# CLIMATE PROSPERITY

A CANADIAN INITIATIVE

MEASURING UP: BENCHMARKING CANADA'S COMPETITIVENESS IN A LOW-CARBON WORLD // REPORT 01


National Round Table on the Environment and the Economy

Table ronde nationale sur l'environnement et l'économie

Canada

# MEASURING UP

*CLIMATE PROSPERITY* MEANS COMPETING WITH THE WORLD TO BUILD A NEW LOW-CARBON FUTURE FOR CANADA AND CANADIANS.

THE GREEN RACE IS ON.

CANADA NEEDS TO BE READY.

// FIRST IN A SERIES

# THIS IS NOT JUST ABOUT COPING WITH CLIMATE CHANGE, BUT PROSPERING THROUGH IT.

A CANADIAN INITIATIVE

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**Disclaimer:** The views expressed in this document do not necessarily represent those of the organizations with which individual Round Table members are associated or otherwise employed. The NRTEE strives for consensus but does not demand unanimity. The NRTEE's deliberations included vigorous discussion and debate reflecting diversity of opinion.

# ACKNOWLEDGEMENTS

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The NRTEE would like to thank the members of the expert advisory committee who provided input into important arenas for low-carbon performance.

The NRTEE wishes to acknowledge the advice and analysis by the Conference Board of Canada and particularly, Deloitte & Touche LLP who conducted the benchmarking analysis and helped develop the Low-Carbon Performance Index (LCPI). A special thank you to David Greenall, from Deloitte & Touche LLP, for his tireless efforts in reviewing results and helping to advance this report.

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# MESSAGE FROM THE CHAIR

As Chair of the National Round Table on the Environment and the Economy, I am pleased to present *Measuring Up: Benchmarking Canada's Competitiveness in a Low-Carbon World*, the first report of a new policy series called *Climate Prosperity*.

As Canadians move to define their position in a carbon-constrained world, we must focus on our innovation, competitiveness, and economic growth. We must create low-carbon solutions that others will want to buy. We must continually benchmark and compare our efforts to our G8 colleagues. We must understand well the carbon context of our trade operations with the G8 and beyond. This is where sustainability and prosperity meet and interact. Our export products will have to meet global carbon standards, but in doing so nurture our own prosperity.

*Measuring Up* examines how Canada ranks within the G8 nations for low-carbon performance. Knowing where we stand today will help us prepare for future climate prosperity. The federal government's consultation paper on its sustainable development strategy made this important observation:

*"Canadian policy makers have long sought a way to benchmark and track our country's progress towards making its economy more sustainable."*

The Round Table agrees and offers this report as a contribution to this goal.

Canada will be challenged. But the NRTEE believes Canada and Canadians are up to that challenge—that with the usual Canadian ingenuity, hard work, and original policy ideas, Canada can become a world leader in the new economy to come.

Sincerely,

**BOB PAGE**
*NRTEE Chair*

# MESSAGE FROM THE PRESIDENT AND CEO

The “green race” is on. And Canada needs to catch up.

That’s the conclusion of the National Round Table on the Environment and the Economy’s latest report, *Measuring Up: Benchmarking Canada’s Competitiveness in a Low-Carbon World*.

This study is first in a series of the Round Table’s new, two-year policy program called *Climate Prosperity*. In the global transition to a low-carbon economy, Canadian competitiveness is at stake. We need to determine where we can succeed and gain in achieving a low-carbon performance that will create jobs and opportunity for Canadians. That transition is inevitable, but Canada’s place in it is not.

The NRTEE has created a new Low-Carbon Performance Index designed to measure how we compare to our most important competitors — the G8 — on key and emerging measures of low-carbon performance. This new index will help governments, industry, and policy makers think in new ways about what really matters in this transition. It gives us a strong starting point in figuring out where we stand, so we can determine how we must go forward.

Canada must position itself to compete and prosper in a new global low-carbon economy. The challenge before us is not just about coping with climate change, but prospering through it.

**DAVID McLAUGHLIN**
*NRTEE President and CEO*

# ABOUT US

Emerging from the famous Brundtland Report, *Our Common Future*, the National Round Table on the Environment and the Economy (NRTEE or Round Table) has become a model for convening diverse and competing interests around one table to create consensus ideas and viable suggestions for sustainable development. The NRTEE focuses on sustaining Canada's prosperity without borrowing resources from future generations or compromising their ability to live securely.

The NRTEE is in the unique position of being an independent policy advisory agency that advises the federal government on sustainable development solutions. We raise awareness among Canadians and their governments about the challenges of sustainable development. We advocate for positive change. We strive to promote credible and impartial policy solutions that are in the best interest of all Canadians.

We accomplish that mission by fostering sound, well-researched reports on priority issues and by offering advice to governments on how best to reconcile and integrate the often divergent challenges of economic prosperity and environmental conservation.

The NRTEE brings together a group of distinguished sustainability leaders active in businesses, universities, environmentalism, labour, public policy, and community life from across Canada. Our members are appointed by the federal government for a mandate of up to three years. They meet in a round table format that offers a safe haven for discussion and encourages the unfettered exchange of ideas leading to consensus.

We also reach out to expert organizations, industries, and individuals to assist us in conducting our work on behalf of Canadians.

The *NRTEE Act* underlines the independent nature of the Round Table and its work. The NRTEE reports, at this time, to the Government of Canada and Parliament through the Minister of the Environment. The NRTEE maintains a secretariat, which commissions and analyzes the research required by its members in their work.

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NRTEE PRESIDENT AND CEO
**David McLaughlin**

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## 0.4 // MOVING FORWARD

## 0.1 INTRODUCTION

*Climate Prosperity* is a comprehensive, two-year policy research and advisory program being undertaken by the National Round Table on the Environment and the Economy on the economic risks and opportunities to Canada of climate change.

Examining what the physical impacts of a warming climate will mean to our environment and what a global low-carbon transition will mean to our economy, *Climate Prosperity* will offer new insights and analysis into shaping Canada's public policy responses to this most extraordinary challenge.

This new report, *Measuring Up: Benchmarking Canada's Competitiveness in a Low-Carbon World*, is the first in the *Climate Prosperity* series of reports the NRTEE will issue examining how Canada can prosper through the economic risks and opportunities of climate change as part of this global low-carbon transition.

*Measuring Up* sets the scene for us. It creates Canada's first-ever Low-Carbon Performance Index (LCPI) so we can begin to compare where we stand against our G8 competitors. As the world moves to a low-carbon economy, Canada can win or lose. The choice is ours. While the transition is inevitable, the outcomes for us as a country are not. To succeed and prosper in this global low-carbon transition, we must first know how we stand against others. We can use this to determine where and how to plan ahead and gain the most.

The NRTEE's LCPI breaks new ground by illustrating what matters most and why when it comes to low-carbon performance. This index is the first word, not the last, on what we should be tracking to ensure low-carbon competitive success. It is of interest to governments, industry, investors, educators, and media. It commences a needed public policy conversation about where we must strategically focus and why, if we are to succeed in the transition to a global low-carbon economy.

## 0.2 NRTEE LOW-CARBON PERFORMANCE INDEX

Developed with Deloitte & Touche LLP and benefitting from advice and analysis of the Conference Board of Canada, the NRTEE LCPI is a composite index of 15 indicators, equally weighted across five low-carbon performance categories.

These categories — emissions and energy, innovation, skills, investment, and policy and institutions — are core to a country's low-carbon performance and competitive success. By low-carbon we mean low greenhouse gas emissions related to how we produce and consume energy in our economy. The categories are meant to illustrate not just the status of Canada's performance at any one time, but also our capacity to prosper and advance in a carbon-constrained world. Any low-carbon growth plan will necessarily build from these core categories in fostering low-carbon performance and future competitive advantage for Canada.

### NRTEE LOW-CARBON PERFORMANCE INDEX

| EMISSIONS & ENERGY | INNOVATION | SKILLS | INVESTMENT | POLICY & INSTITUTIONS |
|---|---|---|---|---|
|  |  |  |  |  |
| CARBON PRODUCTIVITY | LOW-CARBON ENERGY PATENTS | SUSTAINABILITY MBA PROGRAMS | CLEAN TECHNOLOGY INITIAL PUBLIC OFFERING (IPO) | LOW-CARBON GROWTH PLAN |
| EMBODIED CARBON EMISSIONS IN EXPORTS | ENERGY SECTOR BUSINESS EXPENDITURE ON R&D | LOW-CARBON PROGRAM GRADUATES | CLEAN TECHNOLOGY VENTURE CAPITAL | GREENHOUSE GAS TARGETS AND ACCOUNTABILITY |
| LOW-CARBON ELECTRICITY | GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D | SPENDING ON POST-SECONDARY EDUCATION | LOW-CARBON STIMULUS SPENDING | CARBON PRICE COVERAGE AND STRINGENCY |

The 15 indicators are robust and comparable across all G8 countries. They are relevant proxies for important low-carbon performance in the categories in which they are presented. Each was selected following a rigorous assessment of data viability, comparability, and utility. Together, they create a clear and meaningful picture of international low-carbon performance that allows us to benchmark Canada against our main economic competitors.

## 0.3 HOW CANADA RANKS

### Canada scores sixth place in the G8 when it comes to low-carbon performance.

We are at this time firmly in a second tier of countries, along with the United States and Japan, significantly back from the first-tier European nations of France, Germany, and the United Kingdom. Italy and Russia are the clear low-carbon laggards in the G8 community; creating three distinct groupings of performance.

**HOW CANADA RANKS:** BENCHMARKING LOW-CARBON PERFORMANCE OF CANADA & THE G8

| | OVERALL | EMISSIONS & ENERGY | INNOVATION | SKILLS | INVESTMENT | POLICY & INSTITUTIONS |
|---|---|---|---|---|---|---|
| France | 1 | 1 | 4 | 3 | 1 | 4 |
| Germany | 2 | 5 | 2 | 2 | 3 | 2 |
| United Kingdom | 3 | 4 | 6 | 5 | 5 | 1 |
| Japan | 4 | 2 | 1 | 8 | 7 | 5 |
| United States | 5 | 3 | 5 | 4 | 2 | 7 |
| Canada | 6 | 6 | 3 | 1 | 4 | 6 |
| Italy | 7 | 7 | 7 | 6 | 6 | 3 |
| Russia | 8 | 8 | 8 | 7 | 8 | 8 |

Canada's overall ranking is principally a function of an economy that is based on high-carbon energy emissions and of the weak performance in the policy and institutions category. Canada scores highest on skills and shows better than average scores on investment and innovation. While clearly not a leading low-carbon performer, the LCPI does show Canada positioned to do better relative to some of its main competitors, particularly the United States, if actions are taken to reduce our energy emissions profile and institute low-carbon growth plans and policies. Canada's increasingly apparent economic strength and resilience coming out of recession, together with strong performance on the more traditional building blocks for competitiveness such as taxation and public finances, give us a strong foundation to score higher over time on this new Low-Carbon Performance Index.

## 0.4 MOVING FORWARD

The NRTEE Low-Carbon Performance Index paints an initial picture of Canada's international competitiveness in a global low-carbon economy.

More needs to be done to complete that picture and to act upon it. Accordingly, the NRTEE makes the following recommendations to accompany this index:

**FIRST** the LCPI should be updated regularly to continually track performance and measure progress. New indicators should be added and existing ones adjusted to ensure they are robust and relevant. Public accountability is essential for elected officials, governments, businesses, experts, and others to assess progress and propose future steps.

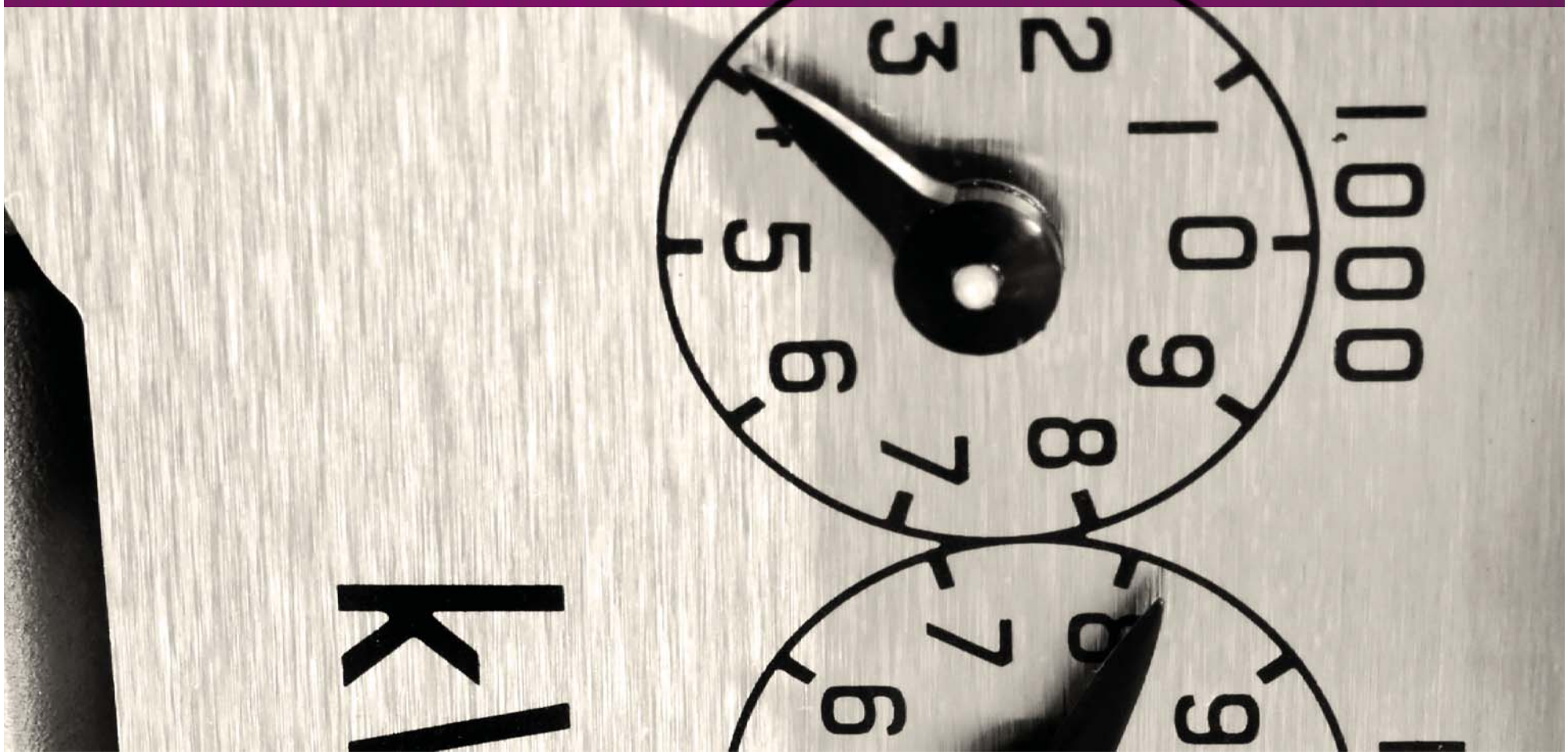
**SECOND** a dedicated nationally scoped low-carbon index should be developed and published regularly with a broader, more comprehensive range of categories and indicators to marshal domestic efforts across all federal, provincial, territorial and municipal governments to develop a low-carbon economy for Canada. This new index of performance measures should be focused on specific objectives considered relevant, meaningful, attributable, and balanced. Expectations and benchmarks should be developed simultaneously to ensure a strong focus on outcomes.

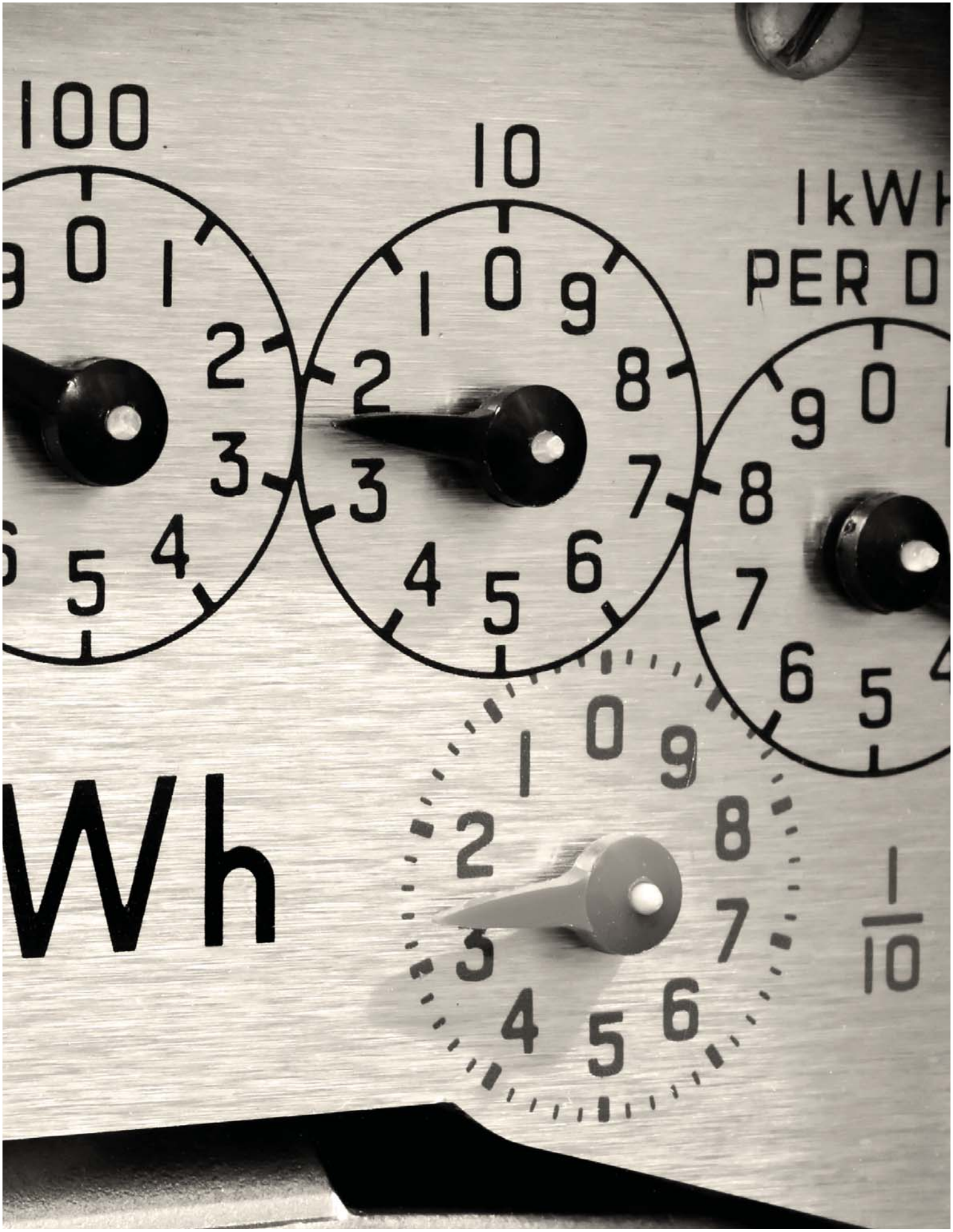
**THIRD** these two indices should form the basis for developing a comprehensive low-carbon growth plan for Canada. Such a policy pathway needs to be fully integrated into existing and future economic, environmental, and social policy planning frameworks.

# BENCHMARKING FOR SUCCESS

CREATING THE NRTEE LOW-CARBON PERFORMANCE INDEX

// CHAPTER 01

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# 1.0 // BENCHMARKING FOR SUCCESS

## 1.1 // INTRODUCTION

## 1.2 // WHY BENCHMARKING?

## 1.3 // THE NRTEE BENCHMARKING STUDY AND METHODOLOGY

## 1.4 // THE NRTEE LOW-CARBON PERFORMANCE INDEX

## 1.1 INTRODUCTION

# The "green race" is on. And Canada needs to catch up.

As the world transitions to a low-carbon economy, Canada faces both risks and opportunities. We need to think differently about what counts as success and how to get there. We need to take steps that minimize those risks and maximize our opportunities.

The reasons why are both basic and compelling.

*First, there are new market opportunities to be gained.* The global market value of traditional environmental goods and services, renewable energy, and emerging low-carbon activities was estimated at $7,770 billion in 2007-2008[1], with growth potential as much as 45% by 2015.[2] We need to position ourselves to tap into this growing opportunity.

*Second, there are new market risks to be avoided.* Just as global demand for low-carbon goods and services will grow, demand for carbon-intensive products could fall. Carbon barriers erected by countries or instituted by market competitors can keep Canadian goods and services from reaching global consumers. We need to shield ourselves from carbon protectionism – in whatever form it takes – to maintain and improve our standard of living.

In a low-carbon world, the yardsticks for measuring competitive success are new and unfamiliar. But the nations that figure them out, focus their thinking, and marshal their strengths will be the ones on top. Canada can be one of those nations.

Canada is an open, trading economy. In 2009, an estimated 30% of our wealth[a] came from exporting our goods and services across our borders.[3] Competition is already fierce in today's globalized economy; it will only grow stronger in a global low-carbon economy. The federal government's Competition Policy Review Panel stated that "New and more aggressive competitors are emerging, and new technologies are shaping entire industries."[4] The same can be said for the new low-carbon economy where so much will be about how the world produces and consumes energy. This is the new driver of world economic change.

