



The Next Economy

Transformation and Resilience in Times of Rapid Change



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Acknowledgements

This foresight study is the result of a collaborative exercise that engaged a wide cross-section of experts from the federal government, the private sector, non-profit organizations, international organizations and universities. The process involved interviews, workshops and regional consultations that occurred between December 2011 and May 2012. Comments on the preliminary drafts of this study were solicited from a range of government and non-government experts between June and August 2012. See Annex 1 for a list of experts and organizations engaged throughout this process. Policy Horizons Canada would like to thank all participants and reviewers for graciously providing their time, energy and ideas.

Policy Horizons Canada's Next Economy Foresight Team was composed of Katherine Antal, Imran Arshad, David Cavett-Goodwin, Steffen Christensen, Alain Denhez, Blaise Hébert, Naomi Kuhn, Marissa Martin, Craig McNaughton, Peter Padbury, Alan Painter, Gary Sawchuk and Nancy White.

“Resilience allows us, even in the most extreme moments, to keep learning, to change. It is a kind of battlefield courage, the ability to innovate under fire because we’ve prepared in the right way and because we’ve developed the strength to keep moving even when we’re slapped by the unexpected.”

The Age of the Unthinkable
Joshua Cooper Ramo



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PH4-122/2012E-PDF
 978-1-100-21448-1

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Executive Summary

Canada's economy is changing, and changing fast. It can be expected to change at an even faster pace over the next 10 to 15 years.

It is worth considering whether Canada will prove resilient enough to take on an economy expected to be:

- technology-intense and increasingly automated;
- globally integrated and globally urbanized, with increasing networks between cities;
- highly networked – people to people, people to machine, machine to people, machine to machine;
- collaborative, even in the context of intense competition (“co-opetition”);
- environmentally “charged,” with an array of sustainability innovations in play against a background of environmental crisis;
- oriented towards services and “intangible” products; and
- increasingly non-traditional in the way businesses and jobs are organized.

In some respects, Canadians are well positioned to thrive in the next economy, enjoying a number of key advantages:

- abundant natural resources, including some in increasingly short supply globally (e.g., water, arable land);
- well-developed services sector;
- sound financial system and relatively well managed levels of public debt;
- generally high level of education and skills;
- access to significant resources in infrastructure and technology; and
- strong social relations and traditions of democratic governance.

Canadians, however, face a number of challenges in handling the next economy:

- keeping pace with the changes in employment and business opportunities created by intensive automation, rapid adoption of new technologies, a strong orientation to services and “intangible” products, the push towards sustainability, and a global economy that is highly networked and both collaborative and competitive;
- adjusting social policies (health, employment insurance, pension, taxation) to take account of jobs that are more scarce, project-based and linked to employers and markets around the world;
- adapting the skills of all Canadian workers (including both younger and older workers, Aboriginal people and new immigrants) to new kinds of employment opening up;
- effectively managing migration and work patterns that are far more fluid and virtual; and
- taking advantage of new market opportunities in the rapidly growing cities of Asia, Latin America and other regions of the world.

Whither the “Next Economy”?

The global economy appears to be shifting under our feet. The sub-prime mortgage crisis in the United States that set off the 2008-2012 global recession is a case in point, as is the ongoing European sovereign debt crisis. Although Canada has fared comparatively well during these times, one of the best ways to meet ongoing and future challenges is to do some thinking about what may be coming. Fortune, as Louis Pasteur pointed out, favours the prepared mind.

It is an interesting challenge to explore how the economy may evolve in the next 10 to 15 years. We live in an increasingly complex world with many variables in play. Plus, our economy is wide-reaching, touching virtually all aspects of our lives – social, cultural, environmental, political, security, education. The essential objective of this foresight study is to identify and discuss those facets of the economy that seem likely to have the greatest impact on the evolution of the Canadian economy over the next 10 to 15 years. Not all facets are discussed, or discussed in depth; rather, the focus is on those that appear to be the source of significant change in the nature of the evolving economy.

Building a strategy and the capacity for resilience hinges on our ability to identify key changes driving the next economy – changes that may or may not conform to present-day assumptions about how to prepare for an uncertain economic future. The key impacts of those change drivers can then be examined within our current economic sectors (e.g., services, manufacturing, natural resources) – and it becomes possible to help identify the kinds of policy challenge Canadians will need to consider as they prepare for the economy of 2025.

A common characteristic of resilience is the ability to respond quickly in difficult and constantly changing times. For Canadians, being resilient over the next decades will entail an ability to develop the skills

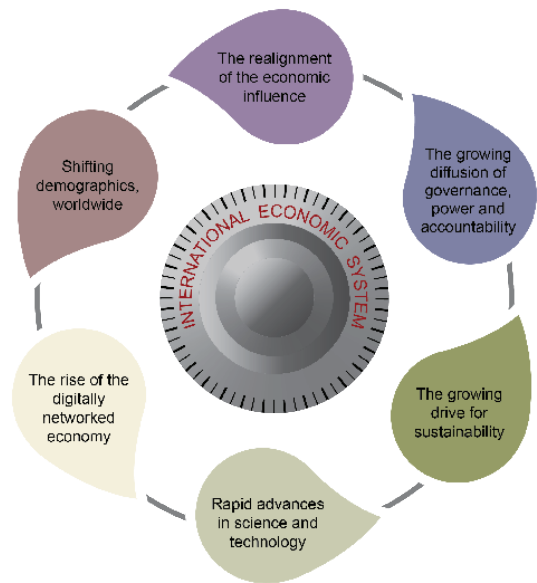
needed for jobs that are shorter term and often located/sourced outside Canada. It will also mean being able to manage significant demographic, technological, social, environmental and economic change. For Canadian firms, it will mean developing innovative models to compete in an economy that is increasingly digital, global, urban, green, intangible and networked. For government and other organizations, resilience will mean working collaboratively to develop effective approaches to help citizens and firms anticipate and adapt to the new realities of the next economy – both negative and positive.

Change Drivers Impacting the International Economic System

What's Driving the Evolving International Economic System?

The global economy is entering a period of considerable economic uncertainty. Many prominent institutions and experts are forecasting a “two-speed” global economy in which growth will continue in the emerging economies but slow if not stall in the West (Spence, 2011; World Bank, 2012). They indicate that many countries in the West have yet to manage successfully a long list of difficult challenges (debt, eroding infrastructure, aging populations, shortage of appropriately skilled workers, low productivity, climate change, etc.), potentially resulting in slower growth, decreasing revenues and fewer public policy options over the next decade. While these forecasters acknowledge that emerging economies have many internal challenges (infrastructure, skills shortages, development of internal markets, etc.), it is broadly assumed they will overcome these challenges and grow at a significant rate in the next 10 to 15 years.

Due diligence requires us to explore a range of plausible futures and to question the robustness of assumptions imbedded in current policies. Some key current assumptions are illustrated in the box below.



The following sections probe the strength of these and other assumptions, starting first with a review of some of the major forces that will likely drive structural shifts in the global and Canadian economies over the next decade.

Some Current Assumptions about the Next Economy... Credible or Not?

1. Global economic power will continue to shift from the West to the East.
2. Global governance institutions and frameworks are dysfunctional but will likely remain stable.
3. Science and technology will help us manage most major challenges, despite some disruptions.
4. Canada has the necessary base of skills and infrastructure to compete in a knowledge-based economy.
5. The manufacturing sector will continue to decline as emerging markets take over.
6. Innovation and productivity will help maintain our standard of living.
7. Immigrants will continue to come to and stay in Canada.
8. Canada will experience growing labour shortages due to an aging population.
9. Natural resources and energy development will be increasingly important to Canada's competitiveness.
10. Canada's education system will evolve to meet our needs.

The re-alignment of economic influence

The structure of the global economy is changing as new markets and players gain economic influence. A polycentric world is shaping up as economic power continues to shift from the West to the East, the BRICS (Brazil, Russia, India, China and South Africa) and the **Global South**.

