and suppliers	Manufacturers and component suppliers.
Project developers	Utilities and independent power producers.
Development services	Resource assessment/modelling, mapping, environmental impact assessment, sea floor environmental assessment and related marine safety and supply consults, permitting, approvals planning, marine corrosion consulting.
Supporting technology providers	Wave/tidal current resource measurement devices, environmental monitoring devices, buoys, underwater remote vehicle operators/owners, technical resource monitoring and data collection.
Engineering and construction	Safety management, work platforms, underwater operators, cabling and electrical interconnect for marine operations/facilities, anchoring systems, engineering firms (electrical, civil, mechanical), on-site supervision and management.
Operations and maintenance	Operational monitoring, transportation, port facilities and marine operators with related experience (including transport vessels and operators and certified diving teams) with the ability to do deployment/removal, emergency repair, mitigation strategies and asset management.

Research and development	Academia, private and public research centres and bodies.
Policy and industry support	Government policy development, industry associations and non-governmental organizations.
Business services	Legal, financial, insurance, business, communications, market research and training activities.

Gathering an industry perspective

The marine renewable energy sector is currently at the prototype stage, meaning most device developers are building working models of their technologies with the goal of deploying single units for learning and further refinement.

To gain a better perspective on the state of the sector and its supply chain, interviews were conducted with 18 people representing various areas of the industry in December 2009 and January 2010. (The interview questions are provided in Appendix B.) Nine of the 18 interview participants provided additional comments and insight into the maturity level of specific categories within the marine industry (see Appendix C).

The surveys identified areas of strengths and perceived weakness in the nascent supply chain. The perceived strengths, as listed below, appear to align with many of the areas of capacity that the marine renewable energy industry will need to succeed.

Strengths:
- deep sea ports;
- marine construction;
- resource monitoring and analysis;
- environmental assessment;
- marine supplies;
- commercial diving; and
- transport.

Weaknesses:
- device manufacturing;
- engineering construction; and
- foundations/anchoring.

No small projects

The marine energy proponents interviewed were unified in their view that the most critical activity in today's marine energy environment is to learn, improve and create confidence in the technologies through large-scale deployments. While available for this purpose, public funding is considered to be inadequate to fully encourage and support robust prototype development for necessary evaluation in Canadian waters.

Prototype development costs are quite significant and generally underestimated [6]. Logistics vary greatly across Canada and costs are affected by location, local capabilities and competing demands for services and expertise. Consequently, it is important for Canada's marine energy industry to gain fuller understanding of the complete costs for marine renewable energy projects and determine areas where efficiencies can be achieved.

Regulatory hurdles

It's worth noting that there are no 'small' marine projects—even demonstration projects have to be at a scale appropriate to the marine environment. However, this causes demonstration projects to attract the same permitting and regulatory attention intended for full-scale projects, creating a considerable burden in dealing with regulators who, like those in the sector itself, are still trying to learn how to manage marine renewable energy. In the end, the effort and costs associated with demonstration projects are disproportionate to the level of activity currently being undertaken.

Interviewees made many comments about the challenges and delays caused by the consenting processes that are designed for commercial-scale projects. There are indications that dialogue is improving between agencies and proponents, but this is an area that has slowed the progress of many projects in the past. Without specific broad regulatory facilitation, it remains a significant risk. That being said, the relatively quick nine-month permitting process for the Fundy Ocean Research Centre for Energy (FORCE) suggests coordination by permitting agencies is possible.

Many companies in Canada are not committing a significant percentage of staff time to engage in the marine energy sector. Instead, many are taking a "watching brief" approach to be ready to participate when opportunities arise.

Project managers leading scale deployments generally commented they have had adequate response to their requests for quotes and not had problems in finding component or service suppliers. There were, however, two exceptions: the first related to cabling and electrical interconnect for marine operations/ facilities; and the second related to the availability of adequate expertise (such as construction contractors) for marine energy projects.

Target 2013–16: Pre-commercialization

The pre-commercial phase is generally defined as having a small number of grid-connected devices deployed in arrays of two to five machines [7]. There are currently no pre-commercial marine renewable energy deployments in Canada. Based on a study of international timelines and interview responses, pre-commercialization should occur within a two- to five-year timeframe following prototyping.

