INSTITUT
DE L'ÉNERGIE
TROTTIER

ENERGY
IN QUEBEC AND CANADA:
A CONVERSATION STARTER

Institut de l'énergie Trottier
Polytechnique Montreal
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To the reader

This *White Paper* is concerned with some key issues arising for Quebec and Canada in energy. Our objective is to provide an opportunity to address them on the basis of reliable data. This paper was prepared in advance of the discussions at the Second Annual Trottier Symposium on Engineering, Energy and Sustainable Design (March 30-31, 2015) at Polytechnique Montreal.

About the Institut de l'énergie Trottier

Created in 2013, the Institut de l'énergie Trottier is dedicated to fostering a new generation of innovators on energy issues and to securing the future of energy.

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FOREWORD

This paper was prepared in advance of the discussions at the Second Annual Trottier Symposium on Engineering, Energy and Sustainable Design (March 30-31, 2015) at Polytechnique Montreal.

The Trottier Symposium on Engineering, Energy and Sustainable Design is a partnership between McGill University's Trottier Institute for Sustainability in Engineering and Design (TISED) and Polytechnique Montreal's Institut de l'énergie Trottier (IET). TISED promotes ideas that are both bold and green through education, outreach, and research, where we aim to connect with the public for a greater understanding and appreciation of sustainability issues in our society. The IET is dedicated to fostering a new generation of innovators on energy issues and to securing the future of energy.

As mentioned above, it is our objective to approach the issues related to energy using data from sources of acknowledged credibility. The data included in this paper cover not only the Canadian energy landscape but also 16 other regions (countries, U.S. states or regions) that share some common characteristics with Canada to see where lessons might be learned to enhance Quebec's and Canada's energy strategies.

We thank Pierre Baptiste, François Cartier, Subhasis Ghoshal, Normand Mousseau, Pierre-Olivier Pineau, Hans Björn Püttgen, Lorne Trottier, Guillaume Baggio Ferla and Chanie Quesnel-Lebel for their support in the preparation of this paper. We also thank the clubs Poly-Énergies, Poly-Finances, and Poly-Monde of Polytechnique for their contributions to the background research.

1

INTRODUCTION

Energy is fundamental for our society. This paper is concerned with some of the key issues arising for Quebec and for Canada in the realm of energy. The objective here is to begin laying out a framework to foster a deeper understanding of the complexities of the issues, and to address them on the basis of data.

An energy strategy consists of the decisions, policies and regulations that touch on energy issues within a political jurisdiction. The purpose of an energy strategy is to determine in broad terms:

1. The total quantity of energy that the jurisdiction needs (or chooses) to use
2. The mix of sources from which to obtain this energy
3. The ways in which the energy obtained will be used to meet the needs
4. The economic and other arrangements under which this strategy is carried out.

Establishing an energy strategy involves making choices that inevitably impact society, and the full consequences of these choices may be difficult to grasp. For example, if transportation needs in a city are primarily met using vehicles that run on gasoline, then the resulting air pollution from vehicle exhausts impacts the health of the city's population. If a large proportion of vehicles would run on natural gas, then the related air pollution would be reduced and so would the negative health impacts. However, implementing such a fuel switch would imply that the natural gas would have to be obtained from somewhere, that the infrastructure to distribute the natural gas would have to be built, that the current vehicles would have to be converted, and so on. Another set of issues arises if electric vehicles are considered. In other words, undertaking any fuel switch would have environmental, economic, and other impacts on society.

An energy strategy is not an environmental strategy nor an economic nor a commercial strategy, even though these strategies overlap in a number of ways. For example, there are environmental matters that are not directly related to energy (such as the greenhouse gas emissions from cattle) and there are energy matters not directly related to the environment (such as whether electricity is provided by a single corporation or through a market mechanism). As another example, there is a distinction to be made between producing more electricity to generate revenue (as part of an economic strategy), and producing more electricity to promote it as an alternative to natural gas for heating (as part of an energy strategy).