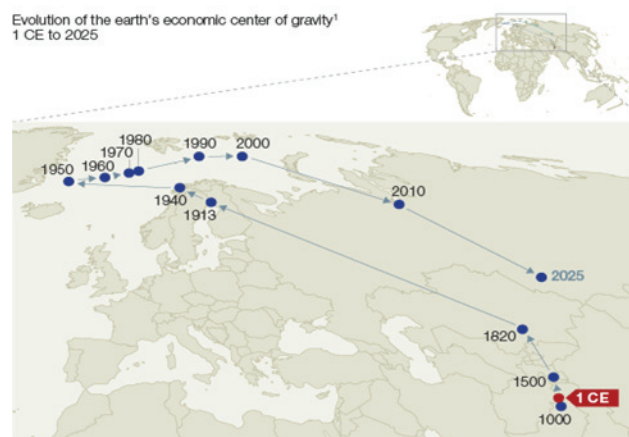
At the same time as the convergence of talent in and around cities creates the “hot house” conditions needed for economic innovation, a network of major cities around the world could result in interesting scenarios for economic strategy. It is estimated that the top 600 mega- and middleweight cities are expected to contribute 60% of global gross domestic

product (GDP) by 2025 and that the majority of these cities (some 423) will be found in the Global South, particularly Asia (Dobbs, 2011). All nine Canadian cities in this group (Toronto, Montréal, Vancouver, Calgary, Ottawa, Edmonton, Québec, Hamilton and Winnipeg) will be middleweights, with six being fairly small in size. This is in contrast to the highly influential mega-cities of over 10 million people, the number of which is expected to increase from 23 to 36 by 2025, with 13 in China alone. Nevertheless, some Canadian and US cities are assessing their comparative advantages and developing local and global alliances for training, research, infrastructure and investment to take advantage of the latest technologies and position themselves in emerging **global value chains** – the full range of activities involved in the design, production and delivery of

A Polycentric World

Economic power is shifting from the West to the East, but also to the BRICS and the Global South (which includes developing countries mostly located in the southern hemisphere). In fact, an increasing number of countries are entering the global market. In 2005, Goldman Sachs identified “the Next 11,” a group of highly populated countries that could have a great impact on the global economy. Indonesia, Mexico, Nigeria and Turkey could be the next economies to emerge as global powers, each offering its own special advantages in terms of natural resource wealth, industrial strength and labour. At the same time, the economies of a number of countries in Africa are growing at a rapid pace and are seeing much investment from emerging economies that are acutely aware of the enormous market potential in the region (Economist Intelligence Unit, 2012).

This shift of the economic power is well illustrated in this simulation by the McKinsey Global Institute on the geographical location of the “center of gravity” of economic activity. Where most activity used to be centred between Europe and North America between 1950 and 2000 CE (Common Era), it is rapidly shifting back towards Asia.



Source: Dobbs et. al, 2011

a product by a variety of companies operating in different jurisdictions around the world. Some cities are also creating foreign trade zones to facilitate and attract foreign investment and international business by reducing trade barriers and bureaucratic requirements. One such example is Winnipeg's **CentrePort Canada**, the first and currently only foreign trade zone in Canada.

Rise of the digitally networked economy

Global exchange is increasingly organized around the Internet, facilitating the enhanced integration of global markets and expanding consumer knowledge and participation. This will likely be the biggest driver in how the next economy evolves, challenging the existing economic framework, based primarily on competition, to evolve to include a more collaborative dimension. Collaborative technologies such as social media and peer-to-peer sharing are providing people with new ways of consuming, producing, selling, trading and working. Accessibility (ie. knowledge and tools) will be key in how far the networked global economy will evolve, who will be included and who will be left out. Certainly high-speed and extensive networking appears to fuel what some have termed "**hyper-competition**" and "**hyper-specialization**." Hyper-competition tends to create lower barriers to entry in certain industries, challenging the ability of firms to sustain competitive advantage. On the other hand, hyper-competition re-opens economic opportunity for those who can adapt quickly to shifting conditions. Hyper-specialization involves breaking down work currently undertaken by one person into more specialized pieces spread out among a variety of people (**Malone et al.**, 2011).

The last wave of technologies (computers, cheap memory and broadband) laid the foundation for the Internet and social media, and we are just beginning to explore how these tools are engaging customers in the co-creation and co-production of goods and services. The next technology wave, a combination of artificial intelligence, sensors, data analytics and

robotics, is sweeping over us now and creating a smart network of capacities that will enable different kinds of organizations, products and value chains. Hal Varian, Google's chief economist, has referred to "micromultinational" companies that will be able to take advantage of this new infrastructure to operate globally (**Varian**, 2011). As the digitally networked economy evolves, we may see both new players in the economy and those excluded based on access, potentially creating a digital class divide. At the same time, countries with strong digital infrastructure will likely accrue the benefits from the digitally networked economy, while others may have to make significant investments before reaping the rewards.

Micromultinationals are small companies that draw on existing and usually free Internet-based communications and computational tools (e.g., social media and cloud computing).

"[Micromultinationals] can exploit comparative advantage due to global variation in knowledge, skills, and wage rates ... Innovation has always been stimulated by international trade, and now trade in knowledge and skills can take place far more easily than ever before."

– Hal Varian, Google's chief economist

Most micromultinationals will likely go out of business or be acquired by larger companies, although some more durable examples include **Skype** and **Rovio Entertainment**, both of which started out as small start-ups before being acquired (by Microsoft in the case of Skype) or expanding their operations (in the case of Rovio Entertainment).

Rapid advances in science and technology

Accelerating scientific discoveries and new technologies are creating major shifts in our economic landscape, producing new risks and opportunities for the economy, the environment and society. Advances in big data, smart products, 3D printing, artificial intelligence, robotics, medical technologies, nanotechnology, biotechnology and innovation systems are altering existing economic systems and business models. These core technologies also support and accelerate one another's development, leading to an even faster pace of change. See the accompanying box (Diffusion of Technology) and Annex 2 for additional detail on the pace and force of change in science and technology.

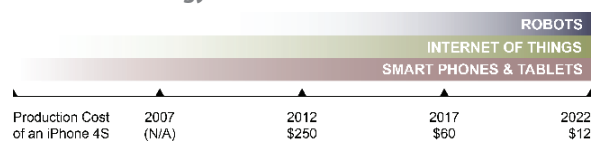
The growing diffusion of governance, power and accountability

According to a study conducted by The Conference Board of Canada, citizens' confidence in government in many developed countries has fallen from an average of 47% in the 1980s to 39% in the 2000s and from 42% in 1982 to 39% in 2006 in Canada (The Conference Board of Canada, 2009). At the same time, a growing awareness of the complexity and intertwined nature of problems is creating an increasing desire for change in current governance structures that seem out of alignment with the emerging reality and the need for agility, flexibility and empowerment. For other players, a growing concern about the economic and political liabilities of social inequality is coming to the fore, as global and national studies are showing that income inequalities are undermining social cohesion and economic productivity and lead to both direct and indirect financial costs to governments (Lewycky, 2012). As a result, different societal actors, including governments, businesses, non-governmental organizations and citizens themselves, are exploring multi-faceted governance approaches that take into account inter-jurisdictional and multi-actor cooperation and collaboration. Examples include

Diffusion of Technology

Digital technology has been found to advance at a predictable rate since the 1970s, in a regularity called Moore's law. There are many forms of Moore's law, but the most useful for policy purposes is the notion that the technology required to produce the same level of computer power drops in price by a factor of four every four years. It is useful to think forward in terms of the basic package of capabilities for the future using one of today's most popular technologies: Apple's iPhone 4S. It has two cameras capable of full-motion HD video and audio recording, GPS, Wi-Fi, 3G, position, orientation and light-level sensors and an artificial intelligence that can listen to and transcribe users' speech and act on their behalf. Replacement cost for a 4S today is about \$250. Projecting these capabilities forward using the International Technology Roadmap for Semiconductors (the high-tech industry's official projection of where technology will be in the future) gives a baseline for how much the 4S equivalent will cost over the next 15 years.

General Technology Timeline



The form of these technologies will continue to change as time progresses, to become physically smaller and incorporated in more devices. At \$60, we expect to find 4S-level technology in cars, houses and major appliances. Think of it as a refrigerator becoming "smart" with the ability to take inventory and communicate with the user for grocery needs. At \$12, Wi-Fi-connected smart devices will be incorporated in shoes, bicycles, wallets, jackets and so on. At \$2, 4S-style technologies get incorporated into umbrellas, coffee mugs, keys and clothing. These advances collectively will lead to an "Internet of Things," in which consumer products and objects in the real world begin to sense their surroundings and usefully process them to assist users. Shortly thereafter, a new generation of commercially available robots could emerge based on these advancements in technology.

Annex 2 provides a more detailed look at expected technological advances in six key areas.

Iceland's crowdsourced constitution, the **Vibrant Communities** initiative that involves collaboration between citizens and civic leaders on poverty reduction issues, and the civil society-led **ISEAL Alliance** that works with business to certify products and services to ensure they meet rigorous social and environmental standards. At the same time, other non-state actors, such as sovereign wealth funds, state owned enterprises and philanthropist organizations such as the **Bill & Melinda Gates Foundation**, are increasingly becoming influential in and will inevitably impact the global economy. See the Policy Horizons foresight study, *Driving Policy on a Shifting Terrain*, for additional discussion of this change driver.