Once the pre-commercialization phase is reached, project developers will need to identify the growing supply chain requirements needed to source and supply the marine renewable energy industry in Canada. This will require a dramatic change in scope as projects progress to multi-unit deployments with greater manufacturing, operational and maintenance requirements. Based on current supply chain gaps, three main areas are anticipated to pose challenges in the near term: operations and maintenance, manufacturing efficiency and grid connection.

Operations and maintenance
At Canada's port facilities, the demand for operational support will increase dramatically. In addition to the demands at the ports, added demands on marine operators are expected to put pressure on the small number of suppliers with previous experience working on prototype devices. Building the expertise and knowledge of a growing operating sector will be critical to achieving reliable marine energy conversion.

Manufacturing efficiency
During the pre-commercial phase, the locations of marine turbine manufacturing plants will begin to be determined. For Canadian manufacturing to include more than just assembly and foundation build-outs, the efficiency, costs and quality of these plants will need to be proven by local suppliers. However, improving manufacturing efficiencies will be challenging at a time when demand for products will still be low.

Grid connection
The number of electrical cables and connections required for small arrays will place additional strain on the already limited cable supply: projects today face lead times of 18 months and this number is expected to grow. Cable corrosion is another challenge that has to be overcome, particularly in high-scour areas. Accordingly, the design and manufacturing of cable armouring could be considered an area with huge potential demand. However, as the cabling issue is not expected to be resolved in the near term, significant lead times will continue to have to be programmed into project timelines. A solution may emerge once international demand reaches the point at which suppliers refocus their attention and accelerate response times to the sector.

Beyond 2016: A commercial industry

A commercial marine renewable energy sector is expected to consist of energy conversion plants made up of large arrays of a particular device to produce significant power output. In this commercial environment, there will be several primary energy conversion designs that excel in various ocean or river environments and conditions (e.g., depth, velocity, turbulence). These primary designs are expected to be developed and optimized by a number of different technology providers as is the case in today's wind industry.

From a supply chain perspective, the consolidation of device types is seen as an important step to allow for: design prioritization; focused foundation/anchoring system development; and the streamlining of the manufacturing, assembly, installation, operations, maintenance and retrieval capabilities needed to achieve some level of competitiveness with other energy sources. A smaller variety of devices will enable cost savings associated with economies of scale for components and manufacturing efficiencies, as well as proven deployment and retrieval advantages.

Gaps and opportunities

The areas of strength, weakness and unknowns identified throughout this report, with specific reference to the supply chain segments identified in Table 1 have been summarized in Table 2 below.

Table 2: Identified gaps based on supply chain segments

Supply Chain Segment	Gaps
Technology developers	Marine energy conversion technologies need to be reliable, efficient and cost-competitive in comparison to other renewables in order to provide an opportunity for a commercial industry to flourish.
Manufacturers and suppliers	A Scottish supply chain study found that most marine energy technology developers want to assemble their devices using proven, reliable, 'off-the-shelf' subcomponents purchased from established suppliers. [2] Identification and design of subcomponents that are not already available but will complement Canada's strengths may provide opportunities for manufacturers and suppliers in Canada.
Project developers	As marine energy technologies advance towards commercialization, risk will decrease and projects will become more financeable, allowing independent power producers and utilities to become more active in the sector; however, policy and incentives are also required in order to engage project developers.
Development services	Considered to be well serviced, with several companies developing experience nationally and internationally with wave and tidal energy activities.
Supporting technology providers	Considered to be well serviced.
Engineering and construction	A number of engineering firms are becoming engaged as opportunities arise. It is critical for Canadian engineering firms to become involved early as the use of Canadian engineering greatly increases the likelihood of supply from Canadian companies.
Operations and maintenance	Deployment, operations, maintenance and retrieval technologies and procedures may be necessary to manage wider weather windows as well as more extreme environmental conditions.
Research and development	More research is needed to address the full spectrum of issues at this stage, from technology and environmental to full-systems considerations.

Supply Chain Segment	Gaps
Policy and industry support	While outside the immediate supply chain issues, support for industry through a national vision and strategy would assist potential supply chain members to recognize the long-term opportunities in marine energy.
Business services	Considered to be well serviced.