**a** This is the 2009 annual average in current prices of the Exports of Goods and Services/ Gross Domestic Product (GDP) at market price expressed as a percentage.

Canadian businesses need to be looking at where and how they can succeed in this emerging reality. Canadian governments need to consider where and how we can position ourselves as a country to capitalize on our strengths and lead for jobs, growth, and prosperity.

The clear reality is this: our competitors are already investing and planning to succeed. We need to do the same.

To assist Canada in getting ready to succeed in a global low-carbon economy, the National Round Table on the Environment and the Economy has created Canada's first-ever Low-Carbon Performance Index. This new strategic tool will help policy-makers assess where we stand by benchmarking Canada's low-carbon performance against the world's most important economies. This new index compares Canada to the G8 economies of the United States, Japan, United Kingdom, Germany, France, Italy, and Russia. It also compares Canada's performance separately with China, Australia, and Norway—countries with unique low-carbon characteristics and challenges we can learn from.

The purpose of the index is simple: to create a comparison of low-carbon performance and capacity across a range of meaningful and comparable indicators that measure where we stand now, and can be updated regularly to track progress. It can help tell us where we are positioned to be strong with real low-carbon competitive advantage, and where we are at risk with room to improve. Governments and businesses can make informed choices about where they need to strategically focus and invest for future low-carbon competitive success.

The index is deliberately forward-looking. It assesses how well Canada is prepared to succeed relative to its peers in a future global economy in which carbon emissions are constrained. Many of the indicators therefore focus on issues of capacity in a low-carbon dynamic. Capacity ensures a country is resilient to risks and provides it with the tools required to prosper in the future, no matter how that future unfolds.

## What do we mean by a "low-carbon economy"?

"Eco-innovation," "green stimulus," "carbon advantage," "green recovery," and "green jobs" are all relatively new terms to describe elements of a low-carbon future. But what do we mean by this low-carbon economy? Despite numerous publications, no standard definition has been adopted.

Above all, a low-carbon economy relates to how we produce and use energy that generates carbon emissions. Therefore, a low-carbon economy is one that functions at low levels of greenhouse gas emissions per unit of GDP. For the purposes of this report, the term *low-carbon economy* really means, and can be used interchangeably with, *low-emissions economy.*

### 1.2 WHY BENCHMARKING?

## For over 30 years the World Economic Forum has been tracking factors that enable competitiveness in national economies by providing benchmarking tools for policy makers and business leaders about where and how to improve economic performance.[5]

The Conference Board of Canada does similar work to measure Canada's success relative to other OECD countries in terms of Economy, Innovation, Environment, Education and Skills, Health, and Society.

International benchmarking studies that illustrate low-carbon competitiveness are newer but emerging rapidly as policy makers and researchers aim to understand how nations stack up against each other in this new dynamic. Low-carbon competitiveness—determined by how nations adapt to a carbon-constrained world—is being increasingly used to define capacity for future economic prosperity.[6] Organizations like the World Wildlife Fund[7] and the U.K.'s E3G,[8] for example, have all published studies that benchmark policies

and progress contributing to a low-carbon transition. Private sector publications have focused on tracking spending and revenues from low-carbon energy production, energy efficiency and energy management, and climate finance,[9] in order to project market growth and investment opportunities. An Ernst & Young benchmarking report tracks the relative attractiveness for investment in renewable energy of 25 countries.[10] Regional indices such as the California Green Innovation Index,[11] sectoral indices including the Royal Institute of Chartered Surveyors Global Zero Carbon Capacity Index,[12] national-level indices like the Yale Environmental Performance Indicators,[13] and firm-level indices like the Dow Jones Sustainability Index[14] all offer different perspectives for how to measure competitiveness in a carbon constrained world.

No single benchmarking study for Canadian competitiveness or performance in a low-carbon world exists. While Canada is included in other studies, none has been conducted from a Canada-first perspective. The NRTEE believes this is an information and policy gap that must be filled; that a uniquely Canadian index is necessary to help focus attention and thinking on what will prove to be the most important prosperity challenge ahead.

Our country has numerous competitive strengths. A recent federal government report noted that "Our primary advantages lie in location, natural resources, a diverse economy, high-quality public education, and institutional and political stability." [15] Our proximity to, and strong trading relationship with, the U.S. market form a core advantage. Our wealth of natural resources and ability to tap into unconventional energy sources are of great economic value. The question is whether these traditional enumerators of competitive advantage are the right ones in a low-carbon future.

Policy direction reports by the Government of Canada have typically focused on these traditional assessments of Canadian economic competitiveness and performance. The government's core economic policy plan, *Advantage Canada: Building a Strong Economy for Canadians,* cites that "Creating a healthier environment and more sustainable economic growth, including through responsible use of our natural resources and effective use of technology" as a priority. Building Canada's comparative advantage in environmental technologies is identified as a component for success. *Compete to Win*[16] notes that Canada's

biggest impediment to competitive success lies in the lack of consensus about what the problem is, what needs to be done to solve it, and whether it constitutes the "imminent crisis" referred to by many. One report, *State of the Nation 2008: Canada's Science, Technology and Innovation System,*[17] takes stock of Canada's performance in areas that affect its ability to innovate. The study is limited to a national, macro-level assessment but it does identify four sub-priorities for research and development in Canada, including environment and natural resources and energy. *Innovation and Business Strategy: Why Canada Falls Short* [18] finds that we have a lagging productivity growth rate, "largely due to weak business innovation," and that decisions oriented to the long term are needed now to develop competitive advantages in new markets, such as those expected to be in high demand in a low-carbon economy. Despite mentions of potential opportunities resulting from the trade of low-carbon goods and services, little emphasis is placed on global economic trends driven by climate change and what this could mean to Canada's future competitiveness.

The NRTEE believes that traditional competitive advantage strengths for Canada can be leveraged into new comparative advantage possibilities in a global low-carbon economy. This will be a transition, not a sharp, sudden turn in a new direction. Low corporate tax rates help business profits, enabling them to invest more in low-carbon innovation, for example. Government support for research and development (R&D) at the university and college levels can help build capacity for new low-carbon R&D. Open investment policies can attract new low-carbon emission investment to fund energy technology transformation. But future policy direction needs focus and measurement to guide it. This is where the NRTEE's benchmarking study comes in.

## 1.3 THE NRTEE BENCHMARKING STUDY AND METHODOLOGY

The NRTEE benchmarking study is predicated on the view that all nations will need to address their performance across a common series of low-carbon performance categories as they decarbonize their economies to meet national and international climate goals and obligations.

These categories will be the core drivers of future low-carbon competitive success. The extent to which a country is able to successfully improve its performance across them will influence its ability to avoid high-carbon risk and optimize low-carbon opportunity. For Canada, this will help us achieve our own greenhouse gas (GHG) emission reduction targets and fulfill the climate policy obligations we have set for ourselves. A comparative assessment of country performance across a uniform set of categories of low-carbon performance provides broad indication of the strengths and weaknesses of particular aspects of Canada's position as compared with other nations. It highlights areas of comparative advantage that can be maximized. It offers important insight to policy makers on where our performance is strong, weak, and needs to be improved.

In this chapter, we explain our benchmarking index and outline how we developed it. Each performance category from our index is then presented in greater detail, including definitions and rationale for their importance in developing competitive capacity for a low-carbon future. The primary focus of this report is on economics and competitiveness in general and how energy is produced and used in particular. This is an important context for considering national climate change policy choices rather than simply comparing international GHG targets and progress toward achieving them. The report does not focus on other areas that are also important to a comprehensive approach to reducing carbon emissions and their contribution to a low-carbon economic future, such as transportation, energy efficiency, and buildings. Neither does it prescribe policy recommendations at this stage regarding

how Canada should respond to the low-carbon challenge; rather, it provides a comparative basis for assessing Canada's relative strengths and weaknesses, and areas of opportunity and improvement. NRTEE advice on developing a comprehensive low-carbon growth pathway for Canada will emerge as a later report from the *Climate Prosperity* program.

To create a better, more comprehensive understanding of how Canada is performing in terms of its relative low-carbon performance, the NRTEE has created an international benchmarking tool consisting of 15 indicators grouped into five categories. Given the innovative nature of this endeavour and the breadth of possible indicators, we used a five-staged methodological approach to arrive at this index:

**1 // A LITERATURE REVIEW** of existing benchmarking studies and relevant reports identified success factors for national low-carbon performance.

**2 // A DATA FEASIBILITY** study conducted by the Conference Board of Canada assessed potential indicators and comparator countries, and their applicability to the benchmarking study and Canada's circumstances.

**3 // A STAKEHOLDER CONSULTATION** session helped us gain insight from experts on the indicator selection and their utility.

**4 // ANALYSIS** by Deloitte & Touche LLP of the benchmarking framework, indicator selection, and methodology used helped us refine and complete the index.

**5 // PEER REVIEW** of the framework and results by Vivid Economics, an international economics and benchmarking firm, and other Canadian experts led to further refinements.

The objective was to create a composite index of meaningful indicators that were rigorous and comparable across all G8 countries. By necessity, this meant making choices about which indicators were most useful and available for this innovative study. The composite index was developed by Deloitte to measure the overall low-carbon performance of the G8 nations by employing a consistent methodological approach. This approach invites easy, cross-nation comparison across all five categories, within each category, and across individual indicators

themselves. The indicators were ultimately selected on the basis that they were (a) *meaningful,* they provided important insight into Canada's and the G8 countries' low-carbon performance both now and in the future, and (b) *comparable*, there existed suitable, reliable, and equivalent data across jurisdictions so valid comparisons could be made across a common range of indicators. We believe they should be subject to adjustment and refinement over time as new and better data sources become available and as understanding of the challenge and opportunity deepens. A full list of indicator definitions is set out in **Appendix 5.2.**

## 1.4 THE NRTEE LOW-CARBON PERFORMANCE INDEX

The NRTEE Low-Carbon Performance Index measures and compares not just progress but capacity for achieving low-carbon competitiveness.

The LCPI is built around five categories with 15 individual indicators. Each category comprises three indicators and represents a core foundation for benchmarking low-carbon performance and capacity to achieve goals and outcomes essential for a successful low-carbon transition. Importantly, while the 15 indicators themselves are uniquely focused on low-carbon performance, several of the categories themselves are well-understood and accepted aspects of any country's general economic performance and competitiveness.

## FIGURE 1 NRTEE LOW-CARBON PERFORMANCE INDEX

| EMISSIONS & ENERGY | INNOVATION | SKILLS | INVESTMENT | POLICY & INSTITUTIONS |
|---|---|---|---|---|
|  |  |  |  |  |
| CARBON PRODUCTIVITY | LOW-CARBON ENERGY PATENTS | SUSTAINABILITY MBA PROGRAMS | CLEAN TECHNOLOGY INITIAL PUBLIC OFFERING (IPO) | LOW-CARBON GROWTH PLAN |
| EMBODIED CARBON EMISSIONS IN EXPORTS | ENERGY SECTOR BUSINESS EXPENDITURE ON R&D | LOW-CARBON PROGRAM GRADUATES | CLEAN TECHNOLOGY VENTURE CAPITAL | GREENHOUSE GAS TARGETS AND ACCOUNTABILITY |
| LOW-CARBON ELECTRICITY | GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D | SPENDING ON POST-SECONDARY EDUCATION | LOW-CARBON STIMULUS SPENDING | CARBON PRICE COVERAGE AND STRINGENCY |
| Energy and emissions profile in order to assess national performance and direction on moving to low-carbon energy production and use. | R&D and technology profile in order to assess national performance and capacity on low-carbon energy technology innovation. | Post-secondary graduate profile in order to assess national performance and capacity on investing and developing a skilled and relevant workforce needed for a low-carbon transition. | Spending in clean technology and low-carbon stimulus in order to assess national performance and capacity on readiness and commitment for a low-carbon transition. | Governance mechanisms and plans in order to assess national performance, institutional capacity and policy approaches to both manage and adapt to a low-carbon economic transition. |

# CANADA AND THE G8 INDEX

OVERALL RANKING OF CANADA'S LOW-CARBON PERFORMANCE

// CHAPTER 02

# 2.0 // CANADA AND THE G8 INDEX: OVERALL RANKING OF CANADA'S LOW-CARBON PERFORMANCE

## 2.1 // CANADA'S RANKINGS

## 2.2 // CANADA'S COMPETITORS

## 2.3 // CANADA'S CONTEXT

## 2.1 CANADA'S RANKINGS

# Canada's overall ranking is sixth place on the NRTEE G8 Low-Carbon Performance Index.

Canada falls within what can be considered a second tier of tightly grouped low-carbon performers, along with the U.S. and Japan. The first-tier countries are—in order—France, Germany, and the United Kingdom. Italy and Russia can be considered to be in the group of third-tier countries, significantly lagging behind the rest of the G8 nations. The performance gap between the "leaders" and the "followers" is reflective of the energy and emissions profile of their economies, as well as their commitment to date in investing in enabling conditions for low-carbon growth, as set out in the five building block categories identified. The most qualitative performance categories is the Policy and Institutions one; in measuring this category, some binary indicators were used, (i.e., "yes" and "no" responses), causing some of the countries to have an equal rank.

**Tables 1 and 2** show the overall ranking of all G8 countries. For the full detailed indicator table, refer to **Appendix 5.5**.

**TABLE 1** OVERALL RANKING OF G8 COUNTRIES BY CATEGORY AND TIER

| | OVERALL | EMISSIONS & ENERGY | INNOVATION | SKILLS | INVESTMENT | POLICY & INSTITUTIONS | NORMALIZED FINAL SCORE |
|---|---|---|---|---|---|---|---|
| **TIER 1** (AVERAGE SCORE: 53 POINTS) | | | | | | | |
| France | 1 | 1 | 4 | 3 | 1 | 4 | 58 |
| Germany | 2 | 5 | 2 | 2 | 3 | 2 | 52 |
| United Kingdom | 3 | 4 | 6 | 5 | 5 | 1 | 48 |
| **TIER 2** (AVERAGE SCORE: 40 POINTS) | | | | | | | |
| Japan | 4 | 2 | 1 | 8 | 7 | 5 | 43 |
| United States | 5 | 3 | 5 | 4 | 2 | 7 | 40 |
| Canada | 6 | 6 | 3 | 1 | 4 | 6 | 38 |
| **TIER 3** (AVERAGE SCORE: 17 POINTS) | | | | | | | |
| Italy | 7 | 7 | 7 | 6 | 6 | 3 | 27 |
| Russia | 8 | 8 | 8 | 7 | 8 | 8 | 7 |

* NORMALIZED SCORE IS ROUNDED UP TO A WHOLE NUMBER.

**TABLE 2** OVERALL RANKING OF G8 COUNTRIES BY CATEGORY AND INDICATOR

| | OVERALL | EMISSIONS & ENERGY | | | | INNOVATION | | | | SKILLS | | | | INVESTMENT | | | | POLICY & INSTITUTIONS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CARBON PRODUCTIVITY | EMBODIED CARBON IN EXPORTS | LOW-CARBON ELECTRICITY | CATEGORY RANK | LOW-CARBON ENERGY PATENTS | ENERGY SECTOR R&D | GOVERNMENT - LOW-CARBON ENERGY R&D | CATEGORY RANK | SUSTAINABILITY MBA PROGRAMS | LOW-CARBON PROGRAM GRADUATES | SPENDING ON POST-SECONDARY EDUCATION | CATEGORY RANK | CLEAN TECHNOLOGY IPOs | CLEAN TECHNOLOGY VENTURE CAPITAL | LOW-CARBON STIMULUS SPENDING | CATEGORY RANK | LOW-CARBON GROWTH PLAN | GHG TARGETS AND ACCOUNTABILITY | CARBON PRICE COVERAGE AND STRINGENCY | CATEGORY RANK |
| France | 1 | 1 | 4 | 1 | 1 | 6 | 4 | 2 | 4 | 4 | 2 | 3 | 3 | 1 | 5 | 1 | 1 | - | 2 | 4 | 4 |
| Germany | 2 | 4 | 5 | 3 | 5 | 2 | 2 | 6 | 2 | 5 | 1 | 2 | 2 | 3 | 4 | 2 | 3 | - | 2 | 1 | 2 |
| United Kingdom | 3 | 2 | 3 | 7 | 4 | 3 | 5 | 7 | 6 | 3 | 4 | 4 | 5 | 5 | 2 | 5 | 5 | 1 | 1 | 3 | 1 |
| Japan | 4 | 5 | 2 | 4 | 2 | 1 | 1 | 1 | 1 | 6 | 6 | 8 | 8 | 7 | 7 | 6 | 7 | 1 | 5 | 7 | 5 |
| United States | 5 | 6 | 1 | 6 | 3 | 5 | 3 | 5 | 5 | 1 | 8 | 6 | 4 | 2 | 1 | 3 | 2 | - | 5 | 6 | 7 |
| Canada | 6 | 7 | 8 | 2 | 6 | 4 | 6 | 3 | 3 | 2 | 7 | 1 | 1 | 4 | 3 | 4 | 4 | - | 5 | 5 | 6 |
| Italy | 7 | 3 | 6 | 8 | 7 | 7 | 7 | 4 | 7 | 7 | 5 | 5 | 6 | 6 | 6 | 7 | 6 | - | 2 | 2 | 3 |
| Russia | 8 | 8 | 7 | 5 | 8 | 8 | 8 | N/A | 8 | 7 | 3 | 7 | 7 | N/A | 8 | 8 | 8 | - | 8 | 7 | 8 |

N/A = NOT AVAILABLE - = NO RANK

The Index illuminates both strengths and weaknesses of Canada's low-carbon performance. In terms of best-to-worst performance by building block category, Canada ranks first in *Skills*, third in *Innovation*, fourth in *Investment*, sixth in *Emissions and Energy*, and sixth in *Policy and Institutions*. **Table 3** illustrates Canada's rankings from a variety of perspectives. Canada ranks among the top three G8 countries in five of the fifteen indicators and is ranked in the bottom three G8 countries in five of the 15 indicators.

Canada ranks ahead of the United States, our main economic competitor and partner, in three of the five categories and six of the 15 indicators. Because of the close ranking among the middle-tier of countries, Canada could find itself climbing to fifth or fourth place in future years if some effort is made, or dropping as other countries advance. A more strenuous effort would be required to move Canada into the top-tier ranking of G8 countries on low-carbon performance given the gap that now exists.

**TABLE 3** CANADA'S LOW-CARBON PERFORMANCE

| | 1ST SKILLS | 3RD INNOVATION | 4TH INVESTMENT | 6TH EMISSIONS & ENERGY | 6TH POLICY & INSTITUTIONS |
|---|---|---|---|---|---|
| In the top 3 INDICATORS | **TWO INDICATORS**<br>• Sustainability MBA programs (2nd)<br>• Spending on post-secondary education (1st) | **ONE INDICATOR**<br>• Government expenditure on low-carbon energy R&D (3rd) | **ONE INDICATOR**<br>• Clean technology venture capital (3rd) | **ONE INDICATOR**<br>• Low-carbon electricity (2nd) | **NONE** |
| In the bottom 3 INDICATORS | **ONE INDICATOR**<br>• Low-carbon program graduates (7th) | **ONE INDICATOR**<br>• Energy sector business expenditure on R&D (6th) | **NONE** | **TWO INDICATORS**<br>• Carbon productivity (7th)<br>• Embodied carbon in exports (8th) | **ONE INDICATOR**<br>• GHG targets and accountability (5th)* |

* FOR THE GHG TARGETS AND ACCOUNTABILITY INDICATOR: CANADA, JAPAN, AND THE U.S. ALL TIED FOR 5TH PLACE.

Benchmarking is an exercise that provides a "moment in time" comparison of performance. It needs to be conducted over several years to fully develop and be confident about the patterns. Nevertheless, a detailed look at each indicator can show a more nuanced story of ranking and provide clues as to why Canada's ranking in each category emerged and what this might mean for the future. While Canada ranks as the overall Skills category leader, it has the second-lowest proportion of low-carbon graduates among the G8, perhaps indicating some pressure on that ranking in the future. Canada's significant hydroelectric generation and nuclear capacity enables it to rank among the leaders in low-carbon energy, but it still has the second most emissions-intense economy in the G8 giving the country its sixth-place ranking in this category. Importantly, energy-related emissions

are growing at a pace exceeding all other G8 nations, suggesting that Canada will face a significant challenge in meeting future carbon reduction obligations. When it comes to the Innovation category, Canada ranks third in government R&D in the energy sector. However, this investment has been heavily oriented to nuclear technologies and funding levels have not kept up over the past two decades. In the Investment category, Canada's relative strength is in clean technology venture capital. The absence of a comprehensive national climate change policy and low-carbon growth plan contributes to Canada's low ranking in the Policy and Institutions category.

Overall, the large European nations exhibit the best balance across performance categories, suggesting that their rankings are understandable and perhaps durable for the time being. As a group, they are the most advantageously positioned to take advantage of low-carbon competitiveness and to make the transition to a carbon-constrained future. By contrast, other countries, including Canada, are competitively well positioned in select building block categories and indicators only, suggesting that they have some but not all of the elements in place to effectively deal with the future transition to strong low-carbon performance. To varying degrees, all G8 nations will face challenges in transforming their economies but some potential strengths and weaknesses for country leaders and laggards are now apparent.