The growing drive for sustainability

International efforts involving a range of actors (including civil society organizations, multinational corporations, governments, etc.) are under way to ensure patterns of economic activity match the capacity of the world's ecosystems. Although these efforts face a range of challenges, they have the potential to significantly shift production and consumption patterns over the next 10 to 15 years. Increasing demand for resources due to population growth, the needs of emerging economies and shifts in use (e.g., using food crops for fuel) is causing resource pressures that may result in greater concerns over the environment and a concerted push to develop sustainable economies. This may be bolstered by falling technology costs for renewables, companies' efforts to improve efficiencies and changing consumer values. Over the next 10 to 15 years we may see significant structural shifts in the way the global economy operates – for example, how to address the challenges of global regulation and reconciling the tension between the Most Favoured Nation principles of the World Trade Organization with the increasing calls to “discriminate” in favour of sustainably generated goods and services (Bollyky, 2012). These decisions will have implications for international competitiveness and market access (**National Round Table on the Environment and the**

Economy, 2012). With or without global agreements on a sustainable economy, more frequent and increasingly intense economic “shocks” created by flooding, drought and desertification, extreme weather, water pollution, invasive species, loss of species (e.g., fisheries), etc. can also be expected to boost pressures for sustainability.

Shifting demographics worldwide

The growth, aging, longevity and mobility of populations will have a major impact on the next economy. The global population is expected to increase from seven billion in 2012 to over eight billion by 2025, with most of the increase occurring in emerging economies and the “Next 11” (UN DESA, 2011). This will have implications for the labour market and consumption and production patterns, as well as pose challenges to a transition to a more sustainable economy.

The demographic profile will be aging in developed regions such as Canada, Europe and Japan, as well as in some emerging economies such as China. This could result in increased demand for products and services that cater to an older population's specific needs, creating new global industries and services. At the same time, an aging population may create fiscal and social challenges for welfare states.

As global value chains continue to become more widespread and workers become increasingly mobile, immigration patterns will likely become more complex, as some immigrants move on to a third country or return to their home country. Canada may see new competitors for immigrants as employment opportunities improve in BRICS and other emerging economies. At the same time, flight from regions of conflict, hardship and adverse climate change or natural disasters will also shape migration flows. With a rise of “global citizens” – people who are quite comfortable migrating between countries to maximize employment and family situations – Canada will have to consider its value proposition to both Canadian and foreign-born workers.

Significant Shifts in Key Economic Sectors

What key impacts could we expect these change drivers to have within Canada's key economic sectors? The answer to this question will allow us to identify a number of key policy challenges.

Canada is ranked as the 10th largest economy in the world according to GDP. Since we generally tend to think of the economy as being dominated by manufacturing, natural resources and services, this study will focus on some significant shifts taking place within each of these three sectors. It is clear, however, that these traditional categories are blurring and increasingly may not serve to represent the nature of the next economy.

Services of the future: intangibility, exportability and the "creative class"

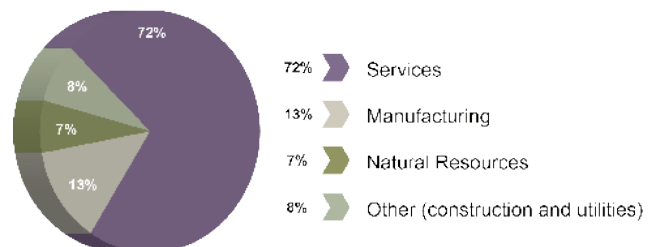
While a large part of the services sector will continue to include low-skilled work, some significant shifts for an economy that increasingly revolves around services are highlighted below.

Economic growth increasingly linked to intangibles: The shift from a goods economy to a knowledge economy has increased the importance of intangibles. **Intangible assets** include brand, customer base, design, human capital, intellectual property and networks, among others, which are all essential aspects driving firm value. Investments in intangible assets are an increasingly important source of growth that could result in a new range of business services. Also reshaping services is the rise of **intangible artifacts** through the digitization of information and arts. Freed from the resource constraints of physical production, the economics of these markets are being transformed by a shift from relative scarcity to relative abundance, suggesting a need for different pricing mechanisms. New monetization models are emerging, no longer centred on ownership but access, such as online

Canada's Industrial Sectors

The Canadian economy is dominated by the services industry, which makes up 72% of GDP and employs 78% of Canada's workforce. The services sector includes accommodation, business, cultural, education, financial, food, health care, information, professional, retail, transportation, wholesale and a range of other services. The sub-sectors that contribute the most to GDP include finance, insurance and real estate services (29% of total services), health care and social assistance (9.3%), retail trade (8.6%), public administration (8.2%) and wholesale trade (8%). Manufacturing also makes up a sizable portion of the Canadian economy, representing 13% of GDP and employing just over 10% of the workforce. This sector includes the production of food and clothes, as well as everything from machinery and electronic and transport equipment to paper, plastic and petroleum products. Canada also has a robust natural resources sector, which includes mining, forestry, agriculture, fisheries, oil and gas. This sector makes up roughly 7% of GDP and employs close to 4% of Canadians.

GDP per Industrial Sector - Canada



Adapted from: Statistics Canada, 2011 and 2012

"The economic landscape of the present and future is no longer shaped by physical flows of material goods and products but by ethereal streams of data, images and symbols."

– Charles Goldfinger

subscriptions or the use of targeted advertising powered by data analytics. The greater ease of replicating intangible artifacts has also increased piracy and intellectual property concerns.

Employers cater to the “creative class”: As developed economies have found their value through knowledge creation and innovation activities, “creative class” workers (e.g., scientists, engineers, media workers, designers) in the services sector have seen their market worth rise, while blue-collar workers and low-skilled service workers have seen little growth in their relative value, even though the latter still dominate the services industry. These creative workers tend to seek to live in diverse and creative cities and are comfortable working in flexible work arrangements such as online employment or self-employment. With the expectation of greater future competition for creative class workers, their preferences may be influential in determining workplace norms and firm location choice (Florida, 2002).

Services increasingly crossing borders: Some service firms may find that the need for proximity to their workers becomes a moot point. Information communication technologies have facilitated the offshoring and exporting of service tasks, which to date have largely been limited to the fields of architecture, engineering, finance, education and research and development. Services have traditionally been less tradable than goods, particularly in the most customer-facing industries such as retail and health care (Farrell et al., 2005). However, even in these fields, virtual and communications technologies are advancing the ability to bridge distance and offer personalized service, for instance through mobile health tools and applications, remotely controlled robots for high-precision surgeries, and the use of avatars and “virtual fitting rooms” to aid online shopping for clothes. Within firms, developments in virtual technologies that can easily reproduce the human interface could expand the tradability of other service tasks, forging a pathway for the greater participation of “virtual service workers.”

Where employers are challenged to find specialized skills in their local labour market, **online contracting** is seen as an advantage to fill needs quickly. The transnational nature of service provision raises important questions for Canada’s labour market and Canadian service providers.

Services influenced by an aging population: Many service industries will likely see greater demand due to the needs and preferences of an aging population (e.g., personal care, health, leisure, tourism, transportation, supplementary careers). At the same time, service industries are concerned about their ability to source specific skills as needed, as they anticipate a smaller working age demographic to fill these needs. Firms are exploring incentives to retain older workers (e.g., flexible work schedules) and interventions to delay the onset of chronic ailments that might limit their ability to keep workers (e.g., offering workplace wellness programs).

The revitalization of manufacturing

Manufacturing has experienced a decline in Canada over the past decade, falling from 17% of GDP in 2002 to 13% in 2012 (Statistics Canada, 2012 [c]). This is also a trend in other developed countries, such as Japan, the United Kingdom and the United States, that experienced slow manufacturing growth from 2000 to 2009 compared to the previous decade (World Economic Forum, 2011). Plants in Canada and other advanced economies are being closed, leading to significant job losses, which could continue over the next 10 to 15 years given sustained international competition, shifting policy priorities and increasing automation. On the other hand, as outlined below, new technologies and business models are opening up exciting possibilities for a potential revival in manufacturing, some of which are explored below.