The impact of human resources on the supply chain

Although human resources were not identified as part of the supply chain, it is an overarching issue that impacts each of its key segments. Particular areas of concern include occupational standards for operations and maintenance and succession planning for an aging trades workforce.

Occupational standards

The physical environment of the marine renewable sector is challenging and requires labourers willing and able to work safely in adverse conditions. There may be a need for occupational standards development and new certifications for workers on vessels and barges at sea deploying, retrieving and maintaining marine renewable energy devices. These standards may echo those of the offshore oil and gas industry, but will need to be adapted to address the unique requirements of wave, in-stream tidal and river current environments.

Succession planning

With an aging demographic, succession planning within the trades workforce is a challenge experienced all across Canada, including marine vessel operators, machinists and fabricators. To ensure the continued availability of a skilled and knowledgeable workforce, ongoing engagement with academic institutions is required to create new curriculums and to insert marine renewable energy modules within existing programs.[1] In this regard, electricity policy, government funding priorities and employment opportunities to drive enrolment will be the impetus for the development and offering of specific education opportunities [8].

Opportunities for knowledge, skill and technology transfer

Canada's experience and expertise in other sectors can be used to accelerate the marine renewable energy industry's journey toward commercialization, with several areas identified as potential outlets for knowledge, skill and technology transfer.

Canada has internationally recognized expertise in extraction equipment, drilling technologies and maintenance systems for the offshore oil and gas industry—expertise that has already been engaged in some aspects of early marine renewable energy prototyping and will be critical to leverage as the sector moves forward [9]. Aligning oil and gas technical skills and resources with the costs and requirements of the marine energy sector will be critical to successfully installing marine energy devices [2]. Interviewees warned, however, about putting too much weight on the direct relevance of offshore oil and gas to marine energy, as operating conditions are typically very different between the two sectors, especially with regard to offshore electrical and communications cabling and near-shore and high-tidal energy operations. In addition, there is the potential for heightened costs driven by higher demand for local marine operation services by oil and gas.

[1] Skills required within the marine renewable industry will include research, hydrodynamic analysis, commercial analysis, planning, oceanography, metocean modeling, marine operations and various types of engineering, including mechanical, hydraulic, control, structural and electrical. Expertise is also needed in the areas of offshore installation, quality assurance, safety, marine operations, welding, procurement, heavy-duty mechanics, crane operation, marine biology, environmental assessment, permitting, commercial diving (with 30–100 m abilities and equipment), remotely operated vehicles, and remote sensing and video.

A similar argument can be made when comparing the marine and wind energy sectors. An article from the 2009 *WindMatters* conference on the opportunities in Canada's wind energy supply and value chains emphasized that "transitioning technology and product development from one industrial sector looks like a natural fit, but panellists at this conference say the highly specialized requirements for wind technology make it surprisingly difficult. Even if you are a maker of gearboxes for the oil and gas industry, it's difficult to convert to a wind gearbox maker." The message here is to avoid downplaying the effort required for knowledge transfer strategies.

Agreement also does not exist on whether Canada should be a manufacturer or an importer of marine energy device components. Some interviewees expect that components will continue to be imported during the prototype and pre-commercial phases, as it may not be realistic for component suppliers to set up shop in Canada until the devices have been proven and a level of confidence developed in the environmental, public, government, and financial sectors to support the emerging industry. Others, however, foresee opportunities to build on the success achieved in device demonstrations and that Canada should look at supplying not only its own components, but also those for marine energy devices around the world.

In the area of education, academic institutions are showing that students are becoming increasingly interested in pursuing a career related to renewable energy. Colleges are striving to expand common trades into areas that will exist in the renewable energy sector, while universities are making efforts to share knowledge internationally and become directly involved in the testing of devices. Collaboration between industry and academia is seen by the sector to be critical to the breakthroughs needed to reach commercialization.[2]

Industry networking opportunities and the resulting working groups—such as those being facilitated by the Ocean Renewable Energy Group (OREG)—are creating valuable opportunities for government, developers, designers and service providers to interact, create momentum and share demonstration findings and best practices. Interviewees mentioned that this exchange of information needs to expand to include current marine project developers in the offshore wind and oil and gas sectors. However, it was also noted that the interface between device designers and environmental practitioners requires more effort to mitigate potential conflicts. Based on the experience in the wind sector, interest in the potential for environmental impacts will emerge as a public debate regardless of any broad acceptance of the value of low-emitting ocean energy.