## 2.2 CANADA'S COMPETITORS

Canada's G8 competitors, are presented in order of top to bottom ranking on the Low-Carbon Performance Index in this section. **Table 4** illustrates top scores and rankings by country on both a *category* and an *indicator* basis.

**TABLE 4** LEADERS BY CATEGORY AND TOP 3 INDICATOR RANKING

| | OVERALL | CATEGORY | | INDICATOR | |
|---|---|---|---|---|---|
| | | LEADER | IN TOP 3 (EXCLUDING LEADER) | LEADER | IN TOP 3 (EXCLUDING LEADER) |
| France | 1 | • Emissions & Energy<br>• Investment | • Skills | • Carbon productivity<br>• Low-carbon electricity<br>• Cleantech IPOs<br>• Low-carbon stimulus spending | • Government - Low-carbon energy R&D<br>• Low-carbon program graduates<br>• Spending on post-secondary education<br>• GHG targets & accountability* |
| Germany | 2 | None | • Innovation<br>• Skills<br>• Investment<br>• Policy & Institutions | • Low-carbon program graduates<br>• Carbon price coverage & stringency | • Low-carbon electricity<br>• Low-carbon energy patents<br>• Energy sector R&D<br>• Spending on post-secondary education<br>• Cleantech IPOs<br>• Low-carbon stimulus spending<br>GHG targets & accountability* |
| United Kingdom | 3 | • Policy & Institutions | None | • GHG targets & accountability<br>• Low-carbon growth plan | • Carbon productivity<br>• Embodied carbon in exports<br>• Low-carbon energy patents<br>• Sustainability MBA programs<br>• Cleantech venture capital<br>• Carbon price coverage & stringency |
| Japan | 4 | • Innovation | • Emissions & Energy | • Low-carbon energy patents<br>• Energy sector R&D<br>• Government - Low-carbon energy R&D<br>• Low-carbon growth plan | • Embodied carbon in exports |
| United States | 5 | None | • Emissions & Energy<br>• Investment | • Embodied carbon in exports<br>• Sustainability MBA programs<br>• Cleantech venture capital | • Energy sector R&D<br>• Cleantech IPOs<br>• Low-carbon stimulus spending |
| Canada | 6 | • Skills | • Innovation | • Spending on post-secondary education | • Low-carbon electricity<br>• Government - Low-carbon energy R&D<br>• Sustainability MBA programs<br>• Cleantech venture capital |
| Italy | 7 | None | • Policy & Institutions | None | • Carbon productivity<br>• GHG targets & accountability*<br>• Carbon price coverage & stringency |
| Russia | 8 | None | None | None | • Low-carbon program graduates |

**NOTE:** FOR THE GHG TARGETS AND ACCOUNTABILITY INDICATOR: FRANCE, GERMANY, AND ITALY ALL TIED FOR 2ND PLACE.

## FRANCE *(Leads in two categories; in top 3 of eight indicators)*

France's low-carbon profile outperforms all nations primarily as a result of an electricity generation mix dominated by nuclear. It performs well in the areas of R&D investment, low-carbon skills and education investment, and has directed significant funds to low-carbon projects through its stimulus spending.

## GERMANY *(Leads in zero categories; in top 3 of nine indicators)*

Germany demonstrates the most well-balanced low-carbon performance of all G8 nations, ranking in the top three across nine indicators. Its use of market incentives and requirements to drive increased renewable energy generation over the past decade has led to the second largest drop in energy-related carbon emissions within the G8. A strong commitment to education, skills, and investment, coupled with the highest carbon price coverage in the group, puts Germany in a strong low-carbon performance position.

## UNITED KINGDOM *(Leads in one category; in top 3 of eight indicators)*

The United Kingdom ranks just behind Germany in its emissions profile, largely due to a shift from coal to natural-gas-fired generation as well as an overall transition from a manufacturing to service economy. The U.K. dominates the area of low-carbon policy and institutions, having established a Low-Carbon Transition Strategy and a Low-Carbon Budget and having the third most stringent carbon pricing coverage among the G8. Performance gaps include both private and public sector energy R&D investment, although the government has directed significant funding through its Low-Carbon Transition Strategy to begin financing renewable energy and carbon capture and sequestration technology development.

## JAPAN *(Leads in one category; in top 3 of five indicators)*

Japan is considered to be one of the world's most energy efficient economies. Having achieved early, relatively low-cost reductions, it now faces the prospect of more challenging and costly improvements. Japan's carbon productivity has remained high over the last 15 years. It has high absolute emissions that have continued to grow, but the size of the economy has grown at a comparable pace. Japan is positioning itself to compete in the global clean technology market, and in line with its reputation, is considered a world leader in low-carbon innovation.

## UNITED STATES *(Leads in zero categories; in top 3 of six indicators)*

The United States' economy is emissions-intensive, and emissions are growing. However, the U.S. exports less carbon than all other G8 countries. While GDP growth outpaced emissions growth over the 1992-2007 period, leading to an overall decrease in emissions intensity, absolute emissions have grown 18.09%,[19] second only to Canada in the G8. The U.S. leads the way in venture capital investment in clean technology, an important indication of technology leadership and clean technology manufacturing capacity. It is strong in the investment category. The U.S. gains in the Policy and Investment category as a result of the appointment of a "climate change czar" by the Obama administration, and the presence of a carbon market through the Regional Greenhouse Gas Initiative.

## ITALY *(Leads in zero categories; in top 3 of three indicators)*

Italy consistently ranks near the bottom across all categories and most indicators. Italy has the lowest percentage of low-carbon electricity generation among the G8. Its carbon productivity profile is relatively high, largely as a result of its industrial makeup. Italy scores poorly across all categories, although it faces relatively stringent carbon price coverage as a result of its latest National Allocation Plan target.

## RUSSIA *(Leads in zero categories; in top 3 of one indicator)*

Russia lags the G8 across almost all indicators, finishing last in four of five categories. While having achieved the largest improvement in emissions intensity over the assessment period (minus 70%), this drop is largely due to the economic transformations occurring within the Russian economy after the dissolution of the Soviet Union. Energy generation is largely coal-fired and projected to increase, and the country is a major net exporter of natural gas to western European markets. The country's relative strength in this Index lies in its technical capabilities, with Russia ranking third in low-carbon graduates.

## 2.3 CANADA'S CONTEXT

The challenge for each country is to identify which nationally appropriate actions are most important to the achievement of its low-carbon objectives, and to push for continual improvement.

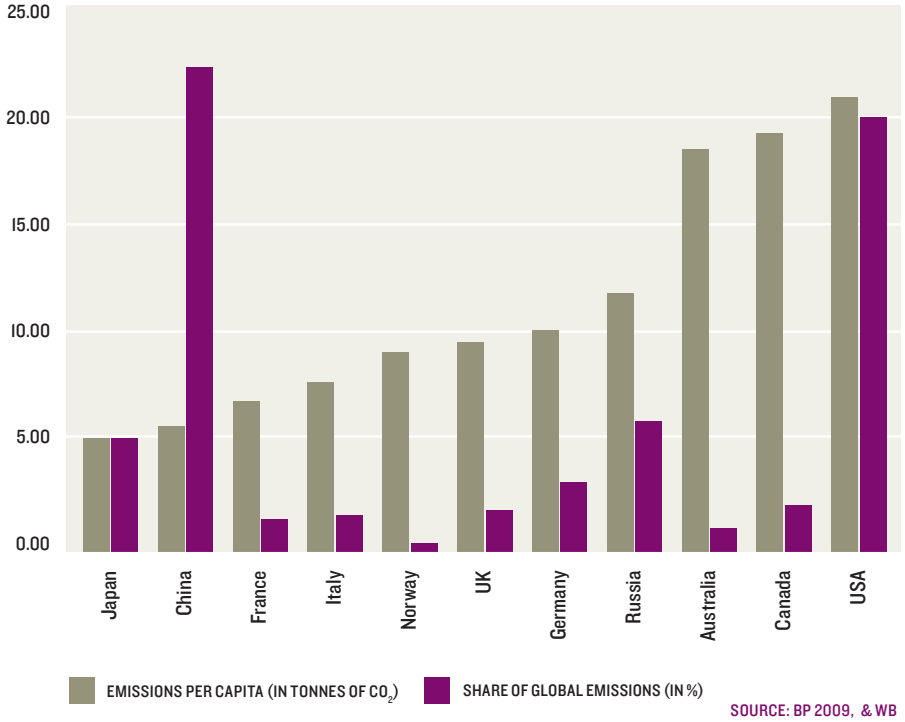
While this report does not evaluate performance trends, secondary data collected and presented for context below suggests areas in which a country's performance is either improving or declining and reinforces the findings of the Index.

All nations face the fundamental challenge of providing a high standard of living with increased energy use, but from more low-emission sources. Each will differ in terms of the type and magnitude of challenges and priorities it faces, influenced in large measure by the particular circumstances of a country, such as its stage of economic development, geography, demographic profile, and climate. Canada is no exception. As the world increasingly moves toward a low-carbon economy, Canada will have to act to ensure competitiveness in this new energy context. As outlined in the NRTEE's 2008 report *Getting to 2050: Canada's Transition to a Low-emission Future*, Canada faces many challenges affecting its ability to compete in a low-carbon economy. Our geography is immense, our climate cold; we are a net energy exporter; our economy benefits from the extraction and exportation of natural resources; and there is a current lack of political consensus about how to reduce domestic emissions, resulting in a patchwork policy approach.

Canada's largest challenge is its current energy emissions profile. While Canada accounts for just over 2% of global emissions, we are the second-highest per capita emitter in the world. **Figure 2** illustrates Canada's emissions profile compared with other major competitors for 2008. In 2008, Canada accounted for 2.08% of the world's carbon emissions—significantly lower than the U.S. (20.18%) or China (21.84%). By contrast, Canada's emissions per capita exceeds that of Norway, also a net energy exporter country (see **Appendix 5.1** for

more details). And, despite the fact that the U.K. has approximately double the population of Canada, it emits a lower relative share of the world's carbon emissions. Of more significance, in per capita terms, Canada's emissions are only slightly lower than those of the U.S. and are significantly higher than China's.

**FIGURE 2** EMISSIONS PROFILES BY COUNTRY, 2008

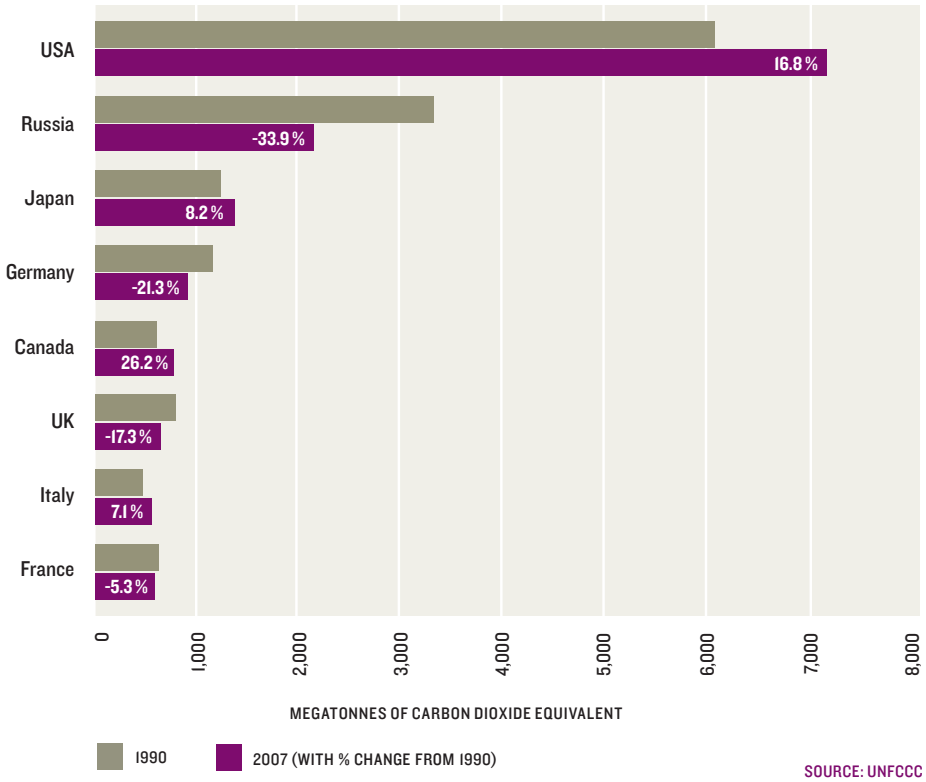



SOURCE: BP 2009, & WB

Absolute emissions over time can be an indicator of a country's track record in reducing its $CO_2$ output, and thus how well it is positioned to compete going forward. As illustrated in **Figure 3**, Canada has experienced the largest relative increase in total emissions over the last 17 years among the G8—a worrying result with impacts for future low-carbon competitiveness. Countries such as Germany and the U.K. have decreased their total emissions over the same period, while Japan's have increased as a result of its much lower starting point. It is important to relate a nation's emissions intensity to its proportion of low-carbon electricity. As a result of public policies mandating nuclear power generation

in France, promoting solar and wind generation in Germany, and shifting market mixes from coal to natural gas in response to changes in relative prices in the U.K., these countries have reduced or minimized overall emissions growth. Notwithstanding the fact that Canada has unique national circumstances that influence its energy supply and demand profile, bending its emissions trajectory to achieve significant reductions will require a substantial transformation in the way energy is produced and used within this country.

**FIGURE 3** GREENHOUSE GAS EMISSIONS BY COUNTRY, 1990 AND 2007




SOURCE: UNFCCC

**NOTE:** THE GREENHOUSE GAS (GHG) EMISSIONS ARE THE TOTAL AGGREGATE GHG EMISSIONS EXCLUDING EMISSIONS/REMOVALS FROM LAND-USE, LAND-USE CHANGE AND FORESTRY (LULUCF).

# CANADA AND THE G8 INDICATORS

DETAILED RANKING OF CANADA'S LOW-CARBON PERFORMANCE

// CHAPTER 03

# 3.0 // CANADA AND THE G8 INDICATORS: DETAILED RANKING OF CANADA'S LOW-CARBON PERFORMANCE

## 3.1 // EMISSIONS AND ENERGY

## 3.2 // INNOVATION

## 3.3 // SKILLS

## 3.4 // INVESTMENT

## 3.5 // POLICY AND INSTITUTIONS

## 3.1 EMISSIONS AND ENERGY CATEGORY

# CANADA RANKS 6TH IN THE EMISSIONS AND ENERGY CATEGORY.

**WHY THIS MATTERS //** A country's energy emissions profile has implications for the range of emission mitigation options available to it and the cost of reducing emissions relative to other countries. Energy production, consumption, and trade are major components of a low-carbon economy. Reducing primary energy demand and shifting production from fossil-fuel-generated energy to more low-emission sources will be necessary to achieve deep emission reduction targets. Previous NRTEE analysis has shown that the most cost-effective way to reach our domestic emissions targets is to implement an economy-wide price on carbon in order to stimulate innovation and technology development and deployment. And the sooner this price is implemented, the lower the ultimate national economic cost to achieve targets will be.[20]

From a trade perspective where future climate regimes will increase demand for low-carbon goods and decrease demand for carbon-intensive ones, net carbon exporting countries will face new competitive risks and disadvantages in a low-carbon world. These will be exacerbated if low-carbon performance standards and/or border tax adjustments are put in place by competitors to reflect the carbon costs of imports and to level the playing field with countries that are operating with weak GHG emissions reduction obligations (and thus may have lower operating costs and perceived competitive advantage). For such reasons, national energy emissions profiles are important indicators for determining carbon productivity, driving innovation, and building competitive advantage in low-carbon goods, services, and technologies.

**TABLE 5** EMISSIONS AND ENERGY RANKINGS

| | CATEGORY RANK | CARBON PRODUCTIVITY | | EMBODIED CARBON EMISSIONS IN EXPORTS | | LOW-CARBON ELECTRICITY | |
|---|---|---|---|---|---|---|---|
| | | RANK | SCORE US$ | RANK | SCORE % | RANK | SCORE % |
| France | 1 | 1 | 4.83 | 4 | 22.7 | 1 | 90.4 |
| Japan | 2 | 5 | 3.19 | 2 | 14.5 | 4 | 38.6 |
| United States | 3 | 6 | 1.94 | 1 | 8.3 | 6 | 29.2 |
| United Kingdom | 4 | 2 | 4.33 | 3 | 21.3 | 7 | 24.6 |
| Germany | 5 | 4 | 3.47 | 5 | 25.3 | 3 | 38.7 |
| Canada | 6 | 7 | 1.78 | 8 | 31.7 | 2 | 76.7 |
| Italy | 7 | 3 | 3.8 | 6 | 26.5 | 8 | 17.9 |
| Russia | 8 | 8 | 0.59 | 7 | 27.5 | 5 | 34.1 |
| | | Amount of GDP in US$1,000 per tonne of carbon dioxide equivalents ($CO_2e$) emitted | | Percentage of carbon emissions embodied in exports | | Percentage of net electricity produced from low-carbon sources | |

# THE INDICATORS

The Emissions and Energy category includes three selected indicators:

// CARBON PRODUCTIVITY

// CARBON EMISSIONS EMBODIED IN EXPORTS

// SHARE OF LOW-CARBON ELECTRICITY

EMISSIONS AND ENERGY CATEGORY INDICATOR //

## CARBON PRODUCTIVITY is a measurement of the level of economic activity or GDP per $CO_2$ equivalent emissions. It is an indicator of how productive a country's economy is in producing low-carbon GDP.

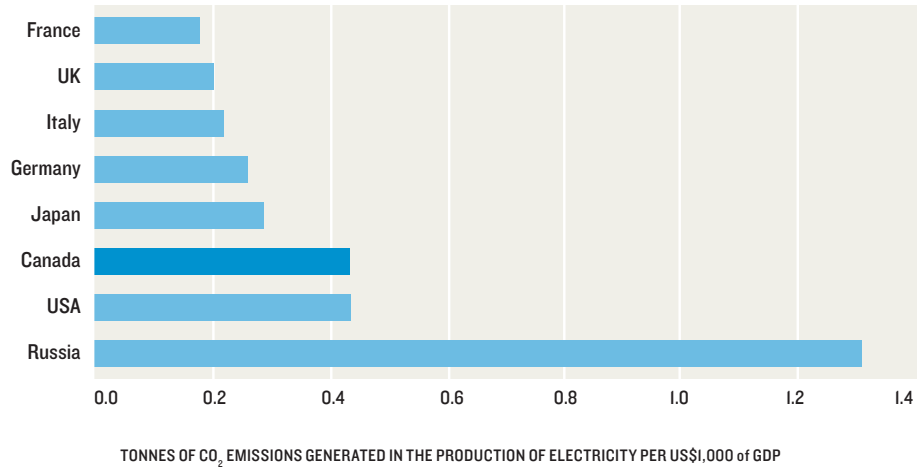
This indicator speaks to the low-carbon productive efficiency of economic growth in terms of emissions.[b] It is used by the Climate Institute (Australia) and E3G (U.K.), Next 10 (California), and the McKinsey Global Institute, to name a few. Improvement in carbon productivity can be achieved through fuel switching, accelerated GDP growth, energy efficiency, and carbon capture and storage along with other measures. The higher a nation's score on this indicator, the more economic wealth it will be able to produce in a carbon-constrained future. And it will be better positioned to avoid prospective carbon tariffs or other trade barriers imposed by countries seeking to protect themselves from lower-price, higher carbon-intensive imports. If a country scores low on this indicator, the challenge is to focus on decoupling sustained GDP growth from further emissions growth in order to become more carbon productive.

Canada ranks seventh in this indicator; our carbon productivity is the second worst in the G8, marginally behind the United States. France scores 2.5 times better. In fact, a significant gap exists between the performance of the leading countries and that of both Canada and the United States. While this could narrow in the years ahead given Canada's progress in achieving efficiency improvements, the current carbon productivity rate is not significant enough to close the difference. As oil sands production increases, this gap will likely increase or at least remain wide.

Even when breaking out energy-related emissions only per unit of GDP, as seen in **Figure 4**, Canada continued to rank seventh in the G8. Looking at the number of tonnes of $C0_2$ generated in the production of electricity per thousand dollars of GDP (in US$), Canada basically tied with the U.S. in second-last place at 0.44 tonnes. France led at 0.16 tonnes, indicating the gap involved and the differences between our respective energy economies.

**b** Emissions are measured by carbon dioxide equivalent sources excluding land use, land-use change and forestry.

**FIGURE 4** EMISSIONS INTENSITY IN THE ELECTRICITY SECTOR, 2007




SOURCE: EIA, & WB

EMISSIONS AND ENERGY CATEGORY INDICATOR //

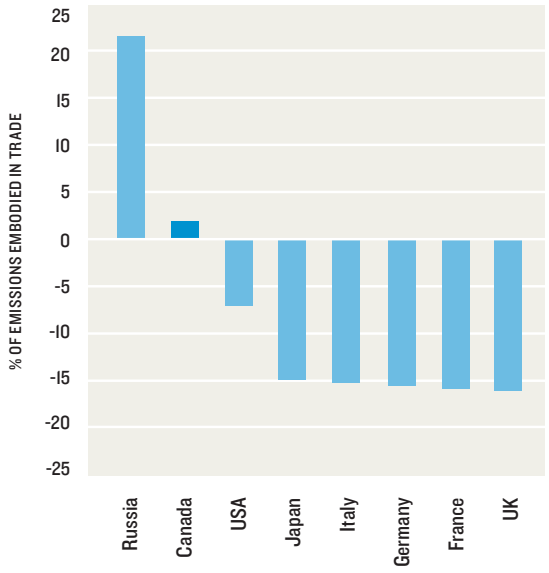
## CARBON EMISSIONS EMBODIED IN EXPORTS refers to carbon dioxide emitted at all stages of a good's manufacturing process, from the mining of raw materials through the distribution process, to the final product provided to the consumer.[21] Embodied carbon in exports is the amount of carbon emissions contained in a country's exports. It is a measure of a country's reliance on emissions associated with the export of natural resources and energy-intensive products.