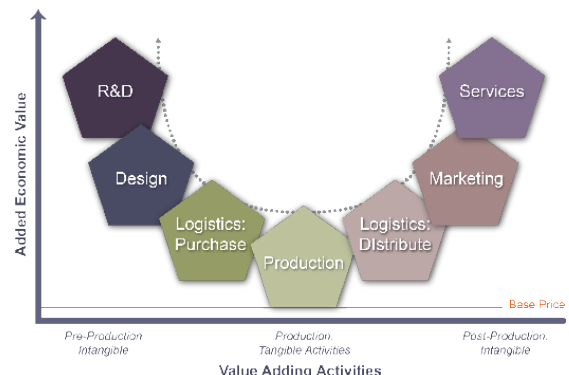
Manufacturing on demand: Technologies and techniques, such as additive manufacturing (also known as 3D printing), advanced software-controlled robotics and reconfigurable manufacturing, are evolving in a way that suggests manufacturing in 10 to 15 years may not be limited to mass production in centralized industrial plants. While not necessarily replacing mass production itself (they can be used to boost mass production as well), these emerging technologies point to the potential personalization of products and to opportunities for local, niche or customized manufacturing that are more dispersed and that take place closer to markets and to the consumers themselves. Start-ups such as [Shapeways](#) are already taking advantage of this trend by providing their members with a platform to buy, sell, create and upload new and existing 3D printing designs and products.

Additive manufacturing is the process of sequentially depositing layer upon layer of material to build products. This technology has been around for a number of years, but the machines are increasingly getting cheaper, utilizing different materials (e.g., metal, ceramic and biological inputs rather than only plastics) and incorporating more user-friendly software. These advancements are enabling designers and engineers to find more practical applications for the technology, which are likely to alter design and manufacturing methods over the next decade.

Reconfigurable manufacturing allows different components and units of machines to be added, removed, interchanged or reconfigured as necessary to quickly respond to changing requirements.

Integration of manufacturing and services:

“Servicization” is an emerging business model whereby firms integrate goods and services into value-added packages. These can range from well-known maintenance and installation components to development, design, production and post-production sales and service. In this model, end-users may pay a fee or rent the product rather than own it outright. For example, [Pure Energies](#), an Ontario-based company, finances, installs and maintains a variety of solar panels for residential roofs, the energy from which flows into the local power grid. It provides opportunities for both the customer and company to share revenues generated via Ontario’s Feed-In-Tariff program that was implemented to help phase out coal-fired electricity ([White, 2011](#)). Another emerging business model is **collaborative consumption**, which provides opportunities for goods to be shared or resold. In both models, there could be a push to manufacture more durable products with less obsolescence, opportunities for product life cycle approaches (i.e., tracking products from raw materials to disposal or recycling phases) and a focus on the more value-added front and back ends of the production process. Employment opportunities in service-oriented positions may emerge as the manufacturing chain increasingly becomes integrated with service components. Manufacturing skills may become more complex as the service and manufacturing industries become fully interconnected and increasingly jobs are found in design, engineering and marketing rather than production.



Adapted from: Presentation by Gary Gereffi at OECD Workshop, Sept. 2010

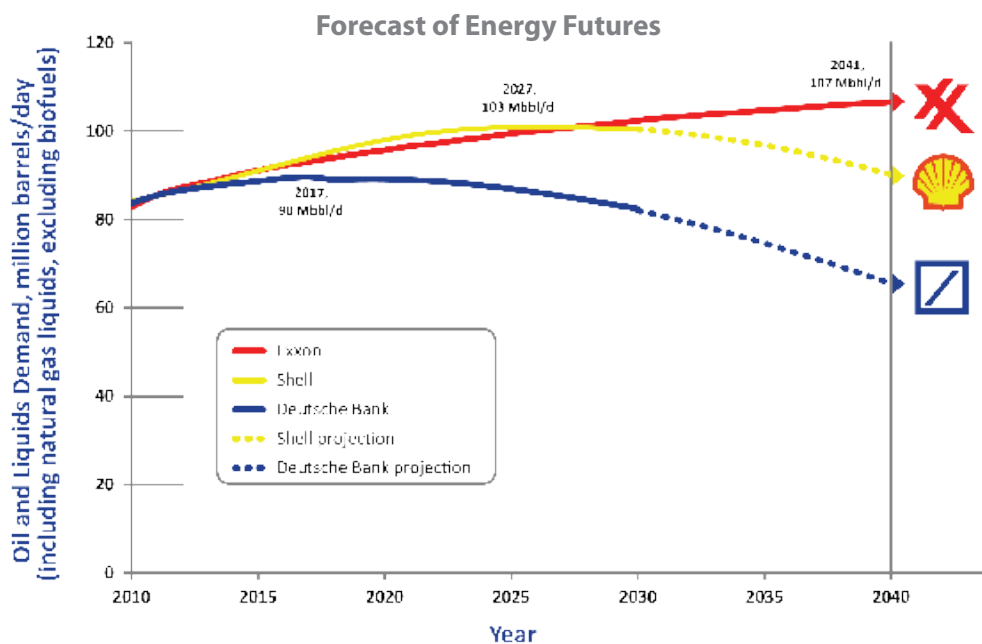
From static to smart products: Companies are exploring how to incorporate artificial intelligence, data analytics, micro-electronics, software, sensors and telecommunications technologies to design intelligent and interconnected products and accompanying services. **Smart products** are able to assess the situation, location or context in which they are operating and adapt accordingly. They are also able to interact with people, other products and larger systems, which enables them to become a part of the “**Internet of Things**” in a product-service system that combines physical smart products with a range of services. Examples include **Nike smart shoes** that use sensors and an accelerometer to record distance, jump height, etc. and sync the data with accompanying Internet and phone applications that allow users to track their own performance. Another example includes smart grids that integrate smart meters, smart appliances and **smart homes** through interconnected software applications that create enhanced value for customers, firms and the general public.

As 3D printing, servicization and the development of smart products enable enhanced customization of goods and services, new companies and customers themselves will get in on the manufacturing chain. This has implications for the design and post-production stages, distribution processes and the production of goods themselves. In some cases a “manufacture locally” revival could take root, as companies cluster their design, production and customer service units regionally to enable faster responses to new trends, demands and preferences of end-users. As production and design become increasingly integrated, off-shoring of the production process will become more difficult and lose its advantage of cost per unit for those products that rely on high customization and new technologies. How far this unfolds depends in part on the evolution of these technologies and their impact on behaviours and institutions.

Complexity within the natural resources nexus

Although the natural resources sector makes up a smaller portion of GDP compared to both services and manufacturing, it is inextricably linked to these two sectors. The natural resources sector relies on a range of goods and services such as financial, business, transportation and wholesaling services, as well as machinery and chemical products. The manufacturing and services industries also provide “a potential means by which Canada can further leverage its natural resource endowments” (**The Conference Board of Canada**, 2012). The natural resources sector forms the backbone of Canada’s comparative advantage in terms of global trade, but hinges increasingly on key social and political factors such as provincial, Aboriginal and community collaboration and environmental sustainability. Some significant shifts in natural resources are highlighted below.

A shift to renewable energy? Although liquid fuels are expected to remain the most popular form of fuel for at least the next 10 to 15 years, the global demand for oil is expected to flatten or decline according to **ExxonMobil** (by 2040), **Shell** (by 2026) and **Deutsche Bank** (by 2018). These estimates hinge on expected changes in the availability of alternative energy sources, hybrid cars, higher emissions standards, consumer incentives and the potential electrification of the global vehicle fleet. On the other hand, it should be noted that a shift to alternative forms of energy for certain parts of the transportation sub-sector, such as the air and marine industries, may prove to be more difficult. In any case, the current infrastructure overhaul required to support a massive switchover will bring many opportunities as well as challenges.



Sources: Exxon Mobil (2012 The Outlook for Energy: A View to 2040^o, 2012), Shell (Signals and Signposts (update)), 2011, corrected for natural gas liquids; Deutsche Bank (The End of the Oil Age, 2011 and beyond: a reality check^o, 2010)

If oil prices remain high, alternative energy sources may become increasingly competitive, particularly as states and enterprises push towards a low-carbon economy. Global investment in renewable energy hit a new record of \$257 billion in 2011 (the biggest attractors being solar and wind power), with US total investment (57% increase from 2010 to \$51 billion) nearly tying China's (17% increase to \$52 billion). Though small in absolute numbers, India's new investment growth in renewable energy has been remarkable, with the sharpest growth in total investment (62% increase to \$12 billion). Global investment in renewables was split between developed and developing countries at 65% and 35% respectively (UNEP, 2012).

Not so rare after all: Rare earth metals, despite the name, are likely to become much more available. Although the global supply is almost entirely produced by China today (over 97%), additional sources are expected to come online in 2015 to 2016 (in Canada's North and many provinces, but also in the United States, Australia, India and South America), increasing supply and moderating prices (Canadian Chamber of Commerce, 2012). Examples of large deposits in Canada include the **Hoidas Lake Rare Earth Project** in Saskatchewan, which contains the highest proportion of **neodymium** (for magnets and batteries) present in any known rare earth deposit (Great Western Minerals Group Ltd., 2012). Of course, these resources will require significant infrastructure and extraction investments.