The design of an energy strategy must take into account the realities of the jurisdiction. These realities are of many kinds: economic, environmental, sociological, political, etc. For example, the Canadian constitution shares jurisdiction over matters concerning energy between the federal and provincial governments; this a political reality for Quebec and for Canada. Also, Quebec and Canada both consist of a large territory with a low population density and a cold climate; these geographical realities influence the choices that can be made as part of their political strategies.

Looking beyond Quebec and Canada, this paper presents information on the energy profiles of 16 other regions around the world, and seeks how Quebec and Canada may learn from other regions that are similar in an energy sense. The selection of regions was based on the following characteristics:

- availability of natural resources,
- population size,
- geographical size,
- energy usage, and
- potential relevance to Canada.

The next sections of this paper provide information on some of the key issues arising for Quebec and Canada in energy. Section 2 describes further the importance of energy, particularly from a Canadian perspective, and some of the impacts of decisions related to energy. Section 3 looks at some economic and political aspects of the Canadian energy reality. Section 4 provides an overview of the financial approaches for reducing emissions of greenhouse gases, and how addressing this environmental issue may impact energy strategies in Canada. Lastly, Section 5 examines the three main sectors of energy use, namely transportation, residential and industrial.

The coverage we provide is not exhaustive; rather the objective is to set the stage for the discussions at the forthcoming Trottier Symposium. These discussions will inform the choice of subjects for future IET studies and public events, and aim to raise public awareness and engagement with the energy choices that Quebec and Canada will make in the coming years.

2

WHY ENERGY MATTERS

A first question is why is an energy strategy so important? There are several reasons for this. For the sake of brevity we mention only four of them here, namely the economic importance of energy, the environmental impacts of energy-related activities, the health impacts, and energy security. While this paper does not explore many of these issues, it is important to keep in mind the variety of potential impacts following from an energy strategy.

2.1 // Economic Impact

In 2010, energy accounted for 7% of the Canadian economy and 23% of merchandise exports. The energy sector therefore represents a significant portion of Canada's economic profile, and energy planning is economically vital. In particular, crude oil (including bitumen) is Canada's main export. Energy also represents an important source of jobs, both present and future. For example, many of the envisioned changes to the power system, such as customer management of energy via two-way electricity flows, and increasing numbers of electric vehicles, will support the development of whole new sectors of the economy. Thus, from an economic perspective, energy plays a significant role for Canada.

2.2 // Environmental Impacts Related to Greenhouse Gases

There is a well-known international impetus to ensure a global reduction of the emissions of greenhouse gases (GHGs). The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) indicates that a reduction in global GHG emissions originating in human activity is necessary. Specifically, a reduction of 40-70% below the 2010 levels by 2050 is necessary to maintain CO_2e[1] concentrations at levels considered acceptable. The European Union has announced its targets for reducing GHG emissions by 2030, and the United States and China have also announced their future goals. December 2014 brought together representatives from the international community in Lima seeking to establish the foundations of a global strategy against climate change that world leaders will agree upon in Paris in December 2015. The position of Canada at the moment is characterized by a lack of engagement in this process, but given the importance of the energy industry to the Canadian economy, and the nature of the Canadian confederation (see Section 3), the Canadian government has a significant role to play.

2.3 // Environmental and Health Impacts

The environmental impacts of energy go beyond the issue of GHGs. They include various others issues such as:

- The potential for significant water usage and groundwater pollution, such as for hydrofracturing to extract shale gas and oil as a potential source of leaks into the water table, as reported in some areas of North America.
- The potential for radiation leaks arising from the use of nuclear technologies to generate electricity, such as when mining uranium or operating a nuclear generation plant.
- The potential health impacts from proximity to power lines. According to the government of Canada, such a connection has not been established but Health Canada, the World Health Organization, and the International Agency for Research on Cancer agree that more research on this topic is needed.
- The air pollution and associated health impacts from the use of gasoline for transportation. Alternative fuels (such as compressed natural gas and biofuels) can help reduce these emissions.