This indicator helps to assess nations' reliance on carbon-intensive exports as well as its potential exposure to tariff and non-tariff barriers placed on the imports of carbon-intensive goods and services. "Embodied carbon" refers to the carbon dioxide emitted at all stages of a good's manufacturing process, from the mining of raw materials through the distribution process,

to the final product provided to the consumer.[22] It is ultimately a measure of a country's ability to reduce emissions associated with exporting high-carbon and energy-intensive products.

Canada ranks eighth in this indicator, producing more domestic emissions than it consumes largely resulting from our role as an energy exporter, principally to the United States. Presented on a balance of carbon trade perspective (exports less imports) Canada continues to score low. This is illustrated in **Figure 5** below.

**FIGURE 5** BALANCE OF EMISSIONS EMBODIED IN TRADE BY COUNTRY, 2001




SOURCE: PETERS & HERTWICH, 2008

Research has found that more than 5.3 Gt of $CO_2$ emissions exist in international trade flows, and that a high share of emissions embodied in exports affects competitiveness.[23] Given the increasingly global nature of economic markets, the carbon intensity of exports will affect trade flows as countries focus on meeting emissions targets and reducing the amount of carbon they import. Demand for carbon intensive exports will likely fall. There could also be higher economic costs associated with participating in a global climate mitigation regime for those nations that maintain a large share of their exports in carbon-intensive production.[24]

Canadian energy producers may face new competitive burdens—so called border carbon adjustments—as a result of policy and market restrictions enacted by our trade partners. Most domestic energy production cannot be relocated, and there are limits to Canada's ability to dramatically shift to a less emissions-intensive production mix over the next two decades. Failing such a development, a 2009 study suggests that Canada could face an average 2.8% tariff on imports of goods and services if embodied carbon is taxed at $50 per tonne of $CO_2$.[25] For example, the State of California has implemented a low-carbon fuel standard that could reduce future exports of relatively carbon-intense Canadian oil-sands exports to California refineries. The NRTEE's forthcoming policy advisory report on Canada-U.S. climate policy options examines in detail the issue of possible national U.S. policies that could present risks to Canadian exports. It finds that U.S. border carbon adjustments could be applied to Canadian exports if the U.S. were to implement climate policy and Canada did not. Exports from specific emissions-intensive and trade exposed sectors like oil production would be at greatest risk.

**EMISSIONS AND ENERGY CATEGORY INDICATOR //**

## SHARE OF LOW-CARBON ELECTRICITY is a measure of a country's low-carbon electricity generation mix. It is an indicator of its ability to produce energy from sources that produce fewer emissions than fossil-fuel-based generation. It is the sum of electricity generated by solar, wind, geothermal, biomass, hydroelectric, and nuclear divided by total net electricity generated.

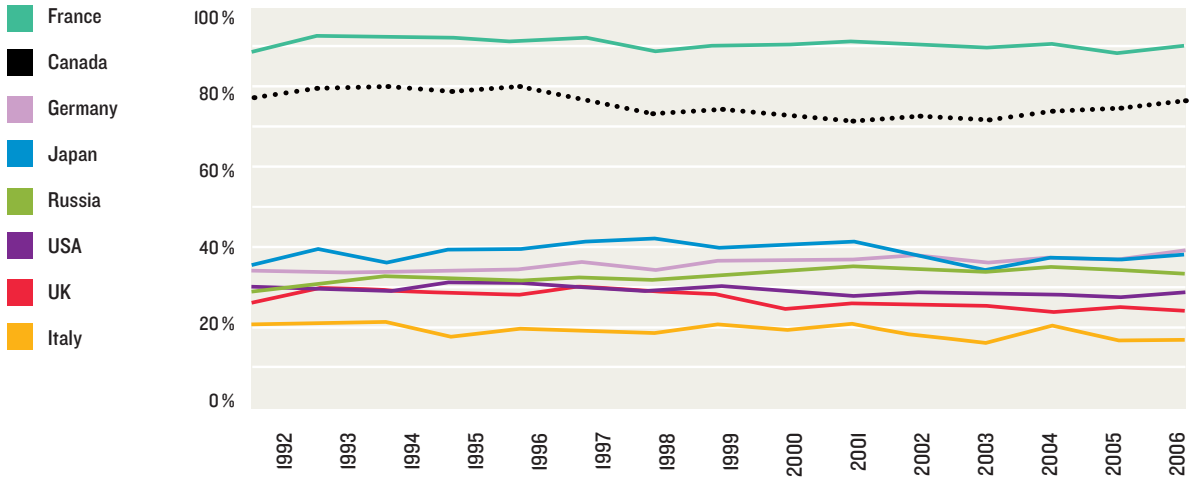
This indicator is a reinforcing proxy for decarbonization of the domestic energy system. It is a measure of a country's electricity generation mix and an indicator of its ability to produce energy from sources that produce fewer emissions than fossil-fuel-based generation. Low-carbon electricity includes solar, wind, geothermal, biomass, large- and small-scale hydroelectric, and nuclear. Power generation and transportation typically rank as the largest sources of $CO_2$ emissions in developed nations; thus understanding a country's electric-

ity generation mix is important when developing national climate change reduction strategies. Power sector decarbonization will be critical to the achievement of deep GHG emission cuts, in particular as energy demand increases over the coming decades to fuel future economic growth.

Canada ranks second in this indicator; our large hydroelectric generating capacity is the major contributor.[c] We are second only to France, which tops the list due to its high percentage of nuclear power.[d] Canada nearly doubles the performance of Germany and has two to three times the low-carbon electricity generating capacity of the remaining G8 countries.

However, without significant growth in its renewable and nuclear generating capacity, Canada will be challenged to maintain this ranking in the face of projections for future growth in energy demand. Renewables currently make up a small percentage of Canada's total supply (3%) and our low-carbon electricity performance actually decreased somewhat since 1992, as indicated below in **Figure 6**. That said, while other countries such as Germany and Japan have seen low-carbon electricity increases over time, all G8 nations may face challenges in raising their low-carbon generation penetration rates—especially as demand rises, prices increase, and existing transmission grids become saturated.

**FIGURE 6** SHARE OF ELECTRICITY FROM LOW-CARBON SOURCES AS A PERCENTAGE OF TOTAL ELECTRICITY PRODUCED, BY COUNTRY, 1992-2006




SOURCE: EIA

c In its 2006 *Power Generation in Canada* guide, the Canadian Electricity Association states that Canada's hydroelectric sector represents 58% of total generation.

d In its 2010 analysis of *Nuclear Power in France*, the World Nuclear Association suggests that over 75% of France's electricity supply is derived from nuclear energy.

## 3.2 INNOVATION CATEGORY

# CANADA RANKS 3RD IN THE INNOVATION CATEGORY.

**WHY THIS MATTERS //** Innovation is a key factor for economic competitiveness in any context. According to the World Economic Forum, "In the long run, standards of living can be expanded only with innovation."[26] Innovation particularly matters for low-carbon performance and reducing GHG emissions. The acceleration and diffusion of less-GHG intensive technologies are imperative to a country's successful low-carbon transition.[27] In what the U.K. Sainsbury Review[28] characterizes as a "race to the top," countries have the opportunity to enter and create leadership in new and expanding markets (e.g., carbon capture and storage) by supporting technology advances through both government and private sector R&D funding.

Public- and private-sector investment in low-carbon energy R&D is an important driver of such technology development given the high costs and scales at stake. Public investment is of particular importance in the absence of comprehensive national and international climate and carbon pricing regimes. Countries must decide whether to invest in a wide range of energy technologies that could be deployed to address their particular national climate and energy circumstances, or to focus on specialized comparative strengths for domestic benefit or export purpose. Finally, to attract investment, encourage and reward innovation, and capture the benefits of technology development, deployment, and commercialization, a country's intellectual property regime in the form of patent protection is foundationally important.

**TABLE 6** INNOVATION RANKINGS

| | CATEGORY RANK | LOW-CARBON ENERGY PATENTS | | ENERGY SECTOR BUSINESS EXPENDITURE ON R&D | | GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D | |
|---|---|---|---|---|---|---|---|
| | | RANK | SCORE # | RANK | SCORE US$ | RANK | SCORE US$ |
| Japan | 1 | 1 | 1.08 | 1 | 9.42 | 1 | 0.73 |
| Germany | 2 | 2 | 0.89 | 2 | 8.35 | 6 | 0.14 |
| Canada | 3 | 4 | 0.76 | 6 | 2.6 | 3 | 0.35 |
| France | 4 | 6 | 0.29 | 4 | 5.06 | 2 | 0.43 |
| USA | 5 | 5 | 0.48 | 3 | 5.44 | 5 | 0.17 |
| UK | 6 | 3 | 0.77 | 5 | 3.83 | 7 | 0.1 |
| Italy | 7 | 7 | 0.28 | 7 | 1.23 | 4 | 0.22 |
| Russia | 8 | 8 | 0.08 | 8 | 0.35 | N/A | N/A |
| | | Domestic low-carbon energy-related patents per million people | | Private energy sector R&D expenditures per US$1,000 GDP | | Government low-carbon energy R&D expenditures per US$1,000 GDP | |

# THE INDICATORS

Three indicators were selected for the Innovation category:

// LOW-CARBON ENERGY PATENTS

// ENERGY SECTOR BUSINESS EXPENDITURE ON R&D

// GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D

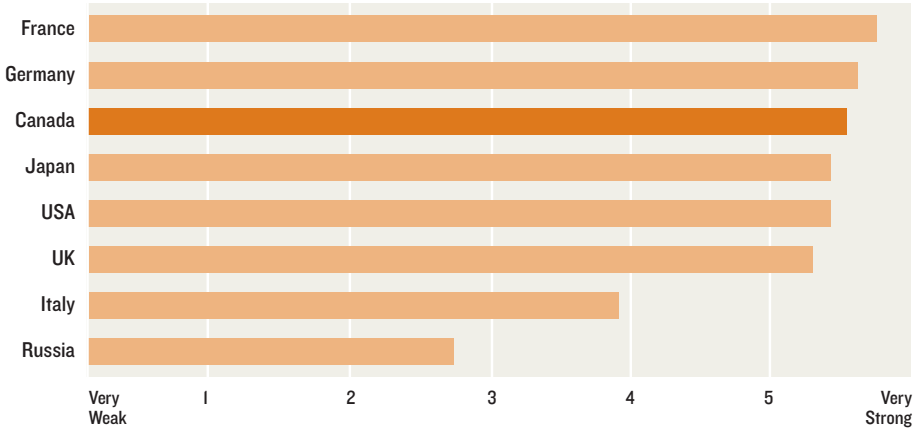
INNOVATION CATEGORY INDICATOR //

## LOW-CARBON ENERGY PATENTS per million people is an indicator of new technology development for low-emissions energy production. It is the gross number of patent applications filed under the Patent Cooperation Treaty related to renewable energy, fuel cells, and nuclear divided by population.

Patent grants are often cited as a measure of the inventive activity and effectiveness of R&D investments since they offer "a good indication of the results of innovative activity and allow for interesting cross-country comparisons."[29] Patents protect competitors from copying the intellectual property of investors by offering exclusive rights to make, use, and sell an invention. Low-carbon energy patents serve as a proxy for technological innovation to meet growing demand for low-carbon energy sources. The scope of technologies included here includes geothermal, solar, wind, tidal and wave energy, fuel cells, hydroelectric and nuclear power, carbon capture and storage (CCS), and even building efficiency and transportation. It is estimated that international "cleantech" patent filings increased by 430% between 1998 and 2007.[30]

Canada ranks fourth in this indicator, marginally ahead of the U.K. Japan is the low-carbon patent leader. Canada's relative strength in this indicator is reinforced by two additional comparative measurements: strength of the intellectual property (IP) regime and growth in low-carbon energy patents. **Figure 7** illustrates findings regarding the strength of overall IP regimes in the G8 from the World Economic Forum. Canada receives a 5.5 ranking out of 7, surpassed only by France and Germany.

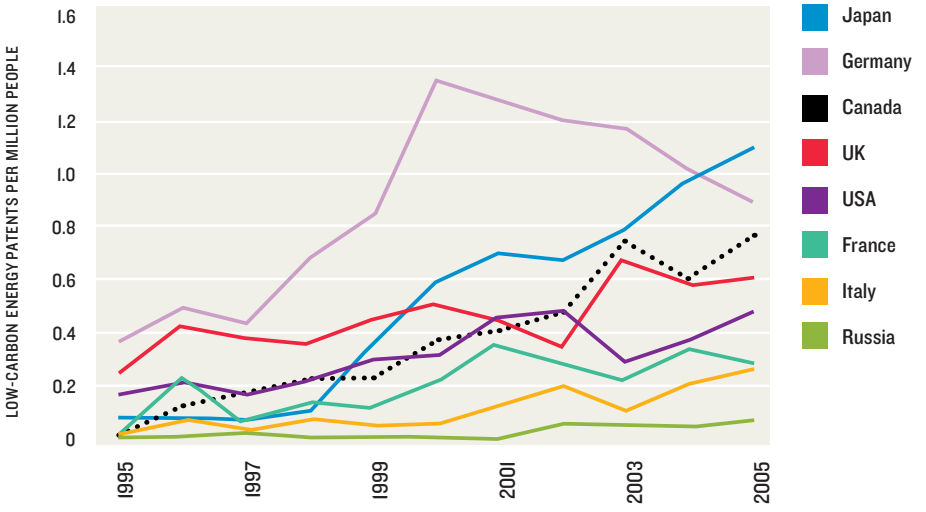
**FIGURE 7** STRENGTH OF INTELLECTUAL PROPERTY REGIMES, 2009




SOURCE: WORLD ECONOMIC FORUM, 2009

Canada has also experienced a strong growth rate in low-carbon patent registrations, surpassing all G8 countries over a ten-year period, as illustrated in **Figure 8**. It has steadily increased its performance to leapfrog past the U.S., and is now ranked in the company of strong patenting nations such as Germany and the U.K. With the expectation of more applications for cleantech patents, especially in the short term, the protection of intellectual property will be critical to helping companies—and by extension countries—prosper over time.[31]

**FIGURE 8** GROWTH IN RENEWABLE ENERGY PATENTS, 1995-2005




SOURCE: OECD PATENT DATABASE

INNOVATION CATEGORY INDICATOR //

## ENERGY SECTOR EXPENDITURE ON R&D per GDP measures how much the private energy sector is spending on research and development as a percentage of GDP. It indicates both the intensity and capacity of that country's private energy sector in investing in new energy innovation and technologies. The energy sectors include emissions-intensive oil and gas and coal sectors.

This indicator acts as a proxy for a country's energy sector capacity and willingness to develop low-carbon energy solutions. It also indicates how conducive the private sector environment is in that country for future low-emission energy R&D investment. Private R&D investment in this sector typically focuses on the development and refinement of existing and operational technologies, as opposed to basic research for long-term technology development. It is difficult for industry, particularly within competitive or highly regulated markets, to justify and

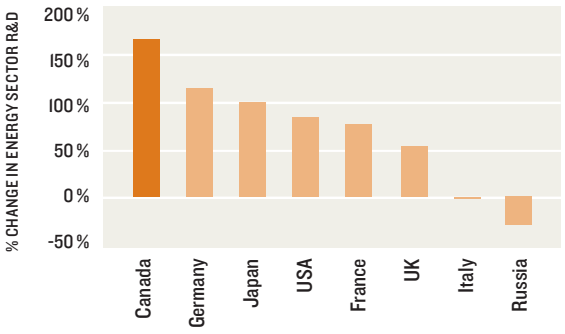
recoup the cost of large, upfront R&D investments that a low-carbon transition requires. This is particularly so without comprehensive carbon pricing regimes.

Canada ranks sixth on this indicator, spending only $2.60 on R&D for every US$1,000 of GDP; Japan is the uncontested leader ranking first in this and two other indicators for this category. It outpaces Germany (2nd) by one-sixth, and more than triples spending by Canada's energy sector. Japan's private-sector investment ranking in energy sector R&D is attributable to its level of investment in nuclear research, reinforcing government spending here also. As a result of its commodity base, Canada is primarily focused on fossil-fuel R&D, although nuclear and renewable-energy technology research has seen growth over the past decade.

While Canada ranks near the bottom of this indicator in terms of actual spending, it has experienced the highest growth rate among G8 nations since 1995 in absolute dollars, significantly outpacing its competitors, as shown in **Figure 9**. Given the realities of the sector in terms of huge capital investment requirements and its ability to recoup investments (as a result of low margins), this spending growth increase suggests that as this sector expanded it has maintained a focus on technology development. Nevertheless, this has proved insufficient for Canada to do better than its current sixth-place rank compared to its G8 competitors.

This may not be surprising when considering overall business expenditures in Canada on R&D as a proportion of GDP. Canadian business spending on R&D of about 1% of GDP has consistently ranked below the OECD average of 1.6% and is only about half of what the U.S. spends.[32]

**FIGURE 9** GROWTH IN ENERGY SECTOR EXPENDITURE ON R&D, 1995-2006




SOURCE: OECD ANBERD DATABASE

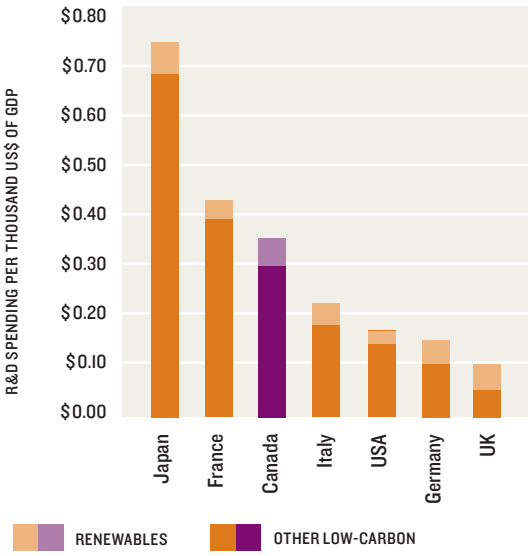
INNOVATION CATEGORY INDICATOR //

# GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D addresses the need for public sector support for encouraging innovation in energy technologies in general and low-carbon technologies in particular. Government support of fundamental research is an important indicator of a nation's leadership in basic technology research and in driving productivity improvements.

Government support for R&D has been a key feature of growth and progress in the energy sector. The timelines required to scale up operability and to reach demonstration and commercialization status and the economics of such technologies mean that government support is critically important at early stages of the technology life cycle. According to the International Energy Agency (IEA), public sector investment in R&D is generally directed to stages of technology development that are of high risk and return, whereas the private sector tends to cover later stages of innovation.[33] Early stage innovation expenditure is critical for the survival of young technologies and firms, so government support of R&D is an important indicator of a nation's leadership in basic technology research and in driving productivity improvements. Government support is considered to play an essential role in the nurturing and long-term development of new, "high-risk" low-carbon technologies.

Canada ranks third on this indicator. As is the case for first-ranked Japan and second-ranked France, this is due to investments in expensive nuclear energy research compared with other areas of energy R&D. Although nuclear investment has experienced a significant decline over the past 15 years, it still accounts for the majority of government R&D spending, with the exception of the U.K. **Figure 10** breaks down these figures between renewables and other low-carbon investments. For every thousand dollars of GDP (in US$), Canada spent 35 cents in low-carbon energy R&D. Investments in basic research for renewable energy technologies lag significantly by comparison with other low-carbon energy R&D across all G8 countries, with only small differences among nations. Canada ties Italy and the U.K. for leadership in renewable energy technology investment. In the same time period renewable investment has increased slightly (on a relative, per GDP basis), a trend that will need to shift for a successful low-carbon transition.

**FIGURE 10** GOVERNMENT INVESTMENT IN LOW-CARBON ENERGY R&D PER COUNTRY GDP (US$1,000s), 2007-2008




SOURCE: IEA/OECD R&D DATABASE & WB

The results are reinforced by other recent studies on Canada's innovation performance. Canada's Expert Panel on Business Innovation has found that we have a serious productivity growth problem, not due to lack of a skilled workforce or capital investment, but to weak business innovation. We tend to be technology followers, not leaders.[34] This general finding was reinforced in a recent benchmarking analysis conducted by the Conference Board of Canada, which ranked Canada 14th out of 17 peer countries.[35] **Figure 11** from the OECD demonstrates Canada's comparative performance for gross domestic expenditures on R&D overall as a percentage of GDP. It indicates that within the G8 group of nations (less Russia), Canada spends approximately 2% of GDP on R&D, 5th in the G8 comparison.