The quest for arable land: There has been a moderate decrease in the quantity and quality of global arable land largely due to soil degradation, along with a growing global populace. By 2020, 40% of the world's arable land may be needed to feed China alone (Canada 2020, 2011). In the last three years, more than 30 million hectares of land in Africa and Asia have been negotiated and purchased by foreign governments (such as China) or investors. In this context, the potential for food shortages is great, impacting global food prices and regional stability. For example, global food prices have increased steadily since 2000, and 37 countries – 21 in Africa – are in a food security crisis (World Resources Institute, 2008). Canada has a lot of land, and over time, more will become climatically arable, though poor soil (i.e., the Canadian Shield) and standing forests may pose problems for cultivation. At the same time, the impacts of biotechnology and emerging practices such as urban farming could provide alternatives in a world where arable land comes at a premium. Land everywhere will become increasingly sought-after and tensely negotiated, with the ocean floor as a new frontier (for food and fish, as well as minerals and other natural resources).

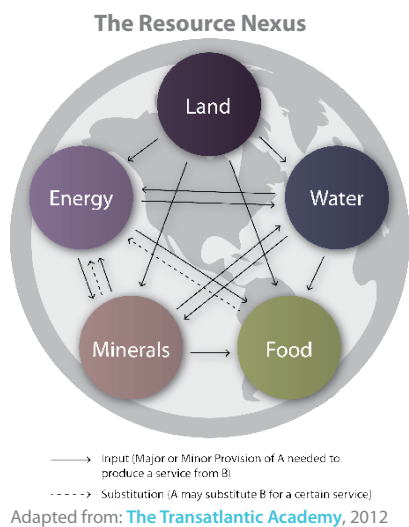
Global water pressures: Fresh water represents one of the major points of pressure for the future of global resources (e.g., rising tensions between farmers and shale gas producers in Texas). In the Middle East and South and Southeast Asia, the potential for water conflicts is far more serious (Transatlantic Academy, 2012). Most of the violent conflict would likely be between countries without a history of negotiated water agreements. Although Israel's water disputes with Jordan have been addressed in a relatively cooperative manner, no long-term solution exists. Water agreements with Syria are impossible because of the current state of conflict (Transatlantic Academy, 2012). Furthermore, the price of "virtual water" (a measure of the amount of water used to produce a good or service) has increased fourfold since 2001, which could provoke severe drought and starvation in developing countries if it continues. Pressures could mount for

Canada to begin selling fresh water, particularly to the United States, though probably not in the near future (Montreal Gazette, 2007). Global desalination of salt water has tripled (with huge energy costs) from 10 million to nearly 30 million cubic metres per day from 1989 to 2003. Canada shows promise in the development of clean, low-energy desalination technology (Daily Commercial News, 2010), though regions facing water scarcity challenges, such as the Middle East, may have the innovation advantage, since the development of these technologies is crucial to their access to water.

Resource infrastructure: A strong natural resources industry and efficient transportation network contribute to the economic well-being of our country. Canada has an opportunity to capitalize on significant energy resources, but equally significant infrastructure investments will be necessary to achieve this goal (e.g., pipelines, export facilities). Natural Resources Canada (NRCan) anticipates that \$500-billion in new energy and natural resources infrastructure and extraction projects could be made over the next 10 years (NRCan, 2012), depending on global price and energy demands.

Complexity in natural resources: Canada's North has become the focus of a complex set of domestic and international geopolitical forces, in which some \$100 billion in new investments is anticipated (Foreign Affairs and International Trade Canada, 2012 [a]); the Arctic contains minerals once thought inaccessible, including an estimated 30% of undiscovered natural gas and 13% of undiscovered oil reserves (The Economist, 2012 [b]). Land, water, minerals, food and energy are increasingly interlinked in supply and demand (e.g., the demands for water in hydraulic fracturing and volatility in global food markets and prices due to demand for biofuels). The increasing interest and investment by China in natural resources worldwide raises issues with respect to balancing foreign investment and foreign ownership with national interests, and has implications for Canada. Many actors are giving voice to environmental concerns, pressuring governments

to regulate resource development sustainably and demanding a “social licence” for businesses to operate. Some British Columbia First Nations, for example, are sending trade missions to China to represent their interests in developing natural resources on their traditional lands to ensure both long-term environmental resources and effective advancement of their communities (Kincaide, 2011). Canada faces both challenges and opportunities in navigating this complex combination of international, Aboriginal, social and environmental issues.



Policy Challenges

Based on this review of significant shifts in the key economic sectors, some interesting policy challenges emerge. For example, as new networking technologies and processes take root, the traditional economic concepts of production and consumption shift and the boundaries between them blur. Collaborative consumption, 3D printing, renewable energy, crowd sourcing, intangible goods, advanced robotics and artificial intelligence are causing

shifts in how goods and services are produced and consumed. As these shifts play out across the three key sectors of the economy, they raise questions on how to effectively harness the resiliency of our people, firms and institutions in managing the rapid and potentially transformative change of the next economy. In this regard, some key policy implications of the next economy are discussed below...



...for people

Automation may impact jobs in a profound way

Rapid technological advancements are shifting the work environment. In the next 10 to 15 years, people and smart machines will increasingly interact to produce goods and deliver services. While automation will continue to displace a variety of routine jobs (i.e., those that can be broken into specific tasks, operate in standardized environments, facilitate self-service), medium- to high-skilled tasks may also increasingly be threatened (i.e., case research for lawyers, analysis and evaluation of visual images for diagnosis, elder care), potentially resulting in substantial unemployment. At the same time, smart algorithms may be used to quickly search, evaluate and summarize information, augmenting the work traditionally done by people and allowing them to take on more creative jobs ([Policy Horizons Canada](#), 2012). While productivity improvements through new technologies will increase output and decrease the number of jobs required in established industries in the natural resources sector, workers may be required to operate more complex machinery and tools, as tasks become more technical. Future jobs will likely consist of existing, evolving and brand new jobs.

- How can automation be used to improve the efficiency and effectiveness of human capital, while creating new job opportunities for both high- and low-skilled workers?
- If automation results in substantial unemployment, how can society address issues such as income inequality, redistribution of wealth and equalizing opportunities for economic and social mobility?
- How will Canadians fare in the global competition for jobs, as automation displaces large labour pools in emerging economies? What will be the implications in terms of Canadians both finding jobs overseas and competing for jobs at home (i.e., with temporary foreign or “virtual” workers)? What is the role of governments and others?

Potential Jobs of the Future

Rick Miner’s recent report, “Jobs of the Future: Options and Opportunities,” points to a range of existing, evolving and new jobs likely to emerge in 2020 to 2030. Examples include:

The future of existing jobs (from the U.S. Bureau of Labour Statistics projections of 2010 to 2011’s fastest growing occupations):

- biomedical engineers
- network systems and data communications specialists
- home health aides
- personal and home care aides
- financial examiners

Evolving jobs of the future (from University of Calgary Career Counselling research on trends that will shape the future of work):

- information system librarian specialists
- Internet specialists
- natural healing practitioners
- software developers
- any elder health field

New jobs of the future (futurists Adam Gordon & Thomas Frey):

- body part maker and organ agents (via bio-printing)
- avatar managers
- robot designers, dispatchers and trainers
- 3D printer maintenance workers
- data hostage specialists and waste data handlers

Source: [Miner](#), 2012.

The future of work may be increasingly non-standard in form

The evolution of a **project economy**¹ and the concept of hyper-specialization, driven by technology, will allow certain tasks to be done virtually anywhere and may drastically shift the way work is organized. While there has been little growth in telework over the past several years, a resurgence seems to be in the works ([Leonard](#), 2011). We may see further growth as information and communication technologies (ICTs) continue to improve and more and more workers (e.g., older workers, people with disabilities, international virtual workers) are able to dictate their own work environments either due to preferences or other issues (commuting challenges, cost of energy, environmental concerns, loss in productivity and time, etc.). We may see a rise in part-time, self-employed, entrepreneurial, temporary, contract and freelance work, with frequent job changes and people working for more than one employer at a time (such as today’s ICT consultants). Enhanced forms of business services and specializations may result as more people move into the small firm entrepreneurial model. These shifts have the potential to erode traditional employer-employee relationships.

- How could non-standard work arrangements impact incomes and access to social security benefits? What type of social policy framework could support Canadian participation in this environment?
- Are societal obligations changing with respect to foreigners working virtually in Canada and Canadians working virtually overseas? What are the implications for taxes and benefits?

¹ The “project economy” refers to the breakdown of work into smaller pieces, which alters the process for firms soliciting the work and people carrying out the work. It is characterized by shorter product lifecycles, mass-customization of goods and services and increasing complexity of the supply chain (Dwight, 2006).