2.4 // Security Impacts

Energy being such a fundamental need, the security of supply is a concern for many countries. Because Canada's natural resources for non-renewable and renewable energy are plentiful, it can be argued that this aspect is less of a concern than in countries more dependent on foreign sources for energy supply. Moreover energy security can be in contradiction with free trade principles, and lead to energy becoming more expensive than necessary. Another economic perspective on security is that because Canada derives significant revenues from energy exports, the security of continued energy business in different parts of the world is key to Canada's future.

1. CO_2e is a unit of measurement of the global warming impact of GHGs. For a given quantity of a specific GHG, the corresponding quantity of CO_2e is the amount of CO_2 that would have an equivalent impact.

3

THE CANADIAN REALITY

This section presents two aspects of the Canadian reality that need to be taken into account in energy. The first one is that jurisdiction over energy is shared between the federal and provincial governments. In particular, the provinces are responsible for energy matters relating to economic and energy security within their borders; for example they are responsible for the electricity systems on their territory. Among the responsibilities of the federal government is the regulation of international and interprovincial movements of energy and energy goods. The federal government is also involved in energy matters that impact the country's economic development and energy security; for example, it has played a role in promoting energy efficiency and alternative energies since the 1970s.

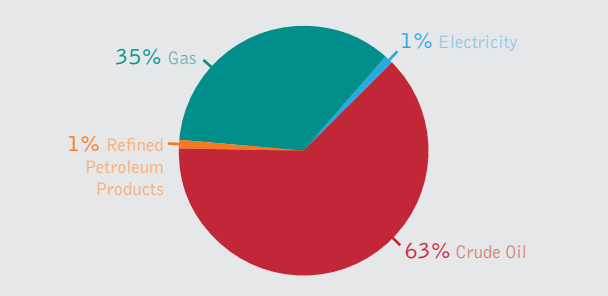
The second one is that, as in many other sectors, trade in energy tends to be predominantly North-South rather than West-East, i.e., between provinces and American states rather than among provinces. The importance of energy trade with the U.S. is exemplified by the following facts:

- Not only is crude oil Canada's largest export, but Canada is the top supplier of crude oil to the U.S.;
- Canada exports large quantities of electricity to the U.S. American imports from Canada in 2012 equalled 1.5% of all electricity consumed in that country.

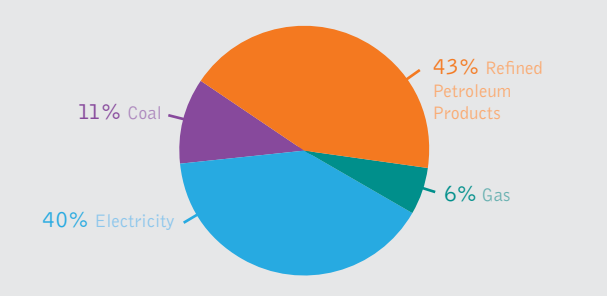
These two aspects have tended to lessen inter-provincial collaboration within Canada on energy.

On the other hand, new collaborations are being established at present. One such agreement is the recent *Joint Memorandum* entitled *Seasonal Exchange Of Electricity Capacity Between Ontario And Québec*. This agreement specifies that starting in late 2015, Ontario will provide 500 megawatts (MW) of electricity capacity to Quebec in the winter while Quebec will provide 500 MW to Ontario in the summer. Additional evidence for the relevance of intra-Canadian energy exchanges between the Eastern and Western parts of the country is evidenced by the following data:

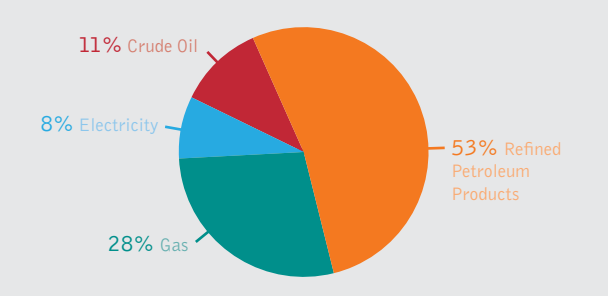
Western Canada Exports



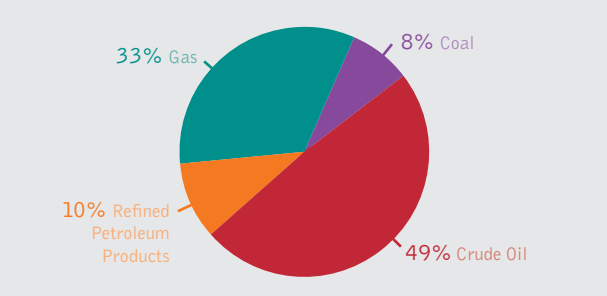
Western Canada Imports



Eastern Canada Exports



Eastern Canada Imports



Statistics Canada: Supply and demand of primary and secondary energy in terajoules, CANSIM database. 2012.
http://www5.statcan.gc.ca/cansim/pick-choisir?id=1280016&p2=+33&retrLang=eng&lang=eng

The graphics show a significant degree of similarity between the exports and imports of the two parts. While other aspects need to be taken into account, it seems still relevant to ask if Canada would not be overall better off by exploiting some of these similarities, particularly because fossil fuels will in all likelihood continue to play a major role in the Canadian energy system for many years.

4

FINANCIAL APPROACHES TO GHG REDUCTION AND ENERGY STRATEGIES

One of the major international trends is the creation of financial means to help control the emissions of GHGs. There are essentially two types of such financial approaches:

- A *carbon tax* is a fee charged for emitting GHGs. The level at which the tax is set will in principle determine the resulting quantity of emissions, although this connection is not straightforward.
- A *cap-and-trade system* fixes in advance the quantity of emissions that are allowed, and issues permits corresponding to this quantity. These permits can be traded, and emitting GHGs without holding a corresponding permit is penalized.

Both of these approaches have been implemented by different regions around the world, with varying sets of rules governing each one. In Sweden for example, the carbon tax is currently around USD$160 per ton of CO_2e but some sectors of the economy benefit from exemptions (for example, energy-intensive industries) and others are covered by the European Union's Emissions Trading System (ETS), a cap-and-trade system where the carbon price is currently around USD$10.

Canada has a variety of initiatives in this area. The federal government advocates a sector-by-sector regulatory approach. For example, it has banned the construction of traditional coal-fired power plants, but no regulation has yet been proposed for the emissions of the oil and gas sector. No financial approach of any kind has been proposed at the federal level.

At the provincial level there have been various initiatives involving financial incentives:

- British Columbia legislated emissions targets of 33% below 2007 levels by 2020, and 80% below 2007 levels by 2050. A carbon tax was implemented on July 1, 2008; the tax is revenue-neutral, meaning that every dollar generated by the tax is returned through reductions in other taxes. The tax is currently at CAD$30 per ton of CO_2e and is not expected to change.
- Alberta set in its 2008 Climate Change Strategy a target of 14% below 2005 by 2050. It combines regulatory and fiscal measures. Emission intensity limits have been set, and emissions beyond the mandated per unit intensity decrease incur a maximum payment of $15 per ton. A new climate strategy was expected in December 2014 but is not yet announced.
- Quebec has the most ambitious target in Canada: 20% below 1990 levels by 2020. It has adopted a cap-and-trade system[2] integrated with California's, so emissions permits are transferable between the two jurisdictions. There are concerns about how well this joint system will work for Quebec given the significant differences between the two jurisdictions. For example, our data show that California generates 60% of its electricity using carbon-emitting natural gas while Quebec gets more than 96% of power generation from hydro. California's industrial and residential sectors also consume much more natural gas than Quebec's. In other words, when it comes to reducing GHG emissions in the energy system, California's opportunities seem more affordable than Quebec's.