Conclusion

Many interviewees asserted the basis of a supply chain for a robust renewable marine energy sector already exists in Canada. However, caution should be taken in regards to this assumption—for example, the wind energy sector expected a supply chain to develop rapidly once the industry reached the commercial stage, but this has not proven to be the case, and Canada currently relies on international suppliers for most of its wind energy plant components.

Canada has an opportunity to leverage suppliers relevant to the marine sector and provide them with a clear sense of the near- and long-term opportunities. The sector must acknowledge that with low volumes and inconsistent workflows, suppliers may not prioritize on its needs until the value proposition is stronger. Looking more broadly to other, indirectly related supply chains may be necessary to bridge supply chain gaps in the short and medium terms.

Overall, the marine renewable energy sector's development needs to be centered on a solid vision that industry, governments and the public can embrace. A strategic roadmap is considered to be critical to

[2] Examples include Acadia University's work with University of Edinburgh, Camosun College's efforts to broaden its curriculum in trades, the University of Victoria's work with SyncWave and the West Coast Wave Collaboration, and the collaboration between Acadia University, Triton and the Bedford Institute of Oceanography.

providing an emerging supply chain with a tangible picture of the opportunity within which they should engage.

Appendix A: Sample project development approach

This section is provided as background to the supply chain discussions related to marine sector project development. While this is not a complete approach to the development of a project, it provides some insight into the commercial project development and operations cycle.

Project Stage	Activities
Site feasibility assessment	• Desktop analysis of energy resource • Constraints analysis • Transmission and grid-connection considerations • Logistics for deployment, operation, maintenance and retrieval
Resource assessment and constraints analysis	• Deployment of measurement devices for data collection • Data analysis and resource modelling • Site conditions and device suitability analysis • Device positioning and array design • Energy yield estimations
Environmental studies and consenting activities	• Environmental studies to identify species at risk or fragile habitats • Seabed studies that consider erosion and flow regime impacts • Environmental review of potential biological constraints to deployment • Public, stakeholder and Aboriginal communities consultation • Design of ongoing monitoring activities for device and environment • Legal, permitting and approvals requirements
Planning activities related to construction and deployment	• Device foundation and anchoring systems • Device procurement and assembly logistics • Deployment and retrieval requirements and availability • Vessel capabilities and availabilities for transport • Barge configurations and equipment requirements • Cable specification and interconnect requirements
Operations and maintenance	• Systems operators, SCADA system • Emergency response planning • Emergency repair systems • Scheduled maintenance planning • Subsea monitoring for potential environmental impacts
Decommissioning	• End-of-life decommissioning, recycling or refurbishing plan • Site restoration to pre-project conditions or otherwise acceptable conditions (as per the code at that time)

Appendix B: Interviewer's guide

Please note that the interviewers used this as a guide; in several instances the interviewees felt the questions were not relevant to their current business or that they would prefer not to share their responses.

Introduction

Thank you for agreeing to participate in this early stage supply chain interview. Your input will assist in describing the current marine energy supply chain and market development opportunities and challenges in Canada. Natural Power Consultants has been retained by Natural Resources Canada (NRCan) and Industry Canada to undertake an early stage supply chain study of the Canadian marine renewable energy industry. The findings of this study may help facilitate a sector-based roadmapping exercise in the future and will inform both industry organizations and government on the current gaps and opportunities that exist in the sector today. This profile encompasses activities involved in harnessing wave, in-stream tidal and river current energy sources from water to wire.

Questions

1. a) What is the position you currently hold within your organization?
   b) How long have you and your organization been involved in the marine energy sector?
   c) What prompted your engagement?