The skills required for future work will likely be different

As the nature of work shifts, the skills required to operate in the work environment may also change. We are facing a strange period of both increased unemployment and underemployment, and at the same time a shortage of highly skilled workers. Past trends indicate that high-skilled workers – those who have strong communication, intellectual and problem-solving skills – have experienced low unemployment and increasing wages ([Manyika et al., 2012](#)). The opposite seems true for some low-skilled jobs that have been displaced to outsourcing and automation. As we move to a more technologically capable world, we will need to examine the comparative advantages of people in the future world of work and how to educate our workforce accordingly. The challenge is that we do not know what the jobs of the future will be or what skills will be required to carry out those jobs. Nevertheless, we can imagine that some of the skills that may benefit the workers of tomorrow could include high-level capabilities such as creativity, cross-cultural competency and adaptive thinking, as well as practical skills such as new media, data literacy and digital skills (see box on “Potential Skills Required in the Next Economy” for further examples). However, our education system is facing some challenges in terms of developing these skills for the future workforce and requires a re-examination of how better to cultivate creativity and multiple forms of intelligence ([Robinson, 2010](#)).

- What impacts will potential skills shortages have on competitiveness, innovation and income inequality?
- Are there shifts required in our education system to help citizens develop the high-level, practical and transition skills necessary to adapt to rapidly changing conditions?

Potential Skills Required in the Next Economy

- **Social intelligence skills** that harness the key “right-brained” tools to effectively come up with innovative solutions to complex problems.
- **Adaptive thinking skills** to help people immediately respond to unexpected situations.
- **Creativity and design capabilities** that enable people to shape imaginative ideas into reality.
- **Cross-cultural competency** to navigate relationships and collaborative efforts in increasingly diverse and unfamiliar contexts.
- **New media and data literacy skills** to aid in better communication of novel ideas through visual, auditory and sensory means.
- **Filtering abilities** to manage information overload and focus, yet still take in and process a vast range of information.
- **Virtual and digital skills** that enable workers to harness collaborative technologies to share ideas and work via online interactions.
- **Science, technology, engineering and mathematics skills** to effectively harness and develop rapid advances in technology.
- **Foresight and systems thinking capabilities** that help people understand particular systems and explore implications of change.
- **Interdisciplinary skills** that allow people to see the linkages between a range of disciplines to help address complex problems.

Sources: [Davies et al., 2011](#); [Gratton, 2010](#); [Pink, 2005](#)

Increasing work, debt and dependency pressures

The move towards more non-standard work arrangements and increased interaction between consumers and firms brings about many opportunities to engage in the next economy. At the same time, a more networked economy accompanied by a 24/7 work lifestyle, income inequality and significant demographic shifts bring about increasing pressures and responsibilities for individuals, families and communities. For example, it is estimated that given the aging population, the Canadian workforce will decline (Miner, 2012). This will create pressures on Canadians, which may be exacerbated by a less stable working environment. Skills development will be key to ensuring that as much of that working population as possible is productively employed. On the other hand, a steadily aging population that lacks adequate pensions from employers, and has a high incidence of debt and low savings, may opt to defer retirement or transition to retirement through supplementary careers and part-time or contract work well past the age of 65.

At the same time, some people are questioning an economic structure that is growth-obsessed, resource-intensive and consumer-oriented and are pushing for a more people-oriented economy. This involves the transition to an economy that incorporates a shorter work week that could help address interlinked problems such as “overwork, unemployment, over-consumption, high carbon emissions, low well-being, entrenched inequalities, and the lack of time to live sustainably” (The New Economic Foundation, 2010).

- What forms of income support and stabilization will governments and others provide citizens experiencing increasing dependency pressures and an uncertain work environment?
- What strategies and supports will Canada develop to harness the talents of younger, older, immigrant and Aboriginal workers in the next economy?
- How can Canada leverage new tools and technologies (e.g., health and environment monitoring sensors) to help improve the well-being of Canadians and secure cost and operating efficiencies?

Enhanced global migration and multiple allegiances

Immigration will inevitably play a role in ensuring that Canada has the skills, creativity, connections and labour force necessary to compete in the next economy. Harnessing the talents of immigrants, as well as those underrepresented in the labour force (e.g., Aboriginal people, people with disabilities and older workers), will also be a key factor in determining how people shape the next economy. The issue of circular migration, which involves the temporary and repetitive movement of people across borders usually for work purposes, and return migration, especially given the rise in fortunes of emerging economies, could foster multiple citizenships and allegiances and significantly impact the Canadian immigration system. These types of migration flows may also be more conducive to an environment of short-term contract work where companies will be searching for various ways to meet labour market needs. However, challenges will arise in terms of ensuring that workers' rights are protected in an environment where employers could have more of a say in the immigrant selection process than governments themselves. Moreover, Canada will not be immune to changes in the developing world that impact migration flows, such as conflict, climate change and the search for better economic opportunities.

- How can governments and others manage a growing percentage of the population that is continually migrating? What allegiances will these people have to host countries?
- As capital, information, products and services move freely across a digitally networked economy, will it be possible and/or reasonable to restrict labour mobility?
- What is Canada's value proposition to domestic and foreign workers?
- What responsibilities will Canada have to global migrants? What bilateral and multilateral social agreements and policies (health benefits, pensions, taxes, etc.) could be put in place for these migrants?



From big, closed and competitive to small, open and collaborative

As global exchanges coalesce around the Internet and move towards a more networked economy, the character of firms may shift from big, closed and competitive to small, open and collaborative. A digitally networked economy can be expected to favour small, smart, agile and networked firms, such as micromultinationals. Successful businesses will increasingly engage in collaborative production processes (e.g., “**crowdsourcing**” with consumers and “co-opetition” with competitors) to design, produce and deliver goods and services. Firms may start to coalesce around mega-cities, where the diversity, creativity and proximity to an array of collaborators, competitors and creative class workers will create hotbeds for innovation. Traditional firms may experience more instability in this environment as low profits due to “hyper-competition” become the

norm (although in some cases, the more nimble firms may experience high profits at the start of their potentially shortened life cycles). New models of accessing venture capital funds are emerging that may help support start-ups and small firms in an increasingly competitive environment (**Yale School of Management**, 2011). **Kickstarter** is a social media platform being used to solicit investors for creative projects and is a good example of the emerging **crowdfunding** model.

At the same time, it is unlikely that big corporations will decline in influence, as the wave of corporate consolidation in the wake of the financial crisis is far from over, especially in natural resources where the large physical, human and technical capital required for projects remains substantial. Although Canada's economy is structured to favour small and medium-sized enterprises (SMEs), large multinational enterprises (MNEs) are likely the ones that have the resources to undertake R&D projects that lead to new technological, product and service developments, as well as the ability to cross borders and create new supply chain links. Like micromultinationals, the avenues for small firms will likely be to expand, go out of business or be acquired by larger firms. MNEs will continue to foster the latter two. Nevertheless, there are actions that can be taken to support small innovative firms, including simplifying the tax-credit system and facilitating access to capital for risky ventures (**Jenkins**, 2011).

- What types of industrial policies could Canada put in place to support small firms and foster innovation in a world where it can come from anywhere?
- What types of incentives could be provided to promote entrepreneurial activity and develop venture capital models that support smart but risky investments?

The evolution of global value chains

Advances in technology, such as 3D printing, reconfigurable manufacturing, advanced robotics and smart products, have the potential to shift business processes as we know them. On one hand, we could see the localization or regionalization of some customized manufacturing and services in advanced and emerging economies, while on the other we could see more and more firms relocating to emerging markets where a growing middle-class consumer population is taking shape. In some cases, services firms could be deemed location insensitive (e.g., today's software companies... tomorrow's remote robotic service providers) and virtual reality may become advanced enough to replicate real experiences that foster enhanced telework and shopping experiences. In this sense, value chains for both goods and services could become both regional and global. At the same time, the focal point of economic activity could be in mega-cities around the world that are connected with each other through trade and finance.

- What is Canada's competitive advantage in a world where many countries are harnessing advancing technology in the design, production and delivery of goods and services?
- How can Canadians and Canadian enterprises determine which niches to invest in, create, hold onto or let go? What role, if any, can governments play in facilitating this?
- What strategies could Canadian middleweight cities adopt as politics and the economy are increasingly driven by a network of global cities?