The Ontario government is considering the introduction of some form of financial approach to carbon mitigation in 2015.

Beyond the government-led initiatives, several non-governmental initiatives concerned with the carbon emissions issue have been undertaken in Canada. Two examples of such initiatives are:

- The Trottier Energy Futures Project[3] is a research and modeling effort to determine how Canada could significantly reduce its GHG emissions. The objective is to chart realistic pathways for Canada to achieve a target of 80% below 1990 levels by 2050.
- Canada's Ecofiscal Commission advocates policies in various areas (including carbon emissions) that are "ecofiscal", i.e., that correct market price signals so as to encourage desirable economic activities (for example, innovation) while discouraging undesirable ones (for example, pollution).

Additionally, with Eastern Canada's proximity to the Northeastern U.S., it might be an option to participate in the U.S. Regional Greenhouse Gas Initiative. This is a cooperative effort among 9 Northeastern U.S. states to limit GHG emissions from the power sector via a cap-and-trade system. The proceeds from the CO_2e auctions are then used for energy-related initiatives, such as consumer benefit programs, energy efficiency, and renewable energy.

2. Système de plafonnement et d'échange de droits d'émission de gaz à effet de serre du Quebec (SPEDE).
3. The first author is a member of the Expert Panel for the Trottier Energy Futures Project.

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COMPARING CANADA TO OTHER REGIONS

In this section we consider three end-use sectors, namely transportation, residential and industrial, and compare Canada with 16 other regions worldwide. The profiles for electricity production are also considered. Section 7 provides data-based comparisons between Canada and these regions, and also with Quebec. While the ways we measure the similarity between Canada and the other regions have inherent limitations, they are meant as a way to encourage the discussion on possible energy pathways for Canada.

5.1 // Electricity Production

Considering Canada as a whole, almost two-thirds (61.7%) of the electricity comes from hydropower. Thus, it is natural to consider other countries/regions which are also heavily reliant on hydropower and compare them to Canada. Among the other regions considered, only Brazil (75.2%), Norway (96.7%), and Sweden (47.5%) obtain nearly 50% or more of their electricity from hydro sources. While Canada relies on coal or gas for about 20% of its electricity, for these other regions that percentage is much lower (Brazil 11.1%, Norway 1.9%, Sweden 1.3%). Moreover, two of the others rely much more than Canada on other forms of non-carbon emitting or carbon-neutral sources: Brazil uses biofuels (6.4%), and Sweden has a mix (nuclear 38.4 %, biofuels 6.3%, wind 4.3%, waste and biomass 1.8%). Some options for Canada include continuing to increase its share of non-carbon power sources to replace the current amounts of coal and gas generation. Another option is to consider a mix (like Sweden does) by developing other sources as well as additional hydropower.

5.2 // Transportation

The transportation sector accounts for nearly 1/3 of the total energy consumption of Canada, and over 94% of the country's transportation needs are met using petroleum products. (In fact these percentages are similar around the world for the regions considered.) This unambiguously shows that transportation will be a critical contributor to any significant reduction in the use of fossil fuels in Canada.

One of the approaches proposed to achieve such a reduction is to increase the use of electricity in transportation. This is particularly promising in jurisdictions such as Manitoba, Quebec, and Newfoundland and Labrador that have a large supply of decarbonized electricity in the form of hydroelectric power. The potential gains are significant: Manitoba procures nearly 95% of its transportation using petroleum products, and the corresponding figure for Quebec, and Newfoundland and Labrador is 99%. (These figures include all forms of transportation.) While this avenue seems promising at first glance, it is not yet clear how quickly and effectively this can be achieved. While strongly supporting initiatives to increase transportation using electricity, the February 2014 report of Quebec's *Lanoue-Mousseau Commission sur les enjeux énergétiques du Québec* observed that "la propagation du transport électrique sera très graduelle".