2. The marine renewables sector is considered to be in a prototype phase with pilot projects and demonstrations advancing towards operations in various locations across Canada. We are looking to create an accurate picture of companies involved in the sector, according to nine broad categories:

   a) If we were to categorize your organization's involvement which of the following categories would apply?

      i) *Development:* Includes assessment and technical analysis of the resource and environment; impact assessment; mitigations; energy potential; all planning phases, including public, First Nations and other consultation; permitting/licensing, etc.
      ii) *Construction:* Includes marine transport and heavy lift management, work platform systems, oversight and hire of underwater operators, cabling, anchoring systems, ROV specialists, buoy placement, electrical engineering, on-site construction/safety supervision and management.
      iii) *Operations and Maintenance:* Includes optimizing energy outputs, engaging proactive maintenance strategies, emergency repair strategies and extreme weather contingencies for all aspects from the turbine, anchorage to water to wire.
      iv) *Technology Developer / Designer*
      v) *Project Developer:* Refers to companies that orchestrate financing, may have in-house expertise for development and construction
      vi) *Manufacturers:* Component fabrication and equipment suppliers of all components from anchor chains to buoys, platforms, systems technology, turbines, cables, transformers, etc.
      vii) *Research and* Development*:* Includes academia, literature research, government and industry association support activities.
      viii) *Utilities*: Private or public.
      ix) *Support Services*: Legal, financial or insurance.

   b) Based on the companies that you engage with directly (through the demonstration you are part of or your organization), can you describe which categories they generally fall into from the nine listed above?

3. What proportion of your company's business/organization's membership is/was focused on this sector in 2008 and 2009 (i.e., current)? Can you share a) the number of staff involved and b) approximate revenues/budget?

4. What proportion of involvement do you anticipate in 2010 and 2011? (A general discussion on this will be helpful to help identify trends.)

5. As we see the sector move from prototype/demonstration stage into short-term/pre-commercial small arrays as a second phase and then into the third stage of commercial industry there will be a need for an expanding supply chain to fill the gaps we are seeing today.

   a) What are your short- (1–2 years), mid- (2–5 years) and long-term (5–10 years) goals within this industry for your business/members in terms of economic opportunities? And opportunities for industries or supplier not currently engaged?
   b) What are your short-, mid- and long-term expectations for the marine renewables sector in terms of contribution to Canada's energy mix? (Notional or megawatts or percentage of current total supply from the renewable sector would be helpful.)
   c) Can you share your thoughts regarding potential barriers in the supply chain that may slow or hinder the development of the sector if not proactively addressed?

6. Marine renewables are competing against other renewables for investment and policy support.

   a) Can you share your thoughts on why (or if) you see unique reasons why marine energy should play a role in Canada's energy market into the future?
   b) From a regional perspective, considering the Atlantic, Pacific, Northern and in-stream opportunities, do you see unique reasons why these energy developments should play a role forward?

7. Additional comments and references.

   a) Do you have any other comments you would like to share relative to this study?
   b) Are there other people or organizations that you believe would be valuable source of information for this study?

Appendix C: Summary of interviewee response chart

The following chart represents the observations of supply chain capabilities from nine of the 18 interview participants:

Respondent	Deep sea ports	Marine construction	Remotely operated vehicles	Resource monitoring and analysis	Electrical and cable interconnect	Environmental assessment and	Device manufacturing	Marine supplies buoys	Undersea cable	Commercial diving services	Marine transportation	Foundations and anchoring systems	Engineering and construction
1	M	M	M	M	M	M	M	M	M	M	M	M	M
2	E	M	M	E	U	E	M	M	E	U	E	U	U
3	M	M	E	M	E	M	I	M	I	E	E/M	E	I
4	M	M	M	M	M	M	E	M	M	M	M	U	M
5	M	M	M	M	I	M	I	M	U	E	M	E/M	I
6	M	M	M	M	M	M	M	M	M	M	M	M	M
7	E	M	I	M	E	M	E	M	E	M	M	E	E
8	E	I	I	M	I	E	E	M	I	M	E	E	I
9	M	M	U	I	E	M	E	M	M	M	M	I	I

Legend

I	*Immature (difficult even at a prototype/pre-commercial level)*
E	*Emerging (infrastructure is in place to expand, current service acceptable at prototype/pre-commercial level, expect delays when sector growth increases, expect to be commensurate with sector growth; some level of difficulty locating service providers)*
M	*Mature (established services of sufficient quantity to minimize service delays, relatively easy to locate services)*
U	*Unknown at this time*

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