The rise of the socially and environmentally conscious firm

Environmental pressures and resource scarcity issues are increasingly influencing how firms operate. Governance inefficiencies in effectively dealing with these issues are pushing firms to fill the void and mitigate risk in supply chains. New strategies for sustainable use of resources (e.g., **collaborative consumption, virtual telepresence** and **urban mining**) are already emerging, providing opportunities for the development of new types of business models and reconceptualising the profit motive traditionally linked to firms. Emerging models may include social enterprises², which use commercial strategies to address social and environmental problems, and the concept of servicization, which combines production and service components to address the global strain on natural resources. These models and strategies have implications for the production of new goods, raise challenges to existing firms and bring new players into the economy (Confino, 2012).

- How might the private and non-profit sectors' growing knowledge of market needs affect publicly offered services? What needs might they fill? What new needs may emerge?
- What will be the impacts of the socially and environmentally conscious firm on the manufacturing of new goods? On newly extracted natural resources?
- What is the future of "corporate social responsibility" in the adaptation of commerce?

²An example of a social enterprise is **B Corporations**, which aim to meet social and environmental performance and legal accountability standards and support sustainable business practices.

From scarcity to abundance through intangible goods

The growth of intangible goods through digitization (e.g., moving from CDs to iTunes, paper print to e-print) will alter the economic fundamentals of various markets from a condition of relative scarcity to one of relative abundance. For content recipients, the wide availability of intangible goods poses a challenge to manage information overload by filtering for what is most personally relevant. Messengers of content (e.g., firms, media, government and increasingly individuals) are challenged by the escalated task of attracting attention in this environment. As digitization enables easier production and reproduction, a natural barrier to market competition softens. This transition raises the normative question of whether artificial market barriers in the form of strong intellectual property (IP) rights should be applied to protect the rents accrued to creators. If set too strong, IP laws can stifle competition and innovation; prices held too high also create fruitful ground for piracy, undermining the income stream of creators and sales tax revenues to governments. If the role of IP is largely to stimulate creation where it would not otherwise occur, the growing open source movement may point to new incentives for creation, such as the joy of sharing and the benefits of building reputation, networks and trust.

- What new business models are arising from the intangible economy? How well can these be monetized?
- How will Canada's intellectual property policies evolve to the unique conditions of intangible goods, to Canadian values and to the IP standards set internationally? How will we develop a responsive regulatory system to ensure we remain competitive?
- How will the evolution of IP affect Canada's ability to attract innovators? What industries might be helped and hindered?

The increasing importance of data and data analytics

To harness intangible assets, firms will have to develop methods to better understand their employees, customers and competitors. The use of data analytics, social media and other technologies is increasing the capacity and speed at which firms can augment this understanding and optimize their operations.

- How can Canadian firms use advances in data analytics to better tap into emerging consumer markets (e.g., 55+ cohort, emerging economies' middle class)?
- As the economic value of personal data grows, what are the implications for the regulation of privacy and international data flows?



...for institutions

From hierarchical to network-oriented global institutions

The recent global financial crisis made it apparent that our global institutions are not working as effectively as they could. Presently, an ongoing debate is taking place over what systems and institutions are appropriate to govern international finance in the future. Any shift in the way the World Trade Organization, International Monetary Fund and World Bank operate will have a profound impact on global trade and investment.

As the next economy evolves, some form of enhanced coordination and effective multi-level governance will likely be required to help a diverse range of societal actors handle an increasingly complex and rapidly shifting global economy (see the Policy Horizons Canada study *Driving Policy on a Shifting Terrain*). Governance institutions at both national and global levels may develop into more network-oriented

entities to manage the next economy effectively. A characteristic of this may be the movement towards collaborative problem-solving processes. This would require conducting open, transparent and inclusive dialogue with a range of state and non-state actors from local to global levels, but will also need to be balanced with the need for streamlining to ensure timely and practical results. Technology is already being harnessed in the move towards these collaborative network-oriented entities, for example in the multilateral **Open Government Partnership** that aims to “promote transparency, empower citizens, fight corruption, and harness new technologies to strengthen governance.” At the same time, it should be recognized that the increase in economic power centres (i.e., increasing influence of mega- and middleweight cities, the BRICS, other emerging countries) will inevitably reshape how global institutions evolve, as will the growing influence of multinational corporations on governance regimes (Crabtree, 2006).

- What policy and coordination changes are required at the national and global levels to make international institutions more effective, accountable and well managed?
- How can future policy and governance responses be more flexible and adaptive to take into account rapidly changing needs and circumstances?
- What are the appropriate roles for the different levels of state and non-state actors (e.g., powerful multinational corporations, industrial associations, civil society organizations) in the next economy?
- Will national governments have the ability to regulate very large multinational firms, particularly financial institutions, in the interests of their citizens’ welfare?
- What international law, jurisprudence, regulations and standards will affect Canada’s economic prospects? Will emerging global arrangements and rules give Canada sufficient scope to manage domestic interests?

The Quest for Resilience

The international economic system is in flux, driven by shifts in economic influence, governance, technology, demographics and environmental sustainability issues. As these drivers interact, we can expect profound changes within the sectors that make up the Canadian economy. This foresight study has examined some of these changes, especially ones driven by rapid advances in technology and a digitally networked global economy.

Canada is well positioned to thrive in the next economy, enjoying a number of key advantages in natural resources, sound institutions, a skilled workforce and sophisticated technological infrastructure. The country needs, however, to take account of a number of key challenges:

- keeping pace with the changes in employment and business opportunities created by intensive automation, rapid adoption of new technologies, a strong orientation to services and “intangible” products, the push towards sustainability, and a global economy that is highly networked and both collaborative and competitive
- adjusting social policies (health, employment insurance, pension, taxation) to take account of jobs that are more scarce, project-based and linked to employers and markets around the world
- adapting the skills of all Canadian workers (including both younger and older workers, Aboriginal people and new immigrants) to new kinds of employment opening up
- effectively managing migration and work patterns that are far more fluid and virtual
- taking advantage of new market opportunities in the rapidly growing cities of Asia, Latin America and other regions of the world

A successful effort to anticipate key facets of Canada’s next economy, to build on the country’s residual strengths and to meet key policy challenges can be expected to ensure a resilient Canadian economy in 10 to 15 years’ time.

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Annex 1: Engagement Process

This foresight study is the result of a collaborative exercise that engaged a wide cross-section of experts through interviews, workshops and various other engagement sessions between December 2011 and May 2012. The purpose of the engagement was to identify and challenge assumptions, examine insights and change drivers, and explore plausible scenarios for the next economy. Policy Horizons Canada would like to thank all participants for graciously providing their time, energy and ideas. Also, we would like to thank all reviewers who provided comments, suggestions and advice on the draft report. Please find below the list of federal and external experts engaged throughout this process.

Federal Government

- Byron Allin, Natural Resources Canada
- Adler Aristilde, Canadian International Development Agency
- Fabiola Bazo, Industry Canada - Vancouver
- Pal Bhogal, Natural Resources Canada
- Jeffrey Biggs, Natural Resources Canada
- Robert Blain, Natural Resources Canada
- Bruno Bond, Natural Resources Canada
- Daniel Boothby, Industry Canada
- Alan Bowman and the Policy Research Division, Foreign Affairs and International Trade Canada
- Carrie-Ann Breckenridge, Human Resources and Skills Development Canada
- Michele Brenning, Canada School of Public Service
- Chris Bywater, Industry Canada - Victoria
- Patrick Chevalier, Natural Resources Canada
- George Claydon, Infrastructure Canada
- Lynn Côté, Export Development Canada
- Dave Donovan, Canadian International Development Agency
- André Downs, Foreign Affairs and International Trade
- Andrea Duncan, Industry Canada - Saskatoon
- Michael Edwards, Industry Canada - Halifax
- Dale Eisler, Natural Resources Canada
- Jeff Frank, Human Resources and Skills Development Canada
- Anthony Muttu, Human Resources and Skills Development Canada
- Brad Gilmour, Agriculture and Agri-Food Canada
- Judith Hamel, Environment Canada
- Jennifer Hayward, Industry Canada - Iqaluit
- Michael Hurst, Industry Canada - Yellowknife
- Samuel Ileso, Service Canada - Charlottetown
- Randy Jewers, Service Canada - Dartmouth
- Benoit Leduc, Industry Canada
- Stelios Loizides, Western Economic Diversification Canada
- Maurice Mandale, Atlantic Canada Opportunities Agency
- François Masse, Privy Council Office
- Robert Mattioli, Service Canada - Vancouver
- Patrick McDuff, Service Canada - Toronto
- Anthony Michel, Canadian Heritage
- John Moffet, Environment Canada
- Wilma Monje, Industry Canada - Edmonton
- David Norton, Industry Canada - Toronto
- Tobias Nussbaum, Canadian International Development Agency
- David Péloquin, Aboriginal Affairs and Northern Development Canada
- François Poitras, Service Canada - Montréal
- Simon Pomel, Foreign Affairs and International Trade Canada
- Arlene Ponting, Natural Sciences and Engineering Research Council
- Michael Presley, Treasury Board of Canada
- Paul Radford, Service Canada - Vancouver
- Daria Rakowski, Industry Canada - Winnipeg
- Shane Reoch, Service Canada - Regina
- Michael Rushe, Service Canada - Halifax
- Annette Ryan, Industry Canada
- Michael Sawyer, Service Canada - Vancouver
- Jennifer Simms, Industry Canada
- Jonathan Simms, Industry Canada - Halifax
- Al Streuber, Industry Canada - Winnipeg
- Mary Toffanello, Service Canada - Timmins
- Namatie Traore, Agriculture and Agri-Food Canada
- John Verdon, Defence Research and Development Canada, Department of National Defence
- Daniel Watson, Western Economic Diversification Canada
- Tushara Williams, Human Resources and Skills Development Canada
- Ramsey Wright, Natural Resources Canada