Canada has taken recent steps to increase funding for CCS projects, an important contributor to GHG emissions reductions. Over $800 million has been announced in federal support for CCS for three large-scale projects. Provincial support from Alberta and Saskatchewan has also been committed.[36]

**FIGURE II** GROSS DOMESTIC EXPENDITURE ON R&D AS PERCENTAGE OF GDP (G8 LESS RUSSIA), 2001-2005

| | 2001 | 2002 | 2003 | 2004 | 2005 (PRELIMINARY) | 2006 (PRELIMINARY) |
|---|---|---|---|---|---|---|
| Japan | 3.12 | 3.17 | 3.2 | 3.17 | 3.33 | MISSING |
| USA[e] | 2.76 | 2.66 | 2.66 | 2.59 | 2.62 | 2.62 |
| Germany | 2.46 | 2.49 | 2.52 | 2.49 | 2.48 | 2.51 |
| France | 2.2 | 2.23 | 2.17 | 2.15 | 2.13 | 2.12 |
| Canada | 2.09 | 2.04 | 2.01 | 2.01 | 1.98 | 1.97 |
| UK | 1.83 | 1.83 | 1.79 | 1.73 | 1.78 | MISSING |
| Italy | 1.09 | 1.13 | 1.11 | 1.1 | 1.1 | MISSING |

SOURCE: CANADIAN COUNCIL ON LEARNING, 2009

e Excludes most of all capital expenditure.

## 3.3 SKILLS CATEGORY

# CANADA RANKS 1ST IN THE SKILLS CATEGORY.

**WHY THIS MATTERS //** The transition to a low-carbon economy will demand new skills and expertise as existing industries and firms adjust and new ones emerge. Nations need to ensure that the education and skills profiles of their populations match the skills requirements and recruitment needs of new low-carbon industries and businesses. Countries' commitments to spending on higher education, combined with a strong educational infrastructure for training in required disciplines, will have important implications for their ability to exploit these benefits. The types of skills required will range from management expertise in firms diving into new low-carbon markets to welders and pipefitters necessary to build the required energy infrastructure. As the Government of the United Kingdom highlighted in its *2009 Low-Carbon Industrial Strategy*[37] *and Low-Carbon Transition Plan*[38], most jobs will require some understanding of energy or resource efficiency, or low-carbon technologies and processes. Nations need to ensure that they are able to supply the right skills in the right place in time to fully exploit the benefits from the move to a global low-carbon economy.

While it has been estimated that, by 2050, low-carbon jobs could employ more than 25 million people worldwide[39], no consensus exists regarding the definition of what constitutes a low-carbon or "green" job. This makes it difficult to track job creation or identify indicators that are specific to skills development in this context. Research to date suggests that a wide array of occupations, skills, and income levels are included in the scope of "green jobs." Beyond broad level indicators related to employment, education, and labour force trends, data gaps create challenges for assessing capacity to support emerging low-carbon industries. The NRTEE agrees that "effective policy for skills and employment requires a much deeper understanding of the nature of the transition and of the skills that will be necessary to transform our economy."[40] Although data collection for education and skills development needs to be improved, the following set of indicators assesses capacity for broadly applicable skills required in a low-carbon economy.

**TABLE 7** SKILLS RANKINGS

| | CATEGORY RANK | SUSTAINABILITY MBA PROGRAMS | | LOW-CARBON GRADUATES | | SPENDING ON POST-SECONDARY EDUCATION | |
|---|---|---|---|---|---|---|---|
| | | RANK | SCORE # | RANK | SCORE % | RANK | SCORE % |
| Canada | 1 | 2 | 0.19 | 7 | 21.1 | 1 | 46.1 |
| Germany | 2 | 5 | 0.01 | 1 | 27.2 | 2 | 42.5 |
| France | 3 | 4 | 0.08 | 2 | 25.8 | 3 | 30.3 |
| USA | 4 | 1 | 0.32 | 8 | 16.8 | 6 | 23.9 |
| UK | 5 | 3 | 0.13 | 4 | 22.1 | 4 | 26.3 |
| Italy | 6 | 7 | 0 | 5 | 21.7 | 5 | 26 |
| Russia | 7 | 7 | 0 | 3 | 23.2 | 7 | 15.8 |
| Japan | 8 | 6 | 0.008 | 6 | 21.4 | 8 | 13.6 |
| | | Sustainability MBA programs per million people | | Percentage of total post-secondary graduates in low-carbon disciplines | | Percentage of per student spending against GDP per capita | |

# THE INDICATORS

Three indicators were selected for the Skills category:

// NUMBER OF SUSTAINABILITY MBA PROGRAMS

// SHARE OF LOW-CARBON TECHNICAL GRADUATES

// POST-SECONDARY EDUCATION SPENDING PER STUDENT AS A SHARE OF GDP PER CAPITA

SKILLS CATEGORY INDICATOR //

# NUMBER OF SUSTAINABILITY MBA PROGRAMS

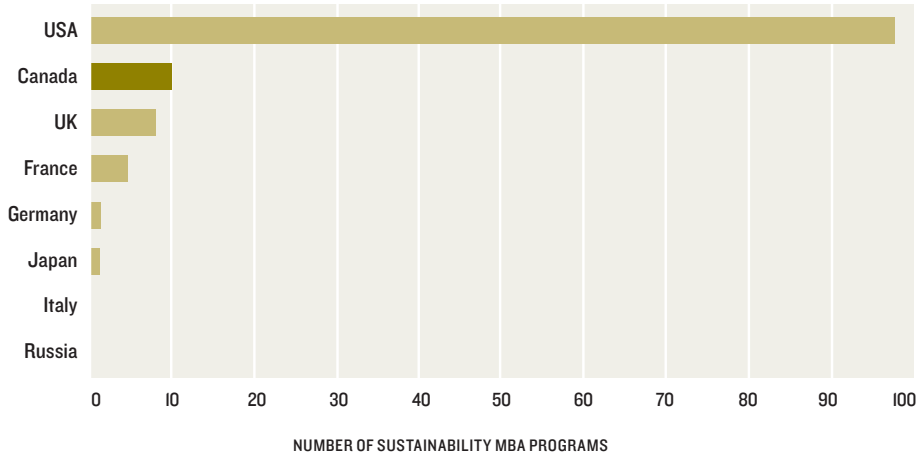
represents a proxy for the production of skilled managers adept at understanding business needs through the lens of sustainable development, ensuring their firms prosper and grow as part of a low-carbon economic transition. This indicator uses data generated by the Aspen Institute[41] and normalizes it by population.

This indicator is a measure of a country's ability to develop the future workforce with graduates that combine business managerial skills and low-carbon knowledge. The emergence of new technologies and related goods and services will require new firms and new business models to support their development and deployment. Comparative advantage in low-carbon, resource-efficient companies is critical for competitive success in a carbon-constrained future. Entrepreneurship and innovation have been identified as key success factors for developing this comparative advantage.[42]

As the U.K.'s Climate Change Task Force concluded, relevant business skills for a low-carbon context will be important.[43] Many schools have MBA programs devoted to equipping business students with the ability to apply sustainability concepts and thinking. While there is disparity between curricula in sustainability MBA programs—affecting quality and comparability between countries and institutions—this indicator still helps to shed light on the level of emphasis placed on sustainable development in business schools.

Canada ranks second on this indicator, some distance behind the U.S. and slightly ahead of the U.K. In absolute terms, the U.S. has nearly ten times more sustainability MBA programs than Canada—indeed the rest of the G8—reinforcing its strong business and managerial culture and expertise. Canada has more sustainability MBA programs than countries such as the U.K., France, and Germany despite their larger populations, as illustrated in **Figure 12**. The results of this indicator are perhaps reflective of such business management programs being part of a more North American phenomenon.

**FIGURE 12** NUMBER OF SUSTAINABILITY MBA PROGRAMS, BY COUNTRY, 2009




SOURCE: BEYOND GREY PINSTRIPES, 2009

SKILLS CATEGORY INDICATOR //

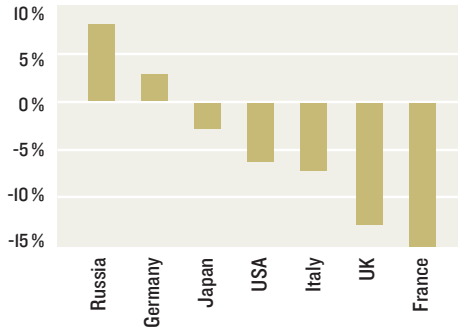
## SHARE OF LOW-CARBON TECHNICAL GRADUATES is a measure of the technical profile of university graduates within a nation's post-secondary institutions, and thus a gauge for its ability to meet the low-carbon skills needs of the future. It is defined as the total number of university and college graduates from the disciplines of science, engineering, manufacturing, and construction divided by the total number of graduates.

Technology development and deployment will be important to a low-carbon transition; therefore, skills in these identified subject areas are critical. Low-carbon economy consultation sessions in the U.K. led to the acknowledgement that "education in the so-called STEM subjects (science, technology, engineering, and maths) would be enormously important" in the transition to a low-carbon economy.[44] This indicator provides comparisons across countries in the more focused "science and technology" disciplines.

Canada ranks seventh in this indicator; we had 21% of our post-secondary graduates being equipped with technical skills in 2002, the last year for which data incorporating Canadian data was available. There are distinct performance clusters for this indicator. Germany and France lead the G8 with over one-quarter of university graduates coming from technical disciplines; Russia follows closely behind. A second mid-tier group of countries comprising the U.K., Italy, Japan, and Canada has, on average, one-third fewer technical graduates than the leadership group. The lowest performer is the U.S., with only 16% of its 2006 post-secondary graduates being equipped with technical skills.

Between 2000 and 2006, all G8 countries except Germany and Russia experienced a decline in graduates of technical disciplines, as shown in **Figure 13**. Canada is omitted due to the fact that data is only available for 2002.

**FIGURE 13** PERCENTAGE CHANGE IN LOW-CARBON TECHNICAL GRADUATES (G8 LESS CANADA), 2000-2006




SOURCE: UNESCO UIS DATABASE

This indicator comprises graduates from disciplines that are compatible to a country's ability to transition to a low-carbon economy. However, no international comparative data exists that indicates the future orientation of these graduates; specifically, whether these graduates contribute to low-carbon growth through the job market in their respective country.

SKILLS CATEGORY INDICATOR //

## POST-SECONDARY EDUCATION SPENDING PER STUDENT AS A SHARE OF GDP PER CAPITA is a leading indicator of a nation's ability to generate economic growth through human capital. It is an indicator of general application (not focused specifically on low-carbon) but provides an indication of a nation's propensity to invest in higher education and to develop higher levels of skills that will be important in a low-carbon future.

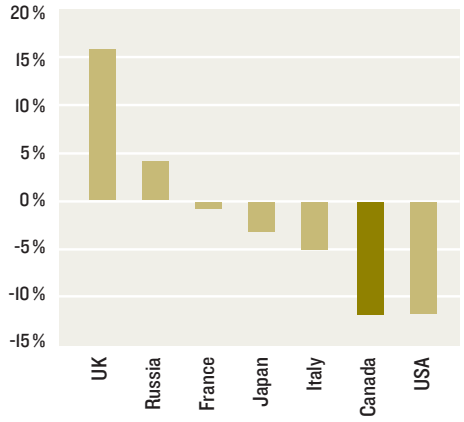
This indicator captures public investment in post-secondary education including universities, polytechnical institutions, and colleges. It does not capture private educational and training programs, which will also be important in a low-carbon economy —especially for those already employed—but which are difficult to track given the confidential nature of their data.

Canada ranks first on this indicator among the G8; its share of investment is 50% larger than France's, and nearly double that of the U.S. This should provide a solid basis for graduating and training the right kinds of educated Canadians for the necessary low-carbon transition. However, the results must be read in conjunction with the previous indicator of numbers of graduates with low-carbon skills. A deeper examination of the data suggests that Canada may still face challenges in the years ahead due to its low proportion of graduates in low-carbon skills areas. While relatively significant post-secondary funding support is provided overall, it may not be directed at developing skills in areas of importance for a low-carbon economy. Skills required to develop, produce, and install new technologies "take a long time to develop and action is required now to achieve the step change required to meet climate change targets."[45] Incorporating data on private education spending by other countries could also erode Canada's ranking.

Over most of the past decade, the G8 countries experienced decreased spending rates overall, primarily due to budgetary pressures, as illustrated in **Figure 14**. Canada's decline matched the worst G8 performer—the U.S. The global economic crisis has likely

exacerbated budget pressures within all governments to reduce funding even further. While Canada may be able to keep up its relative position in this indicator by virtue of other countries' decline in funding, this trajectory is not consistent with the achievement of increases in human capital and skills needed for a low-carbon, knowledge-based economy. Some of this has been moderated with increased federal fiscal transfers to provinces for post-secondary education since 2006. The U.K., meanwhile, outpaced Canada and grew its level of investment by 16%. Taken together with its commitment to develop a low-carbon skills strategy, the U.K. is positioning itself strongly to build capacity for the skills demands of a low-carbon future.

**FIGURE 14** CHANGE IN POST-SECONDARY EDUCATION SPENDING PER STUDENT AS A PERCENTAGE OF GDP PER CAPITA, 1998-2006




SOURCE: UNESCO UIS DATABASE

## 3.4 INVESTMENT CATEGORY

# CANADA RANKS 4TH IN THE INVESTMENT CATEGORY.

**WHY THIS MATTERS //** Public and private investment in low-emission or clean technology development will be crucial to propelling nations ahead to a strong competitive position in a low-carbon economy. Such investment will be essential to meet domestic GHG emission reduction targets. While market and regulatory measures, such as carbon pricing and renewable portfolio standards, will create market demand for and drive investment in cleantech development, government stimulus and direct investment can help lay a foundation for a low-carbon economy by acting as near-term catalysts of new cleantech development and job creation.

The IEA estimates that the total technology investment required to avoid dangerous climate change is more than US$1 trillion per annum.[46] Global private investment in renewable energy and energy-efficient technologies is estimated to reach $450 billion annually by 2012 and $600 billion by 2020.[47] HSBC Global Research found that global climate change-related revenues rose by 75% in 2008, to US$30 billion, and has estimated that by 2020 revenues from the equity market could reach US$2 trillion.[48] Previous NRTEE research on carbon pricing for Canada estimated that investment would need to increase by $2 billion per year between 2010 and 2020 to meet the federal government's GHG reduction targets. [f, 49]

Investments are required at all stages of technology and business development: angel investors, venture capitalists, banks, and public funding all cater to unique funding needs. The Toronto Stock Exchange (TSX) is developing a global competitive advantage as a place for investment in clean technologies and the renewable power sector.[50] Nations with strong investment environments in low-carbon industries will generate capacity for building new firms and technologies to take full advantage of the transition.

**f** This was based on a 20% reduction in GHG emissions by 2020 from 2006 levels.

**TABLE 8** INVESTMENT RANKINGS

| | CATEGORY RANK | CLEAN TECHNOLOGY INITIAL PUBLIC OFFERING | | CLEAN TECHNOLOGY VENTURE CAPITAL | | LOW-CARBON STIMULUS SPENDING | |
|---|---|---|---|---|---|---|---|
| | | RANK | SCORE US$ | RANK | SCORE US$ | RANK | SCORE % |
| France | 1 | 1 | 447 | 5 | 0.08 | 1 | 21.2 |
| USA | 2 | 2 | 135.3 | 1 | 0.59 | 3 | 12 |
| Germany | 3 | 3 | 91.5 | 4 | 0.2 | 2 | 13.2 |
| Canada | 4 | 4 | 32.7 | 3 | 0.22 | 4 | 8.3 |
| UK | 5 | 5 | 16.9 | 2 | 0.26 | 5 | 6.9 |
| Italy | 6 | 6 | 10.7 | 6 | 0.078 | 7 | 1.3 |
| Japan | 7 | 7 | 0 | 7 | 0.01 | 6 | 2.6 |
| Russia | 8 | N/A | N/A | 8 | 0 | 8 | 0 |
| | | Annual average of domestic IPO value per millions of US$ (2006) | | Venture capital investments in clean technology per US$1,000 of GDP | | Percent of total economic stimulus plan (2008/09) funding directed to low-carbon power | |

# THE INDICATORS

Three indicators were selected for the Investment category:

// CLEAN TECHNOLOGY INITIAL PUBLIC OFFERING (IPO)

// CLEAN TECHNOLOGY VENTURE CAPITAL (VC)

// LOW-CARBON STIMULUS SPENDING

INVESTMENT CATEGORY INDICATOR //

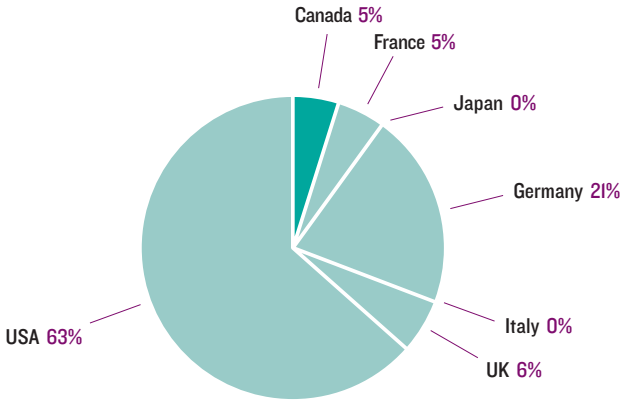
## CLEAN TECHNOLOGY INITIAL PUBLIC OFFERING (IPO) BY MILLIONS OF US$ is a measure of the market attractiveness of clean technology companies and their ability to raise funding through equity markets. It is defined as the average IPO value for cleantech firms. This measure relates to IPOs within a particular country, and does not necessarily mean that the issuing companies are from that nation.

This indicator is a measure of the average amount of money raised in public markets for clean technology companies—a higher score on this measure is an indication of the amount of equity market capital being raised, on average, in that country by cleantech firms. IPOs are important to consider as they are indicative of a company reaching the point in its life cycle where it is successful enough to attract equity investment to grow. Financial capital is crucial for market and business development, and the presence of investors willing to take bets on cleantech firms indicates, among other things, the level of confidence that investors have in the domestic clean technology marketplace.

Canada ranks fourth on this indicator, in the middle of the G8 pack; France is first principally due to a large IPO in 2006 (the base year) that inflated its ranking. The worldwide cleantech IPO market is dominated by the U.S., with Germany coming in a distant second.

The U.S. has attracted nearly two-thirds of G8 cleantech IPO activity since 2005, in terms of both dollars and deals, as shown in **Figure 15**. Canada falls in the middle range of average IPO value, but with only 5% of the value of total funding raised, it cannot be considered a significant player in the global IPO market. This should be of concern to Canadian-based clean technology companies seeking access to global capital via domestic markets. It suggests that other mechanisms such as public investment and regulatory developments will be the key drivers of clean technology development and commercialization in this country through the establishment of long-term price signals. As Deutchse Bank has recently emphasized, clean energy investors assess country-level risk when considering where to invest, and seek out climate change regimes characterized by transparency, longevity and certainty.[51]

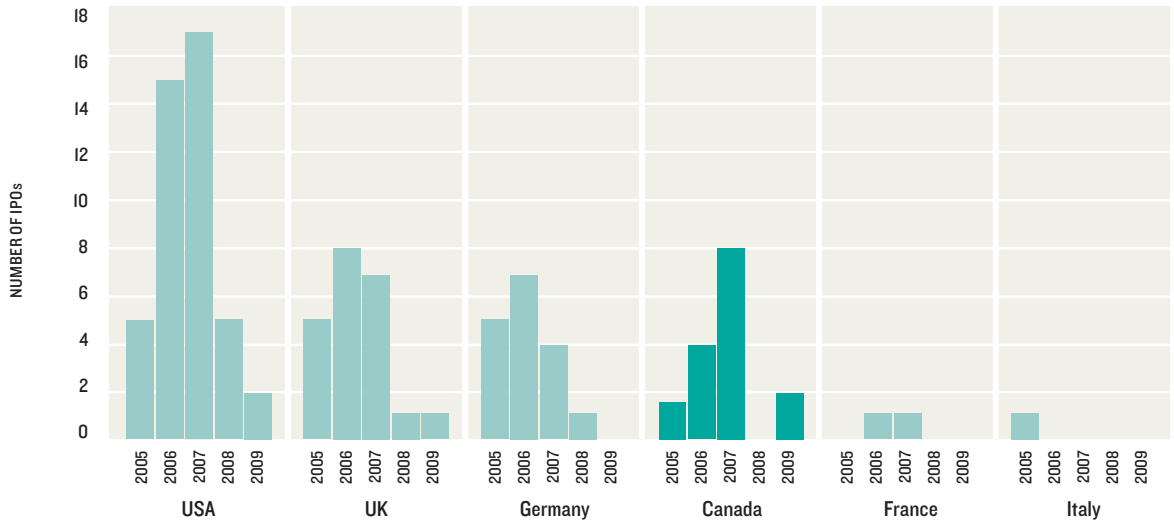
**FIGURE 15** SHARE OF G8 (LESS RUSSIA) IPO FUNDING (US$), 2005-2009




SOURCE: CLEANTECH GROUP, 2009

IPO activity has decreased over the past three years—likely due to the global economic recession—although there are recent signs of new activity and investor interest in the sector. As **Figure 16** shows, Canada did not have any cleantech IPOs in 2008, but had two deals in 2009.

**FIGURE 16** INITIAL PUBLIC OFFERINGS BY COUNTRY (G8 LESS RUSSIA), 2005-2009




SOURCE: CLEANTECH GROUP, 2009

INVESTMENT CATEGORY INDICATOR //

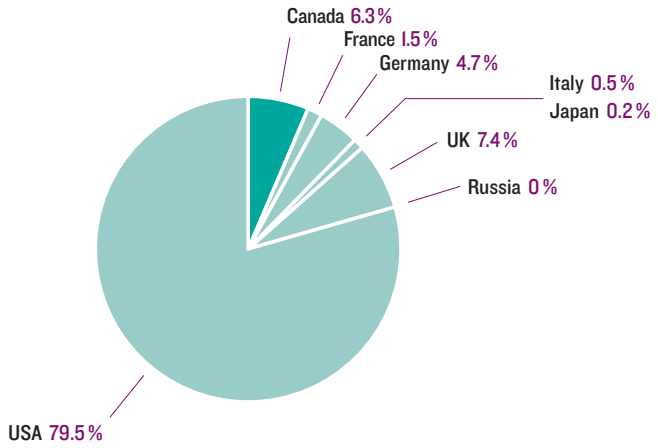
## CLEAN TECHNOLOGY VENTURE CAPITAL spending measures total venture capital spending dedicated to clean technology, represented as a share of GDP. It is an important measure of the strength of a country's cleantech sector and ability to accelerate growth of early stage technologies.

Cleantech venture capital (VC) spending is an indicator of private sector energy-related investment in new companies selling products and services that "offer competitive returns for investors and customers while providing solutions to global challenges."[52] Countries that score well on this indicator are helping to create an innovative and entrepreneurial environment, as well as generate employment, which will position them well in the transition to a low-carbon economy. As such, it is an important measure of the strength of a country's cleantech sector and its ability to accelerate growth of early-stage technologies.

Canada ranks third on this indicator, quite behind the U.S. but competitive with the U.K. and closely followed by Germany; all other countries are well behind.

Cleantech is a rapidly growing industry and is becoming a mainstream investment category. Research has shown that every $100 million of VC invested could result in 2700 direct jobs, as well as additional revenues and other indirect employment opportunities.[53] VC is an important source of financing for early stage, high-growth potential firms with significant upfront expenses that are too small to raise capital in public markets, and with limited ability to secure debt financing. The U.S. leads the G8 in cleantech VC activity, capturing almost 80% of the total of these countries over the past five years, as illustrated in **Figure 17**. In 2009 alone, its investments more than doubled those of the U.K., and nearly tripled Canada's.

**FIGURE 17** TOTAL G8 VENTURE CAPITAL FINANCING BY COUNTRY, 2004-2009




SOURCE: CLEANTECH GROUP, 2009

INVESTMENT CATEGORY INDICATOR //

## LOW-CARBON STIMULUS SPENDING is an indicator of a country's investments in positioning for both a low-carbon economic recovery and long-term low-carbon transition. It is defined as the percentage allocation of total announced economic stimulus spending in the period starting 2009 by all levels of government directed to low-carbon power initiatives, including renewables; CCS; energy efficiency in buildings and vehicles; and rail and grid upgrades.

Stimulus spending by governments has been a major public finance tool used by all industrialized economies to climb out of the recent financial crisis and economic downturn. Many of the trillions of dollars in global stimulus spending have been directed in the form of short-term stimulus aimed at kick-starting economic recovery and boosting GDP, rather than investing in longer-term low-carbon transition. However, effective stimulus directed

to low-carbon energy projects, energy efficiency in buildings, and technology development can be useful to spur more low-carbon job creation and thus a more sustainable recovery.

Canada ranks fourth in this indicator, allocating just over eight per cent of budgets to low-carbon initiatives; France leads this indicator, with over one-fifth of its stimulus budget directed to low-carbon energy projects and energy efficiency. **Figure 18** illustrates the magnitude of each country's green stimulus package.

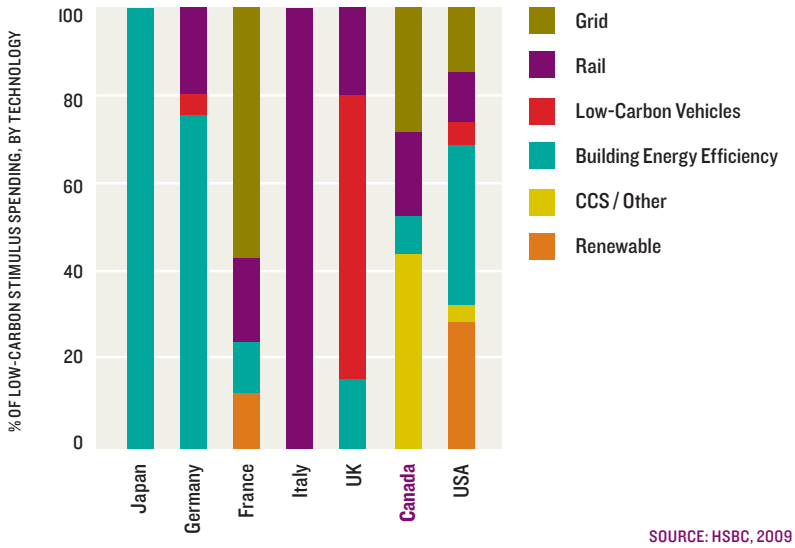
**FIGURE 18** G8 ECONOMIC STIMULUS PLANS (LESS RUSSIA)

| | FUND (US$ BILLION) | PERIOD YEARS | GREEN FUND (US$ BILLION) | % GREEN FUND |
|---|---|---|---|---|
| Italy | 103.5 | 2009 ONWARD | 1.3 | 1.3 |
| UK | 30.4 | 2009-2012 | 2.1 | 6.9 |
| Canada | 31.8 | 2009-2013 | 2.6 | 8.3 |
| France | 33.7 | 2009-2010 | 7.1 | 21.2 |
| Japan | 485.9 | 2009 ONWARD | 12.4 | 2.6 |
| Germany | 104.8 | 2009-2010 | 13.8 | 13.2 |
| USA | 787 | 10 YEARS | 94.1 | 12 |

SOURCE: HSBC, 2009

Canada's stimulus priorities lie in the areas of low-carbon power and energy efficiency, and it is the only nation in the G8 to include nuclear in its stimulus plans. There is considerable variation across the G8 countries in terms of how low-carbon stimulus dollars are being spent. Energy efficiency accounts for nearly two-thirds of global investment in this area. As shown in **Figure 19**, only the U.S. and France have undertaken significant investment in renewables, with countries such as Japan and Germany focusing almost exclusively on investment in building energy efficiency. Energy efficiency in buildings and renewables rank highest in terms of low-carbon stimulus potential. Canada has directed the bulk of its funding toward CCS and nuclear, as well as rail and grid upgrades.

**FIGURE 19** PERCENTAGE OF LOW-CARBON STIMULUS SPENDING BY TECHNOLOGY




SOURCE: HSBC, 2009

The London School of Economics has devised a methodology for evaluating the potential for a country's stimulus measures to drive a low-carbon economic transition. The criteria for evaluation are timeliness, long-term social returns, positive lock-in effects, job creation potential, focus on economic slack, and extent to which the spending is temporary.[54]

## 3.5 POLICY AND INSTITUTIONS CATEGORY

# CANADA RANKS 6TH IN THE POLICY AND INSTITUTIONS CATEGORY.

**WHY THIS MATTERS //** A low-carbon economy will come about only as a result of committed and focused public policy direction. The nature of the response to climate change and low-carbon competitiveness requires countries to adopt horizontal policy initiatives across jurisdictions and sectors and support these with ongoing policy adaptation and governance mechanisms. From the presence of a low-carbon growth plan (LCGP), to carbon pricing, to guiding governance mechanisms, the implementation of strong, integrated public policies is imperative for a successful low-carbon transition. Policy certainty is a key signal to private investors and consumers that a new, different, and reliable focus on low-carbon is essential and emerging. It tells individuals whether and how to reduce energy use, and firms whether and how to develop low-carbon energy alternatives. As no one policy measure will successfully shift any country or society onto a low-carbon pathway, governments need to consider and adopt a range of policy instruments designed for differing national, regional, and sectoral economies and needs. Appropriate governance mechanisms for managing policy implementation and administering monitoring and evaluation activities are equally important. Policies and institutions can therefore act as an important enabler of a nation's ability to address climate change challenges and to achieve low-carbon performance objectives over time.

**TABLE 9** POLICY AND INSTITUTIONS RANKINGS

| | CATEGORY RANK | LOW-CARBON GROWTH PLAN | | GHG TARGETS AND ACCOUNTABILITY | | CARBON PRICE COVERAGE AND STRINGENCY | |
|---|---|---|---|---|---|---|---|
| | | RANK* | SCORE YES/NO | RANK | SCORE # | RANK | SCORE US$ |
| UK | 1 | 1 | YES | 1 | 100 | 3 | 16.19 |
| Germany | 2 | - | NO | 2 | 75 | 1 | 23.65 |
| Italy | 3 | - | NO | 2 | 75 | 2 | 19.18 |
| France | 4 | - | NO | 2 | 75 | 4 | 14.02 |
| Japan | 5 | 1 | YES | 5 | 25 | 7 | 0.00 |
| Canada | 6 | - | NO | 5 | 25 | 5 | 3.71 |
| United States | 7 | - | NO | 5 | 25 | 6 | 0.06 |
| Russia | 8 | - | NO | 8 | 0 | 7 | 0.00 |
| | | Existence of a national strategic plan to assist the country in shifting its development path to a low-carbon economy | | Existence of (1)a medium term GHG target; (2) a central independent body (CIB); (3) public reporting role for the CIB; and (4) mandatory peer-review | | Stringency of domestic carbon price [(Emissions covered/total emissions) X (Maximum annual compliance price)] | |

*NOTE: RANKINGS ARE NOT APPLICABLE TO BINARY INDICATORS (I.E. YES/NO OPTIONS)

# THE INDICATORS

Three indicators were selected for the policy and institutions category:

// PRESENCE OF A LOW-CARBON GROWTH PLAN (LCGP)

// GREENHOUSE GAS (GHG) TARGETS AND ACCOUNTABILITY

// CARBON PRICE COVERAGE AND STRINGENCY

POLICY AND INSTITUTIONS CATEGORY INDICATOR //

# PRESENCE OF A LOW-CARBON GROWTH PLAN, OR LCGP,

in a country is an indicator of national leadership in developing and implementing a comprehensive strategy for a low-carbon economic, environmental, and social transition.

An LCGP can be defined as:

*"a strategic plan to assist the country in shifting its development path to a low-carbon and climate resilient economy and achieve sustainable development. It is based on the socio-economic and development priorities of the country. It has a long-term component that includes a strategic vision and a short- and medium-term component that shows which specific actions will be undertaken to get on a low-carbon, climate resilient pathway."* [55]

A number of key success factors for the development of LCGPs have been identified, including senior government leadership, strong data and analysis of mitigation potential and costs, extensive stakeholder engagement, and continuous improvements to the plan to build consensus around priorities.[56] LCGPs developed to date are neither consistent in methodology, nor content. They can be very quantitative and goal-driven, or more concerned with qualitative assessments of policy needs. Some place more emphasis on mitigation and competitiveness in a low-carbon economy, while others include more of an adaptation focus.

As this is a "yes/no" question (the indicator measures whether a country has an LCGP or not), there is no ranking of any G8 country. Canada does not have an LCGP; only Japan and the U.K. do. The U.K.'s Low-Carbon Transition Plan and Japan's Action Plan for Achieving a Low-Carbon Society represent the only LCGPs within the G8. The climate bill in the U.S. meets the criteria, but because it has not been passed in both Houses of Congress it does not receive credit in this benchmarking exercise. Other countries, including Canada are at various stages of implementing policies and measures to reduce emissions and stimulate investment in and market penetration of low-carbon technologies, but no comprehensive LCGP has been attempted or initiated.

The U.K. Low-Carbon Transition Plan[57] is one of the most substantive LCGPs produced to date. Sectoral priorities highlighted by the U.K. include power generation; energy use in homes, communities, and workplaces; transportation; agriculture; and waste. Driven by the goal of achieving emission cuts of 18% from 2008 levels by 2020, it includes a five-point plan:

// Protecting the public from immediate risk

// Preparing for the future

// Limiting the severity of future climate change through a new international climate agreement

// Building a low-carbon U.K.

// Supporting individuals, communities, and businesses to play their part

As emerging economies and key trading partners plan for policy development and investment in low-carbon markets, the potential for Canada to lag behind in a carbon-constrained future grows. Development of a Canadian LCGP would offer an opportunity for a collaborative engagement process to assess the country's vision and to develop the policies required for future low-carbon competitiveness. According to research conducted by the OECD and others, pitfalls to avoid include development of the LCGP by an external body (instead, it should be country-led), lack of integration into mainstream decision making, lack of policy prioritization, poor stakeholder engagement leading to lack of local ownership, and use of out-of-date or inaccurate information.[58] Building on the experiences of others in developing successful plans will help Canada reduce its learning curve and develop strategies and solutions for long-term economic development with a lower emissions profile.

POLICY AND INSTITUTIONS CATEGORY INDICATOR //

**GHG TARGETS AND ACCOUNTABILITY** is a four-level indicator. It is aggregated to assess on a yes/no basis the presence of (1) medium-term GHG targets, (2) a central independent body to measure GHG progress and performance, (3) a public reporting role for the central independent body, and (4) mandatory peer-review of GHG-emission forecasting and measurement.

The foundation of any viable low-carbon performance policy by a country are its GHG reduction targets. These indicate the level of climate ambition by a nation as it creates the focus of policy efforts to achieve those targets. But the mere presence of targets is insufficient; governments and citizens need to know how they are progressing on meeting those targets. Accountability, derived from independent measurement and reporting on target achievement, helps authorities assess the effectiveness of policies and actions. And it helps citizens determine whether their governments are moving in the direction and at the speed they want to reduce greenhouse gas emissions. But effective policy needs equally effective institutions to guide implementation, evaluate instruments and effectiveness, and ensure transparency. This will, in turn, foster greater confidence in the policy itself.

This indicator combines four core elements of strong performing low-carbon policy, linking institutions and accountability to GHG targets and ambition. It builds on previous NRTEE research on best international practices in GHG emission forecasting and the governance chapter of our carbon pricing report *Achieving 2050*.[59]

Canada scores fifth on this indicator, gaining performance points only for having medium-term GHG emission reduction targets; the U.K. is the undisputed leader scoring a "yes" on each of the four sub-indicators. Three other countries scored "yes" across three of the four sub-indicators (Germany, Italy, and France), reinforcing the European Union's attention to this common approach flowing from its history of shared governance and institutions. Canada's scoring on one of the sub-indicators was matched by two other countries—the U.S. and Japan. **Figure 20** sets out the results for all countries across all four sub-indicators.

**FIGURE 20** GHG TARGETS AND ACCOUNTABILITY

| | MEDIUM-TERM GHG TARGET | CENTRAL INDEPENDENT BODY | REPORTING ROLE FOR CENTRAL BODY | MANDATORY PEER-REVIEW RESULTS |
|---|---|---|---|---|
| France | YES | YES | YES | NO |
| Germany | YES | YES | YES | NO |
| UK | YES | YES | YES | YES |
| USA | YES | NO | NO | NO |
| Japan | YES | NO | NO | NO |
| Canada | YES | NO | NO | NO |
| Italy | YES | YES | YES | NO |
| Russia | NO | NO | NO | NO |

SOURCE: VARIOUS

POLICY AND INSTITUTIONS CATEGORY INDICATOR //

**CARBON PRICE COVERAGE AND STRINGENCY** measures a country's use of policy to impose a price on GHG emissions in order to incent emissions reductions. The two most important characteristics of a carbon pricing policy are (1) the stringency of the policy as reflected by the price (a greater price incentive leads to greater reductions) and (2) the coverage of the policy as reflected by how broadly emissions in a country are priced (the broader the coverage, the more emissions reductions will be incented throughout the economy). This indicator considers both of these factors. It represents the maximum carbon price imposed by a policy as a weighted average according to the emissions covered under the pricing policy as a share of total emissions.

Carbon prices, whether applied through a carbon tax or a cap-and-trade system, are broadly recognized as the most cost-effective policy tool to drive long-term decarbonization. Carbon price coverage and stringency measure a country's use of policy to impose a price on GHG emissions in order to incent emissions reductions.[60] This indicator is calculated as the maximum carbon price experienced under a pricing regime, multiplied by the percentage of national emissions covered under this regime. Countries with a higher price applied to a greater share of national emissions have a higher score.

The indicator also accounts for sub-national carbon pricing policies. Canada, for example, has different carbon pricing regimes in different provinces. Regional carbon prices contribute to the weighted average according to the share of national emissions covered. Similarly, the U.S. score is calculated by considering the Regional Greenhouse Gas Initiative, a regional cap-and-trade system that applies only to emissions from electricity generation in ten states. For countries with different carbon prices within the country, the indicator can be calculated by summing the score calculated for each distinct sub-national carbon price and corresponding emissions coverage.

Canada ranks fifth on this indicator with a carbon price measure of only $3.71, significantly ahead of the U.S. at $0.06, but well behind the European Union members of the G8; Germany, Italy, the U.K., and France face the most stringent carbon pricing policies within the G8. Germany leads and outpaces Canada by a nearly seven-to-one margin. Japan and Russia do not have functioning trading programs or carbon taxes and thus receive no score on this measure. Canada's ranking is entirely due to provincial measures as no federal government measures for carbon pricing have yet been adopted.

# DRAWING LESSONS

SUCCEEDING IN LOW-CARBON PERFORMANCE

// CHAPTER 04


38.69
-0.62
+0.07
+0.13
+0.46
2.09%

# 4.0 // DRAWING LESSONS: SUCCEEDING IN LOW-CARBON PERFORMANCE

The NRTEE Low-Carbon Performance Index represents a first step in gaining deeper understanding of where Canada needs to strategically focus to prosper in a low-carbon economy. Tracking these indicators over time, and expanding the list of indicators while deepening the analysis, will provide further insight on our progress and our competitive positioning. Data availability and quality are of utmost importance for this analysis, and as collection improves for indicators specific to a low-carbon context, the Index can be adjusted and improved to reflect advancements and new priorities. Research in this rapidly developing area will surely reveal new insights to policy makers on which are the best indicators for measuring durable low-carbon competitive capacity. It will then be possible to incorporate new knowledge as it emerges so that this tool can continue to provide a valuable contribution to an evolving challenge. The NRTEE offers this Index as both a tool for policy makers now, and also as a way of thinking through the inevitable policy challenges ahead.

For Canada, the inescapable conclusion is that when it comes to low-carbon performance, we need to do better. Canada's performance on the Index is sixth place among the G8 countries. Our competitors, save for the United States at this stage, are all investing more and preparing their economies for the low-carbon transition. Low-carbon policies and plans are only just being contemplated and implemented in this country, federally and provincially. Canada's rankings in the five benchmark categories reinforce current perceptions and past investments and commitments. Our high energy and therefore carbon-intensive economy clearly leaves us second from the bottom in Emissions and Energy, while uncertainty about national carbon pricing and coordinated federal/provincial/territorial climate policy approaches keeps us near the bottom on Policy and Institutions. On Investment and Innovation, Canada is squarely in the middle of the G8 pack, while on Skills we are the leader.

So, Canada's story is moderately positive in some areas and clearly requires improvement in others. It is why we fall firmly in the second-tier of low-carbon performing countries, behind the European Union countries, in the overall rankings. Unless a significant effort is made in some of the categories, particularly Emissions and Energy and Policy and Institutions, we can expect to remain there. But now, with this Index, we can measure not just

where we are now but, as policies and actions accumulate, whether we are closing the gap between us and the leaders. Competitive advantage in the future requires competitive advance in low-carbon performance.

Every country in the world will feel the effects of the low-carbon transition. How they position themselves to compete in terms of their domestic emissions and energy use, investment, innovation, skills, and policies will have lasting effects on their economic viability. The message stemming from this analysis is clear: Canada will face unique challenges competing in a global low-carbon economy based on our current profile, but this by no means holds us back from a prosperous future. Action now to build capacity for trade and investment in a carbon-constrained market will propel us forward to be leaders in providing the skills, technologies, financing mechanisms, and goods and services that will only grow in demand.

The core lesson to be drawn from the creation of this new Low-Carbon Performance Index is that Canada needs to perform across a range of factors if our country is to truly succeed as low-carbon performers. Investment in low-carbon energy innovation will lead to a better energy and emissions performance; strong national carbon pricing regimes will drive much of the investment capital and behaviour for this innovation. Having a low-carbon growth plan developed collaboratively with industry and across jurisdictions in Canada will help identify where to focus and invest strategically. It can help governments and businesses make the right choices so Canada succeeds in the global race for low-carbon economic success.

This will be a challenge but the NRTEE believes Canada is up to it.

# RECOMMENDATIONS //

**FIRST** the LCPI should be updated regularly to continually track performance and measure progress. New indicators should be added and existing ones adjusted to ensure they are robust and relevant. Public accountability is essential for elected officials, governments, businesses, experts, and others to assess progress and propose future steps.