External

- Maxim Armstrong, The Conference Board of Canada
- David Autor, Massachusetts Institute of Technology
- Alan Barber, Government of Manitoba
- Perrin Beatty, Canadian Chamber of Commerce
- Peter Bell, University of Victoria
- Michael Benarroch, Asper School of Business
- Sam Boutziouvis, Canadian Centre of Chief Executives
- Brendon Boyd, University of Victoria
- Emmanuel Brunet-Jailly, University of Victoria
- Michael Buda, Federation of Canadian Municipalities
- Narendra Budhia, Government of Manitoba
- Michael Burt, The Conference Board of Canada
- Dennis Bushnell, United States National Aeronautics and Space Administration Research
- Andrew Cardozo, The Alliance of Sector Councils
- Chuck Cartmill, LED Roadway Lighting
- C. Scott Clark, C. Scott Clark Consulting
- Stephen Clarkson, Centre for International Governance Innovation
- Ken Coates, University of Waterloo
- Rod Dobell, University of Victoria
- Norman Dolan, University of Victoria
- Don Duval, Northern Centre for Advanced Technology Inc.
- Paul Evans, University of British Columbia
- Deborah Fehr Barkman, Government of Manitoba
- Giles Gherson, Government of Ontario
- Jean-Pierre Giroux, Canadian Manufacturing Network
- David Good, University of Victoria
- Joe Greenwood, MaRS Discovery District
- Karen Greve Young, MaRS Discovery District
- Budd Hall, University of Victoria
- Greg Halseth, University of Northern British Columbia
- Joseph Heath, University of Toronto
- Allyson Hewitt, MaRS Discovery District
- Cindy Holder, University of Victoria
- Terry Hunsley, Canadian Centre for Social Development
- Irene Huse, University of Victoria
- Roberta Jamieson, National Aboriginal Achievement Foundation
- Anja Jeffrey, Centre for the North, The Conference Board of Canada
- Paul Jenkins, Centre for International Governance Innovation
- Bruce Katz, Brookings Institute
- Vinod Kumar, Carleton University
- Diana Kuzmanovic, Government of Ontario
- Dennis Lewycky, Social Planning Council of Winnipeg
- Evert Lindquist, University of Victoria
- Veronika Litinski, MaRS Discovery District
- Leah Littlepage, Canadian Services Coalition
- Maeve Lydon, University of Victoria
- Colin McKay, Google
- Earl Miller, MaRS Discovery District
- David Moorman, Canada Foundation for Innovation
- Monique Moreau, Canadian Federation of Independent Business
- Alan Nymark, Public Policy Consultant on Growth and Sustainability
- Louis-Martin Parent, Canadian Federation of Independent Business
- E. Thomas Penner, Government of Manitoba
- Chor Pharn, Ministry of Trade and Industry, Singapore
- Corinne Pohlman, Canadian Federation of Independent Business
- Mario Polese, Institut national de la recherche scientifique
- Tom Rand, MaRS Discovery District
- Tony Redpath, MaRS Discovery District
- William B. P. Robson, CD Howe Institute
- Lester Salamon, Johns Hopkins University
- Kim Speers, University of Victoria
- Usha Srinivasan, MaRS Discovery District
- Sim Phei Sunn, Ministry of Trade and Industry, Singapore
- M. Scott Taylor, University of Calgary
- Harold Thomson, Government of Manitoba
- Lisa Torjman, MaRS Discovery District
- Diane-Gabrielle Tremblay, Université de Québec à Montréal
- Ilse Treurnicht, MaRS Discovery District
- Armine Yalnizyan, Canadian Centre for Policy Alternatives

Annex 2: Technology Futures Mapping

The technology futures map below offers a detailed look at technological advances in six key areas, with plausible times for commercial introduction of the various technologies. These technology sectors were selected as they are likely to have the largest direct impact on work, life, firms and policy over the next 15 years. The dates given are prospective only, and depend upon several factors, of which the most important are the IP regime in place and market demand. Note: Concepts such as data analytics, smart products, biotechnology and nanotechnology are embedded in the six technology sectors identified below.

Artificial intelligence

The central features of artificial intelligence (AI) include such traits as reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects. Significant advances are expected in this field over the next 15 years. Face, gesture and expression recognition, all-speech user interfaces, spoken natural language translation, real-world object identification and autonomous semantic search will likely be integrated into devices. Digital systems may adapt to the personality and emotions of their users. It will be possible to automate many tasks through AI, improving efficiency and productivity, while displacing employment, both in physical and “creative class” work. In some cases entire jobs will disappear, while in others certain parts of jobs will be carried out by AI.

Sensors

The cost of devices that get information from the world is falling by a factor of four every four years for a given level of performance. Today location, gravity, magnetic, temperature and radio sensing are commonplace; in the future, speaker-tracking stereo HD video and audio will likely be standard in

consumer electronics. Tactile sensors as responsive as human fingertips are available; air and liquid chemosensors that can sense levels of a million substances at once are on the market. Many sensors will be partly or fully mobile, roaming to get the best placement for data recording. Sensor systems in the future will likely be able to automatically track people and objects, their location and identity anywhere. Searching for objects or people will be as easy as privacy legislation allows.

Virtual Telepresence

It is expected that virtual telepresence technology will improve greatly over the next 15 years, due to improvements in display, recording and communications technologies. High-bandwidth fiber-to-the-home and wireless multi-gigabit Ethernet will enable smooth full-motion videoconferencing with stereo audio capture with \$500 of hardware that looks as good as watching a live theatre performance. Sunglasses with heads-up displays, virtual reality glasses and data gloves that allow force-feedback will likely exist, but most may choose to use digital surfaces and tracking stereo cameras for telepresence. This will change the way we work, where we work and with whom we work: either across town or across the globe. Soon education, health care and other services will likely be affected by telepresence technology.

The Internet of Things

The Internet of Things is a set of technologies that make it possible to connect devices to the Internet allowing the physical world to be accessed through software. Consumer products in every category will distinguish themselves by being “smart”: providing information and wirelessly responding to users. In 10 years, most citizens will likely own 10 to 50 smart objects that talk to each other. Parking lots may track occupancy, sports shoes may profile exercise behaviour and toilets may measure health biometrics. Smart devices will likely link up through

cloud services, allowing advanced user services and data analytics for business intelligence. The Internet of Things will likely drive and interact with services, embodying service models in a way that is difficult to copy without the device.

Robots

A robot is a mechanical or software agent that can perform tasks automatically or with remote-controlled guidance. Mobile robots with arms are already being used for stock-taking, load-moving, housework, elder care and security and will likely become more commonplace; a personal humanoid robot might cost between \$10,000 and \$25,000. Many task-specific robots will exist, to do tasks as diverse as surgery, cooking and farming. Most robots will likely not be humanoid in form (e.g., camera-equipped sensor robots will likely be widespread and most new cars will likely have a self-driving feature).

Medical technology

Medical technology is expected to advance significantly over the next 15 years. This is particularly true in the domains of medical devices and medical software. Advances in sensors may enable early detection and warnings of disease states for hundreds of infections, diseases and disorders by a simple blood test. These labs on a chip could be deployed first to doctors' offices, then directly to homes as costs fall. Genomics can be expected to advance greatly: by the end of 2012, sequencing a human genome to a high level of certainty will likely cost \$1000. Routine sequencing of both patients' and infecting organisms' genomes may be commonplace. Vaccines will likely experience a renaissance as vaccines for the cold, nicotine addiction, birth control and some cancers become available. 3D printers are currently being used to print biocompatible replacements for hips and jaws, and can be expected to evolve further, with printing of entire organs likely to follow.

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Technology Futures Map