**SECOND** a dedicated nationally scoped low-carbon index should be developed and published regulary with a broader, more comprehensive range of categories and indicators to marshal domestic efforts across all federal, provincial, territorial and municipal governments to develop a low-carbon economy for Canada. This new index of performance measures should be focused on specific objectives considered relevant, meaningful, attributable, and balanced. Expectations and benchmarks should be developed simultaneously to ensure a strong focus on outcomes.

**THIRD** these two indices should form the basis for developing a comprehensive low-carbon growth plan for Canada. Such a policy pathway needs to be fully integrated into existing and future economic, environmental, and social policy planning frameworks.

# APPENDICES

# 5.0 // APPENDICES

## 5.1 CASE STUDIES: BENCHMARKING CANADA TO CHINA, NORWAY AND AUSTRALIA

In addition to the G8 analysis, the NRTEE conducted three separate case studies with countries having unique economic, energy, or geographic characteristics with which to compare Canada and draw further insight. These are:

**CHINA** due to the fact that it is an emerging economy increasing its investment in low-carbon performance, making it an important future competitor;

**NORWAY** because it is a net energy exporter like Canada, but has placed strong importance on building capacity for low-carbon competitiveness; and

**AUSTRALIA** with a large geography and dispersed population, it also shares a number of energy and emission challenges with Canada.

The following three case studies illustrate Canada's low-carbon performance relative to these countries. Using the same Low-Carbon Performance Index categories and indicators gives a broader sense of capacity for competitiveness in a low-carbon future. In some cases, data availability means an incomplete picture emerges, but it remains useful for comparative purposes.

**CASE I** CANADA VS. CHINA

| | EMISSIONS & ENERGY | | | INNOVATION | | | SKILLS | | | INVESTMENT | | | POLICY & INSTITUTIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CARBON PRODUCTIVITY | EMBODIED CARBON IN EXPORTS | LOW-CARBON ELECTRICITY | LOW-CARBON ENERGY PATENTS | ENERGY SECTOR R&D | GOVERNMENT - LOW-CARBON ENERGY R&D | SUSTAINABILITY MBA PROGRAMS | LOW-CARBON PROGRAM GRADUATES | SPENDING ON POST-SECONDARY EDUCATION | CLEAN TECHNOLOGY IPOs | CLEAN TECHNOLOGY VENTURE CAPITAL | LOW-CARBON STIMULUS SPENDING | LOW-CARBON GROWTH PLAN | GHG TARGETS AND ACCOUNTABILITY | CARBON PRICE COVERAGE AND STRINGENCY |
| Canada | 1.78 | 31.7 | 76.7 | 0.76 | 2.6 | 0.35 | 0.19 | 21.1 | 46.1 | 32.7 | 0.22 | 8.3 | NO | 25 | 3.71 |
| China | N/A[g] | 24.4 | 15.9 | 0.02 | N/A | N/A | 0 | 35.7 | 85.8 | 67.6 | 0.25 | 37.8 | YES | 25 | 0 |

China's energy and emission profile makes it a high carbon producer. It is well known as the fastest-growing carbon-emitting nation, although on a per capita basis, Canada ranks ahead of China for emissions. Still, Canada scores better on the Energy and Emissions category, but China ranks higher on the Skills, Investment, and Policy and Institutions categories. Available data is insufficient to make cross-country comparisons on the Innovation category.

Of most concern for China is that while its absolute emissions have grown rapidly, its emissions intensity has increased. As a result, China faces a significant challenge in reducing overall emissions, a fact that has probably underlined its reluctance to take on binding absolute emission reduction targets. Given its coal reserves, fossil-fuel generation will continue to play a large role in China's future energy consumption; however, it also has vast hydroelectric potential and is investing heavily in renewable technologies, nuclear power plant production, and high-speed rail in order to achieve the double dividend of lowering its carbon profile and gaining global clean technology market share.

g Since China qualifies as an Annex II country as per the UNFCCC, the data for $CO_2e$ emissions excluding LULUCF was not available for 2007. The latest available year was 1994, in this year, China's carbon productivity was 0.14.

China has experienced exponential emissions growth over the past fifteen years—much faster than Canada. Despite becoming the world's largest emitter of GHGs, China is now making increasingly large investments aimed at prospectively transitioning its economy onto a low-carbon, more resource-efficient pathway although uncertainties exist to timing and achievement. It has made choices based on the fact that energy demand is predicted to surge in the coming decades and pollution concentrations are negatively affecting quality of life. It may see significant potential to carve out a dominant position in the fast-growing global clean technology production market. China is making and attracting significant investments in low-carbon technologies, which will drive future manufacturing opportunities, relevant skills development, and job growth. On a per capita GDP basis, for example, China pours nearly double the level of investment into post-secondary education than Canada.

When compared to the G8, China is the second largest IPO market, far outpacing Canada. In terms of stimulus spending, China outpaces Canada by a four-to-one margin. Its investment is directed almost entirely to high-speed rail and grid development, as it seeks to transform its transportation and electricity transmission infrastructure.

China will be important to watch for its international participation and commitment to GHG emission reductions. Just two weeks before COP-15 in Copenhagen, China announced its first firm target for GHG reductions: a 40-45% reduction in carbon intensity from 2005 levels by 2020.[61] It leads globally for low-carbon stimulus spending in absolute terms, with over US$220 billion (or about 38%) allocated to building a low-carbon economy.[62] Its LCGP, the National Climate Change Program, was developed in June 2007 to achieve stated goals of developing a circular economy, protecting the environment, and accelerating the construction of an environmentally friendly society.[63]

## CASE 2 CANADA VS. NORWAY

| | EMISSIONS & ENERGY | | | INNOVATION | | | SKILLS | | | INVESTMENT | | | POLICY & INSTITUTIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CARBON PRODUCTIVITY | EMBODIED CARBON IN EXPORTS | LOW-CARBON ELECTRICITY | LOW-CARBON ENERGY PATENTS | ENERGY SECTOR R&D | GOVERNMENT - LOW-CARBON ENERGY R&D | SUSTAINABILITY MBA PROGRAMS | LOW-CARBON PROGRAM GRADUATES | SPENDING ON POST-SECONDARY EDUCATION | CLEAN TECHNOLOGY IPOs | CLEAN TECHNOLOGY VENTURE CAPITAL | LOW-CARBON STIMULUS SPENDING | LOW-CARBON GROWTH PLAN | GHG TARGETS AND ACCOUNTABILITY | CARBON PRICE COVERAGE AND STRINGENCY |
| Canada | 1.78 | 31.7 | 76.7 | 0.76 | 2.6 | 0.35 | 0.19 | 21.1 | 46.1 | 32.7 | 0.22 | 8.3 | NO | 25 | 3.71 |
| Norway | 7.06 | N/A | 99.52 | 2.63 | 0.96 | 0.2 | N/A | 15.8 | 46.5 | 1131 | 0.32 | 29.7 | NO | 25 | 30.89[h] |

As a strong low-carbon performing nation, Norway ranks very high. Canada's status as a net energy producer and exporter generates challenges for reducing its emissions profile. Norway is also a net exporter of petroleum, natural gas, and coal,[64] but has taken important measures to position itself for low-carbon success, and outperforms Canada across the majority of the benchmark indicators. It is the only major industrialized nation to have set a carbon neutrality target, with a 2030 achievement goal. It plans to achieve neutral status through deep cuts in carbon emissions by ramping up domestic renewable energy production (which is already significant due to its abundant hydroelectric generating capacity), and through international offset projects (e.g., reduced emissions from deforestation and degradation projects). Norway is also the only country in this report to have a national carbon tax (in place since 1991).

Despite its northern climate and energy exports, Norway's carbon productivity is four times higher than Canada's, and has shown steady improvements over time. Its economy is electricity intensive but, like in Canada, hydro dominates its generation mix, supplying nearly 100% of total production. Like Canada, however, Norway will be challenged to achieve further low-cost emissions reductions through improvements in industrial energy efficiency.

h According to the Norwegian National Allocation Plan for the Emissions Trading System (ETS) in 2008-2012, Norway will participate in ETS alongside its national carbon tax system. The inclusion of the ETS will mean a reduction on the carbon price for offshore sectors, and an overall broadening of Norway's carbon coverage. The overall effect will be an even larger carbon coverage for Norway.

## CASE 3 CANADA VS. AUSTRALIA

| | EMISSIONS & ENERGY | | | INNOVATION | | | SKILLS | | | INVESTMENT | | | POLICY & INSTITUTIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CARBON PRODUCTIVITY | EMBODIED CARBON IN EXPORTS | LOW-CARBON ELECTRICITY | LOW-CARBON ENERGY PATENTS | ENERGY SECTOR R&D | GOVERNMENT - LOW-CARBON ENERGY R&D | SUSTAINABILITY MBA PROGRAMS | LOW-CARBON PROGRAM GRADUATES | SPENDING ON POST-SECONDARY EDUCATION | CLEAN TECHNOLOGY IPOS | CLEAN TECHNOLOGY VENTURE CAPITAL | LOW-CARBON STIMULUS SPENDING | LOW-CARBON GROWTH PLAN | GHG TARGETS AND ACCOUNTABILITY | CARBON PRICE COVERAGE AND STRINGENCY |
| Canada | 1.78 | 31.7 | 76.7 | 0.76 | 2.6 | 0.35 | 0.19 | 21.1 | 46.1 | 32.7 | 0.22 | 8.3 | NO | 25 | 3.71 |
| Australia | 1.6 | 31.4 | 8.06 | 1.35 | 2.18 | 0.09 | 0.19 | 21.1 | 24.9 | 27.4 | 0.05 | 9.3 | NO | 25 | 1.88 |

Australia provides an interesting comparison given similar challenges in geography, distance, dispersed population, transportation infrastructure, export-driven economies, and reliance on emission-intensive energy production and consumption. Overall, Canada leads Australia on most low-carbon performance indicators contained in the Index.

Electricity represents 44% of Australia's total primary energy supply, and it is heavily dependent on coal. Canada generates nine times as much low-carbon electricity as does Australia. Australia's growth in $CO_2$ emissions has been significantly higher than Canada's over the past 15 years, with triple the growth rate, making it the highest rate among the countries assessed in this report. The magnitude of Australia's challenge in reducing emissions related to power generation is underscored by the fact that it has been less successful than Canada at improving industrial energy efficiency and in shifting its generation mix to less polluting fuels such as natural gas.

Australia's economy is heavily dependent on the export of coal and uranium production, along with other mineral products. Its proportion of emissions embodied in trade is nearly

eight times that of Canada, and approaches the level of Russia. As much of its natural resource exports are used for electricity generation overseas, Australia stands to be competitively disadvantaged in a scenario where its trading partners decrease their demand for carbon-intensive goods.

Canada significantly outspends Australia in terms of government investment in energy R&D and private sector spending on energy research. While both countries have experienced declines in public sector R&D investment over the past decade, the gap between the countries has widened due to Australia's faster rate of decline. Taken together with the low level of attracted VC investment and the lack of a compelling regulatory framework or price signal, Australia will be challenged to match other countries' clean technology development performance.

Looking ahead, Australia will be challenged like Canada to meet growing demand for energy from population growth while simultaneously decarbonizing the major emissions-intensive energy generating mix, in its case, coal. Australia's federal government has made strides in more integrated climate policy development with the recent creation of a central department for climate change, potentially enabling its ability to coordinate planning across multiple ministries.

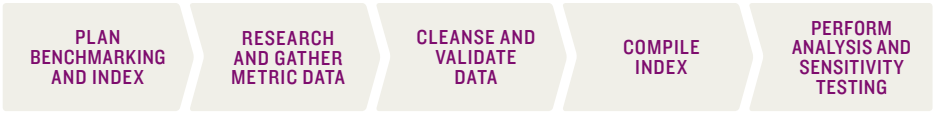
## 5.2 INDICATOR DEFINITIONS

| INDICATOR | DEFINITION | CALCULATION |
|---|---|---|
| CARBON PRODUCTIVITY | *Ratio of GDP per unit of greenhouse gas emissions* | Total GDP production (expressed in US$) (Source: WB) divided by the production of carbon dioxide equivalent ($CO_2e$) emissions (Source: IPCC), 2007 |
| EMBODIED CARBON IN EXPORTS | *Percentage of carbon emissions embodied in exports* | Carbon dioxide ($CO_2$) emissions embodied in exports expressed as a percentage of the production-based emissions (Source: Peters & Hertwich, 2007, using 2001 data) |
| LOW-CARBON ELECTRICITY | *Share of net electricity produced from low-carbon sources* | The sum of solar, wind, geothermal, nuclear, and hydroelectric power generated divided by total net electricity generated (Source: EIA), 2006 (or latest available date) (% of total million tonnes of oil equivalent) |
| LOW-CARBON ENERGY PATENTS | *Domestic low-carbon related patents per million people* | Gross number of patent applications filed under the PCT relating to renewable energy, fuel cells and nuclear (Source: Patent Transfer Office) divided by population (Source: WB) for 2005 and multiplied by 1,000,000 |
| ENERGY SECTOR EXPENDITURE ON R&D | *Private energy sector R&D expenditures per GDP* | Energy sector R&D expenditures in 2008 US$ and exchange rates in 1,000,000 divided by current US$ GDP in 1,000 (Source: OECD ANBERD Database, WB for GDP data) |
| GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D | *Government low-carbon energy R&D expenditures per GDP* | R&D expenditures in 2008 US$ and exchange rates in 1,000,000 divided by current US$ GDP in 1,000 (Source: IEA OECD R&D Database, WB for GDP data) |
| THE NUMBER OF SUSTAINABILITY MBA PROGRAMS | *Sustainability MBA programs per million people. This represents a proxy for the production of skilled managers adept at understanding business needs through the lens of sustainable development* | Number of MBA programs with a sustainability stream, as per listings in Beyond Grey Pinstripes study (2009) divided by population (Source: WB) multiplied by 1,000,000 |

| | | |
|---|---|---|
| SHARE OF LOW-CARBON TECHNICAL GRADUATES | *Percentage of total post-secondary graduates in low-carbon disciplines* | Number of post-secondary graduates in the fields of science and technology divided by the total number of post-secondary graduates (Source: UNESCO 2005) |
| POST-SECONDARY EDUCATION SPENDING PER STUDENT AS A SHARE OF GDP PER CAPITA | *Ratio of per student spending against GDP per capita* | Reported current government spending on post-secondary education, divided by the total number of pupils in post-secondary education, expressed as a percentage of per capita GDP (Source: UNESCO 2006) |
| CLEAN TECHNOLOGY IPO | *Average annual domestic IPO value in US$* | Average IPO value for clean technology firms, expressed in US$, 2006 (or latest available date). (Source: Cleantech Group) |
| CLEAN TECHNOLOGY VENTURE CAPITAL | *Venture capital investments in clean technology per $000s GDP* | Total venture capital dedicated to clean technology, represented as a share of GDP (Source: Cleantech Group for Investments, WB for GDP data) |
| LOW-CARBON STIMULUS SPENDING | *Percent of total economic stimulus plan (2008/09) funding directed to low-carbon power initiatives* | Percentage of total economic stimulus plan funding directed to low-carbon power (renewables, CCS/other), energy efficiency (building EE, low-carbon vehicles), rail and grid. (Source: HSBC 2009) |
| LOW-CARBON GROWTH PLAN | *Existence of a national strategic plan to assist the country in shifting its development path to a low-carbon economy* | Yes or No<br>(Various sources) |
| GHG TARGETS & ACCOUNTABILITY | *Existence of (1) medium-term GHG targets, (2) a central independent body to measure progress and performance, (3) a public reporting role for the central independent body, and (4) a mandatory peer-review of GHG emission forecasting and measurement.* | (Yes or No)<br>Calculated as follows:<br>0 if all No<br>25 if 1 Yes<br>50 if 2 Yes<br>75 if 3 Yes<br>100 if 4 Yes<br>(Various sources) |
| CARBON PRICE COVERAGE & STRINGENCY | *Stringency of domestic carbon price as a weighted average by coverage* | Product of: (Emissions covered/total emissions) and the (Maximum annual compliance price). For countries with multiple sub-national prices, the following formula was used: $\sum$ (all regions, sectors with price) [maximum price * (Emissions covered/total emissions)] (Various sources) |

## 5.3 DETAILED METHODOLOGY

The approach to conducting the benchmark analysis following the initial literature review, stakeholder consultation, and data feasibility study, consisted of five steps, as described below:




**STEP 1 // PLAN BENCHMARKING AND INDEX** Deloitte & Touche LLP was initially provided a draft benchmarking framework and list of 25 performance indicators developed by the Conference Board of Canada and tested out. The framework and indicators were developed as an output of a multi-stakeholder consultation exercise facilitated by the NRTEE.

A draft benchmark framework was prepared by Deloitte & Touche LLP designed to measure a country's "carbon competitiveness" as expressed by overall level of country low-carbon performance. Focusing on energy production and use was deemed a useful, and realistic means of considering comparative low-carbon performance. Deloitte and the NRTEE project team subsequently agreed that the purpose of the exercise was to assess Canada's position relative to other comparator countries in a variety of low-carbon performance categories beyond energy and emissions deemed important to Canada's ability to reduce carbon emissions while fostering economic growth and prosperity. Two different types of indicators were initially identified:

1 // STATUS INDICATORS: ENERGY, EMISSIONS AND OTHER RELATED OUTPUTS

2 // CAPACITY INDICATORS: INNOVATION, INFRASTRUCTURE, INVESTMENT, SKILLS, INSTITUTIONS, AND POLICY

It was acknowledged that differing stages of economic development, physical geography, and natural resource endowments make comparing countries difficult, because countries require different efforts to reach their specific objectives in relation to their current status and needs. However, it was felt that the indicator categories identified above had common importance for all countries and were therefore appropriate for the purpose of this exercise.

It was agreed that given the project execution timelines, selection of indicators was to be based on the following criteria:

- Relevance to emerging definitions of country low-carbon performance
- Public availability of indicator data (e.g., free or nominal fee) from credible sources
- Broad geographical scope (in order to capture all comparator countries) and regularly produced
- Quality of the data (e.g., completeness, reliability of data)
- Relative ease of data manipulation (e.g. in complete format within existing datasets, and / or in correct format within multiple data sources that could be quickly researched and manipulated)

After application of these decision criteria, an initial list of 33 potential indicators with perceived high importance (which comprised the status and capacity indicators) was refined into a list of 15 feasible indicators. These were selected to provide a comprehensive and meaningful analysis, eliminate duplication and overlap among indicators, and create a basis for an equally weighted composite index.

The benchmarking framework selected consisted of a single composite index comprising 15 metrics across the G8.[i] For classification purposes, the indicators were grouped into five equally balanced categories:

- Emissions and Energy
- Innovation
- Skills
- Investment
- Policy and Institutions

i Although the LCPI is a benchmarking exercise primarily across the G8, data was collected for three additional countries: Australia, China, and Norway. Their performance in the benchmarked metrics is not calculated into the index. Rather, the individual countries' performance in particular metrics is used as a comparator to support or refute Canada's relative performance and position.

## NRTEE LOW-CARBON PERFORMANCE INDEX

| EMISSIONS & ENERGY | INNOVATION | SKILLS | INVESTMENT | POLICY & INSTITUTIONS |
|---|---|---|---|---|
|  |  |  |  |  |
| CARBON PRODUCTIVITY | LOW-CARBON ENERGY PATENTS | SUSTAINABILITY MBA PROGRAMS | CLEAN TECHNOLOGY INITIAL PUBLIC OFFERING (IPO) | LOW-CARBON GROWTH PLAN |
| EMBODIED CARBON EMISSIONS IN EXPORTS | ENERGY SECTOR BUSINESS EXPENDITURE ON R&D | LOW-CARBON PROGRAM GRADUATES | CLEAN TECHNOLOGY VENTURE CAPITAL | GREENHOUSE GAS TARGETS AND ACCOUNTABILITY |
| LOW-CARBON ELECTRICITY | GOVERNMENT EXPENDITURE ON LOW-CARBON ENERGY R&D | SPENDING ON POST-SECONDARY EDUCATION | LOW-CARBON STIMULUS SPENDING | CARBON PRICE COVERAGE AND STRINGENCY |

**STEP 2 // RESEARCH AND GATHER METRIC DATA** For each of the 15 metrics, we validated the existence and accessibility of the identified information sources. Where multiple data points were combined to create a metric, we sought to identify additional valid information sources (and additional indicators) to reinforce the benchmark data sets. Our review focused on secondary sources, including the following:

// Organisation for Economic Co-operation and Development (OECD)
// International Energy Agency (IEA)
// Energy Information Administration (EIA)
// Various published reports / studies.

Where possible we sought to collect time series data and sought information for a common base year (e.g., 2006 for energy use and $CO_2$ emissions data; 2007/08 for institutions and policy data). Time series data, while available, does not factor into the index or any of the weightings. It is used to provide context to the performance of particular countries.

Through this process the final list of 15 indicators were gathered and populated to conduct the country benchmark analysis.

**STEP 3 // CLEANSE AND VALIDATE DATA** This step involved validating, organizing, and "cleansing" data (i.e., some interpretation was required) in order to present the data in a uniform manner so that it could be accurately analyzed. This included:

// Documenting sources of data and data definitions,
// Applying a naming scheme to identify data set / type of data, and
// Scanning the data for truncated / repeating / nonsense / missing / zero values / outliers / duplicates.

The indicators differed in terms of completeness, magnitudes, trends, and volatility. We had to normalize, standardize, and restructure the data in a manner that allowed it to be properly analyzed. Sub-tasks within this step included the following:

// Consolidation of fragmented data or data set components
// Imputation of missing data (this was a key issue with countries such as Russia) – depending on the indicator under consideration, we either defaulted to the most recent year with data available
// Standardization of data (to enable direct comparisons)

Where possible and relevant, we adjusted the metrics for size by dividing each indicator by a denominator (such as GDP, population) in order to control for the size of a country. This approach was undertaken to avoid rewarding (or penalizing, depending on the indicator) large countries simply for being large.

**STEP 4 // COMPILE INDEX** Based on the 15 metrics selected, their categories, and the data sources, the index was compiled and metrics populated for each of the G8 countries. Where data was available, metrics were compiled for the three additional countries as well (Norway, China and Australia), but were not included in the Low-Carbon Performance Index (LCPI).

To calculate the actual composite index, a country's raw value for each indicator was first normalized between 0 and 100 based on relative position in the G8. Each indicator was equally weighted within its category, and the normalized scores were then summed up by category. For example, the country with the best ranking was given 100, and the lowest was given 0; all others received a score in between 0 and 100 based on their relative position. Weightings were applied at the category level—this exercise applied an equal weighting. The sum of the equally weighted categories produces the index. This is a standard practice in the benchmarking of performance where no rationale can be applied for differentiated weightings. The framework was designed to be replicable in order that improvements over time can be monitored and Canada's relative position reassessed.

$$= \frac{(\text{Actual Value} - \text{Minimum Value})}{(\text{Maximum Value} - \text{Minimum Value})} \times 100$$

The formula above calculates a country's normalized score on a scale between 0 and 100 while maintaining the relative differences between countries' raw scores. For example, in the carbon productivity indicator, Canada ranks in seventh position, scoring a raw value of 1.78 and a normalized value of 28.07. The normalized value for Canada reflects its relative position between the metric leader (France, with a raw value of 4.83 and normalized value of a hundred) and the metric laggard (Russia, with a raw value of 0.59 and normalized value of zero).[j]

The normalized scores are summed up by category equally. Weightings are applied at the category level. The sum of the weighted categories produces the LCPI. The sensitivity of the weightings is discussed further in the next section.

As outlined above, the selection of the indicators, building block categories, and weightings was strongly influenced by the pre-project scoping exercise. No rank-correlation-type exercise was conducted to determine the relationship between the Index and potential indicators in order to screen for their inclusion, and as a result no such analysis was available as input to the relative importance/attributed weightings for each of the final selected indicators.

j Typically, a metric is compiled for each country in the G8. In a few instances, data did not exist to compile a metric. Rather than artificially impute a zero for that country, the metric is left blank and excluded from future calculations. In those circumstances, the other countries are still normalized to a score between 0 and 100 but the sub-sample of countries is reduced by the excluded country (i.e., ranking of the G8 in that metric is actually only seven countries, with the country with the missing data excluded).

**STEP 5 // PERFORM ANALYSIS AND SENSITIVITY TESTING** In the absence of such analysis to inform the relative weighting of indicators, building block and support categories, we defaulted to an equal weighting approach in the initial development of the LCPI.

While there are strengths and weaknesses associated with adopting an equal weighting approach, we felt that in this situation where we are conveying not just the results of an LCPI but the importance of developing one, that such an approach was prudent and defensible. Benefits of this approach include avoiding the introduction of deliberate bias of the index results against any particular country or group of countries, and enabling the reproduction and enhancement of the index in subsequent iterations (equal weighting of the building block categories means that as further research is conducted, and as data improves, indicators can be tweaked and/ or replaced without affecting the overall integrity of the index).

We then ran multiple scenarios to test the relative weighting assumptions to the overall index results. These scenarios were selected through discussion with the NRTEE. The advantages of selecting different scenarios include helping to gauge the robustness of the results, increase the index transparency, and identify the countries whose performance can improve or deteriorate under certain assumptions. The following scenarios were selected:

// EQUAL WEIGHTING OF EACH OF THE FIVE CATEGORIES;

// TWO-THIRDS WEIGHTING ON CANADA'S TWO STRONGEST CATEGORIES (INNOVATION, SKILLS); 1/3 WEIGHTING ON ALL OTHER CATEGORIES; AND

// TWO-THIRDS WEIGHTING ON CURRENT CAPACITY AND GOVERNANCE (EMISSIONS & ENERGY, POLICY & INSTITUTIONS); 1/3 WEIGHTING ON ALL OTHER CATEGORIES.

The relative rankings of countries remained relatively static across the three selected scenarios, as outlined below:

| | EQUAL WEIGHTING | CANADA'S COMPETITIVE ADVANTAGE | CAPACITY AND GOVERNANCE |
|---|---|---|---|
| Canada | 6 | 4 | 7 |
| USA | 5 | 6 | 5 |
| Japan | 4 | 3 | 4 |
| Russia | 8 | 8 | 8 |
| Germany | 2 | 1 | 3 |
| Italy | 7 | 7 | 6 |
| France | 1 | 2 | 1 |
| UK | 3 | 5 | 2 |

## 5.4 REFERENCES


| DATA SOURCE | REFERENCE | INDICATOR |
|---|---|---|
| BEYOND GREY PINSTRIPES | The Aspen Institute. (2009). *Beyond Grey Pinstripes 2009-10*. New York, New York, 2009. Accessed from *http://www.beyondgreypinstripes.org/index.cfm* | *Sustainability MBA programs* |
| BP | BP. (2009). "BP Statistical Review of World Energy, June 2009. Accessed March 29, 2010, from http://www.bp.com/statisticalreview | |
| CANADIAN COUNCIL ON LEARNING | Canadian Council on Learning (2009). Post-Secondary Education in Canada 2008-2009. Table 5.5 "Gross domestic expenditures on research and development as a percentage of gross domestic product for selected OECD countries, 2001-2005" Chapter 5, p. 91. Accessed March 29, 2010, from http://www.ccl-cca.ca/pdfs/PSE/2009/PSE2008_English_Chapter5.pdf | *Government expenditure on low-carbon energy R&D* |
| CLEANTECH GROUP | Cleantech. (2009). IPOs, Venture Capital, Companies Seeking Funds 2001-2009. Accessed November 6, 2009. | *Cleantech IPO, Cleantech venture capital* |
| ENERGY INFORMATION ADMINISTRATION (EIA) | *International Energy Outlook 2009*. $CO_2$ emissions from electricity generation, Net Energy Generation. Accessed December 2009, from http://www.eia.doe.gov/oiaf/ieo/graphic_data_electricity.html | *Low-carbon electricity* |
| GLOBAL CLIMATE CHANGE POLICY TRACKER (DEUTSCHE BANK) | Deutsche Bank. (2009). "Global Climate Change Policy Tracker" in *An Investor's Assessment Detailed Analysis of Targets by Region and Country.* | *Low-carbon growth plan; GHG targets & accountability; Carbon price coverage and accountability* |
| HSBC GLOBAL RESEARCH | (2009). "Climate Change Global" in *A Climate for Recovery - The colour of stimulus goes green.* Accessed from http://www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf | *Low-carbon stimulus spending* |
| INTERNATIONAL ENERGY AGENCY (IEA) | *IEAOECD RD&D Database*. Group 1: Energy Efficiency, Total $C0_2$ Capture And Storage, Group III: Renewable Energy Sources, Group IV: Nuclear Fission And Fusion, Group V: Hydrogen And Fuel Cells, Group VI: Other Power And Storage Techs. Accessed November 6, 2009, from http://www.iea.org/stats/rd.asp | *Government expenditure on low-carbon energy R&D; Energy sector business expenditure on R&D* |
| NEW ENERGY FINANCE | (2009). *"Global Carbon Quarterly, Q3"* | *Carbon price coverage and stringency* |

| | | |
|---|---|---|
| ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD) | OECD ANBERD Database, STAN R&D Expenditure in Industry (ISIC Rev 3). Ed 2009. Accessed November 2009, from http://www.oecd.org/document/17/0,3343,en_2649_34451_1822033_1_1_1_1,00.html OECD Patent Database, Patents by country and technology fields (EPO, PCT, USPTO, Triadic Patent Families), June 2009. Accessed November 2009, from http://stats.oecd.org/Index.aspx?DatasetCode=PATS_IPC | *Low-carbon energy patents; Energy sector business expenditure on R&D* |
| PETERS & HERTWICH | Peters, Glen P., & Hertwich, Edgar G. (2008). $CO_2$ Embodied in International Trade with Implications for Global Climate Policy. In *Environmental Science & Technology* 42(5): 1402-1407. | *Embodied carbon emission in exports* |
| REGIONAL GREENHOUSE GAS INITIATIVE | (2009). Market Monitor Report for Auction 6. New York, New York. | *Carbon price and stringency* |
| UNITED NATIONS EDUCATION, SCIENTIFIC AND CULTURAL ORGANISATION (UNESCO) | *UNESCO UIS Database- Education*. Table 16: Graduates by broad field of education in post-secondary education, Per Student Tertiary Spending. Accessed November & December 2009 from http://stats.uis.unesco.org/unesco/ReportFolders/ReportFolders.aspx?IF_ActivePath=P,50&IF_Language=eng | *Low-carbon graduates; Spending on post-secondary education* |
| UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC) | *National greenhouse gas inventory data for the period 1990-2007.* Table 4. Total aggregate anthropogenic emissions of $CO_2$, $CH_4$, $N_2O$, HFCs, PFCs and $SF_6$ excluding emissions/removals from land use, land-use change and forestry, 1990, 2000 and 2005. 2007. Accessed March 2010, from http://maindb.unfccc.int/library/view_pdf.pl?url=http://unfccc.int/resource/docs/2009/sbi/eng/12.pdf | *Carbon productivity* |
| WORLD BANK (WB) | *World Development Indicators*. GDP (current US$), Population, total 1990-2008. Accessed October 2009, from http://go.worldbank.org/4C55Z0H7Z0 | *Carbon productivity; Low-carbon patents; Energy sector business expenditure on R&D; Government expenditure on low-carbon energy R&D; Sustainability MBA programs; Spending on post-secondary education; Cleantech venture capital* |
| WORLD ECONOMIC FORUM (WEF) | *World Economic Forum Global Competitiveness Report, 2009-2010* (Results based on CEO survey conducted by WEF) | *Low-carbon energy patents* |

## 5.5 FULL INDICATOR TABLE

# NRTEE LOW-CARBON PERFORMANCE INDEX

| | LCPI | | EMISSIONS & ENERGY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CARBON PRODUCTIVITY | | | EMBODIED CARBON IN EXPORTS | | | LOW-CARBON ELECTRICITY | | | | |
| | RANK | N* SCORE | SCORE | N* SCORE | RANK | SCORE | N* SCORE | RANK | SCORE | N* SCORE | RANK | N* SCORE | RANK |
| Canada | 6 | 37.64 | 1.78 | 28.07 | 7 | 31.7 | 0 | 8 | 76.7 | 81.1 | 2 | 109.17 | 6 |
| USA | 5 | 39.94 | 1.94 | 31.72 | 6 | 8.3 | 100 | 1 | 29.2 | 15.53 | 6 | 147.25 | 3 |
| Japan | 4 | 43.17 | 3.19 | 61.29 | 5 | 14.5 | 73.5 | 2 | 38.6 | 28.62 | 4 | 163.41 | 2 |
| Russia | 8 | 7.28 | 0.59 | 0 | 8 | 27.5 | 17.95 | 7 | 34.1 | 22.39 | 5 | 40.34 | 8 |
| Germany | 2 | 52.3 | 3.47 | 67.87 | 4 | 25.3 | 27.35 | 5 | 38.7 | 28.7 | 3 | 123.92 | 5 |
| Italy | 7 | 27.33 | 3.8 | 75.7 | 3 | 26.5 | 22.22 | 6 | 17.9 | 0 | 8 | 97.92 | 7 |
| France | 1 | 58.33 | 4.83 | 100 | 1 | 22.7 | 38.46 | 4 | 90.4 | 100 | 1 | 238.46 | 1 |
| UK | 3 | 48.45 | 4.33 | 88.12 | 2 | 21.3 | 44.44 | 3 | 24.6 | 9.28 | 7 | 141.84 | 4 |

N*: NORMALIZED VALUE

| INNOVATION | | | | | | | | | | | SKILLS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOW-ENERGY PATENTS | | | ENERGY SECTOR R&D | | | GOVERNMENT LOW-CARBON ENERGY R&D | | | | | SUSTAINABILITY MBA PROGRAMS | | | LOW-CARBON PROGRAM GRADUATES | | | SPENDING ON POST-SECONDARY EDUCATION | | | | |
| SCORE | N* SCORE | RANK | SCORE | N* SCORE | RANK | SCORE | N* SCORE | RANK | N* SCORE | RANK | SCORE | N* SCORE | RANK | SCORE | N* SCORE | RANK | SCORE | N* SCORE | RANK | N* SCORE | RANK |
| 0.76 | 67.82 | 4 | 2.6 | 24.88 | 6 | 0.35 | 40.39 | 3 | 133.09 | 3 | 0.19 | 58.06 | 2 | 21.1 | 41.04 | 7 | 46.1 | 100 | 1 | 199.1 | 1 |
| 0.48 | 39.84 | 5 | 5.44 | 56.18 | 3 | 0.17 | 11.98 | 5 | 107.99 | 5 | 0.32 | 100 | 1 | 16.8 | 0 | 8 | 23.9 | 31.69 | 6 | 131.69 | 4 |
| 1.08 | 100 | 1 | 9.42 | 100 | 1 | 0.73 | 100 | 1 | 300 | 1 | 0.008 | 2.43 | 6 | 21.4 | 44.02 | 6 | 13.6 | 0 | 8 | 46.44 | 8 |
| 0.08 | 0 | 8 | 0.35 | 0 | 8 | N/A | N/A | N/A | 0 | 8 | 0 | 0 | 7 | 23.2 | 62.06 | 3 | 15.8 | 6.77 | 7 | 68.82 | 7 |
| 0.89 | 80.75 | 2 | 8.35 | 88.24 | 2 | 0.14 | 7.12 | 6 | 176.1 | 2 | 0.01 | 3.78 | 5 | 27.2 | 100 | 1 | 42.5 | 88.92 | 2 | 192.7 | 2 |
| 0.28 | 19.77 | 7 | 1.23 | 9.75 | 7 | 0.22 | 19.39 | 4 | 48.91 | 7 | 0 | 0 | 7 | 21.7 | 47.6 | 5 | 26 | 38.15 | 5 | 85.76 | 6 |
| 0.29 | 20.92 | 6 | 5.06 | 51.94 | 4 | 0.43 | 52.42 | 2 | 125.28 | 4 | 0.08 | 25 | 4 | 25.8 | 87.05 | 2 | 30.3 | 51.38 | 3 | 163.44 | 3 |
| 0.77 | 68.36 | 3 | 3.83 | 38.43 | 5 | 0.097 | 0 | 7 | 106.79 | 6 | 0.13 | 40.43 | 3 | 22.1 | 50.87 | 4 | 26.3 | 39.08 | 4 | 130.37 | 5 |

| INVESTMENT | | | | | | | | | | | POLICY & INSTITUTIONS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLEAN TECHNOLOGY IPOs | | | CLEAN TECHNOLOGY VENTURE CAPITAL | | | LOW-CABON STIMULUS SPENDING | | | | | LOW-CARBON GROWTH PLAN | | GHG TARGETS AND ACCOUNTABILITY | | | CARBON PRICE COVERAGE AND STRINGENCY | | | | |
| SCORE | N° SCORE | RANK | SCORE | N° SCORE | RANK | SCORE | N° SCORE | RANK | N° SCORE | RANK | SCORE | N° SCORE | SCORE | N° SCORE | RANK | SCORE | N° SCORE | RANK | N° SCORE | RANK |
| 32.7 | 7.33 | 4 | 0.22 | 36.11 | 3 | 8.3 | 39.15 | 4 | **82.59** | 4 | NO | **0** | 25 | 25 | 5 | 3.71 | 15.69 | 5 | **40.69** | 6 |
| 135.3 | 30.26 | 2 | 0.59 | 100 | 1 | 12 | 56.6 | 3 | **186.86** | 2 | NO | **0** | 25 | 25 | 5 | 0.06 | 0.26 | 6 | **25.26** | 7 |
| 0 | 0 | 7 | 0.01 | 0.47 | 7 | 2.6 | 12.26 | 6 | **12.73** | 7 | YES | **100** | 25 | 25 | 5 | 0 | 0 | 7 | **125** | 5 |
| N/A | N/A | N/A | 0 | 0 | 8 | 0 | 0 | 8 | **0** | 8 | NO | **0** | 0 | 0 | 8 | 0 | 0 | 7 | **0** | 8 |
| 91.5 | 20.48 | 3 | 0.2 | 34.03 | 4 | 13.2 | 62.26 | 2 | **116.77** | 3 | NO | **0** | 75 | 75 | 2 | 23.65 | 100 | 1 | **175** | 2 |
| 10.7 | 2.38 | 6 | 0.08 | 12.7 | 6 | 1.3 | 6.13 | 7 | **21.22** | 6 | NO | **0** | 75 | 75 | 2 | 19.18 | 81.13 | 2 | **156.13** | 3 |
| 447 | 100 | 1 | 0.08 | 13.53 | 5 | 21.2 | 100 | 1 | **213.53** | 1 | NO | **0** | 75 | 75 | 2 | 14.02 | 59.3 | 4 | **134.3** | 4 |
| 16.9 | 3.79 | 5 | 0.26 | 42.89 | 2 | 6.9 | 32.55 | 5 | **79.23** | 5 | YES | **100** | 100 | 100 | 1 | 16.19 | 68.46 | 3 | **268.46** | 1 |

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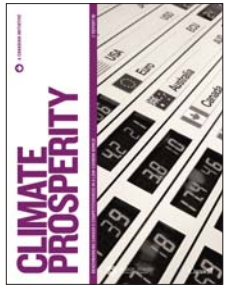
# CLIMATE PROSPERITY

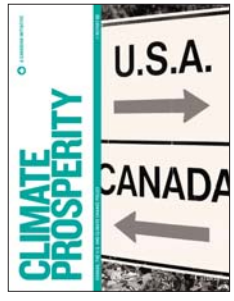
## THE TIMELINE

2010 → 2011




**REPORT 01 //**
**BENCHMARKING CANADA'S COMPETITIVENESS IN A LOW-CARBON WORLD**

This report will assess Canada's capacity to be competitive in a new global low-carbon economy, by comparing us to other G8 nations in areas such as emissions and energy, skills, investment, innovation and governance.

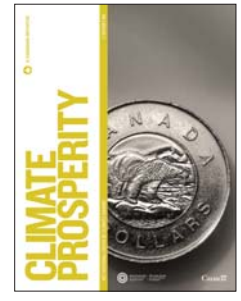



**REPORT 02 //**
**CANADA-U.S. CLIMATE POLICY STUDY**

This report will examine Canadian climate policy choices based on potential U.S. courses of action and what this means for achieving Canadian environmental goals at the least economic cost.

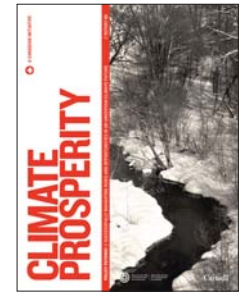

**REPORT 03 //**
**PHYSICAL IMPACTS OF CLIMATE CHANGE IN CANADA**

This report will communicate the risks and benefits that a warming climate poses to Canada over the next one-hundred years in areas such as ecosystems, water resources, health, infrastructure and natural resource sectors and how adaptation can help.



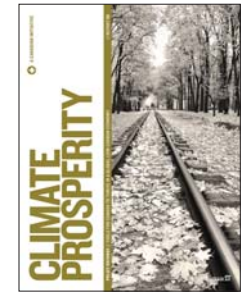

**REPORT 04 //**
**NET NATIONAL COSTS OF CLIMATE CHANGE**

This report will provide, for the first time, national economic costings of the impact of climate change on Canada, together with a detailed look at four key sectors: coastal zones, human health, public infrastructure and forests.



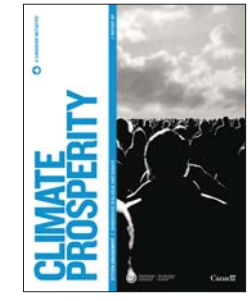

**REPORT 05 //**
**POLICY PATHWAY REPORT FOR CLIMATE IMPACTS AND ADAPTATION**

Building on previous reports in the series, this advisory report will provide a range of policy pathways and actions to help Canada take advantage of its potential to adapt to a changing climate.




**REPORT 06 //**
**POLICY PATHWAY REPORT FOR GLOBAL LOW-CARBON TRANSITION**

Building on previous reports in the series, this advisory report will provide policy pathways and actions necessary for Canada to thrive in a global low-carbon economy in areas such as energy, innovation, skills, investment and governance.

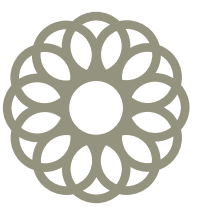



**REPORT 07 //**
**CITIZEN ENGAGEMENT**

This report will highlight input from Canadian citizens sought during the course of the program to ensure action on climate change is underpinned by a broad social consensus informed by democratic dialogue and debate.

National Round Table on the Environment and the Economy | Table ronde nationale sur l'environnement et l'économie

A CANADIAN INITIATIVE



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