Moreover, looking over the 16 non-Canadian regions included in our study, we found that only three of them are procuring less than 90% of their transportation needs from petroleum products: Brazil (82%), Russia (63%), and Sweden (88%). Let us look at these three regions.

- Brazil procures 15% of its transportation needs through biofuels, primarily ethanol from sugar cane. Given the differences in climates and soils between Canada and Brazil, and the much lower number of cars per capita in Brazil, it seems unlikely that a similar strategy could be implemented in Canada.

- Russia procures 8.5% of its needs from electricity, largely due to a significant rate of electrification of its train network for passengers. It procures further 29% of its needs from natural gas. Given the low propensity for Canadians to travel by train, an increase in the use of natural gas for transportation might be a way for Canada to reduce its consumption of petroleum products.
- Sweden procures 8% of its needs from biofuels, primarily from agro-biomasses and bio-waste, and 3% from electricity. It officially aims to have a vehicle fleet that is independent of fossil fuels by 2030 through highly aggressive biofuel objectives.

Of these three, Sweden is arguably the "closest" to Canada. Let us therefore look a little deeper into this region. When it comes to electricity production, Canada and Sweden share several similarities. For example both countries predominantly obtain their electricity from hydropower (Canada 61.7%, Sweden 47.5%), and the next largest source of electricity is nuclear (Canada 15%, Sweden 38.4 %). They differ somewhat in their use of fossil fuels (coal, oil, gas) versus biofuels. A little over 20% of Canadian electricity is derived from these fossil fuels while for Sweden it is less than 2%. By contrast, Sweden has over 8% of electricity from biofuels and biomass and Canada's share is 0.5%. On the other hand, it is unclear whether Canada (or for that matter, Sweden) has sufficient access to sources of biofuels (of any kind) to displace a large percentage of the petroleum products used for transportation. While the similarities between Canada and Sweden are significant, further research would be needed to determine if the Swedish experience could influence possible Canadian strategies, for example for exchanging use of fossil fuels to more renewable biofuels.

An alternative to biofuels that may be relevant for Canada is to transition to less carbon-emitting natural gas vehicles. Compressed natural gas for vehicles can be generated from non-conventional sources such as digester-processed wastewater. The use of wastewater has the interesting features that its amounts increase with population growth, and that it does not require the use of land for growing specific crops.

5.3 // Residential and Industrial Sectors

One of the issues often mentioned with respect to both the residential and industrial sectors is energy efficiency. There are multiple aspects to efficiency. The American Council for an Energy-Efficient Economy uses 31 energy efficiency indicators to establish its *International Energy Efficiency Scorecard*. We use here a simpler approach, namely we look at the 16 regions considered and we seek those that are "closest" to Canada according to the data.

Canada satisfies the bulk of its residential energy needs from two main sources: natural gas and electricity. Indeed, in Eastern Canada these sources amount to 91.6% of the total residential sector usage, and 99.7% in Western Canada. Using a minimum threshold of 90% reliance on these two sources for residential energy demand, the jurisdictions that show the most similar profiles are Texas and the United Kingdom. A first observation is that in the case of Texas, the residential demand is largely driven by air conditioning; in Canada this is only true in Ontario, and only during the warmer months. Looking a little deeper, the similarity is more subtle. Indeed, Texas produces just over 50% of its electricity using natural gas so clearly there is a preponderance of natural gas use (directly and indirectly) in the residential sector. The U.K. also has a heavy reliance on natural gas (27.5%) for power production. Hence for both Texas and the U.K., the reliance on natural gas is significant. Perhaps more interesting is the fact that for the residential sector, Canada finds itself somewhere between these two regions. Canada's share of natural gas use in that sector (52%) is between Texas' share (26%) and that of the U.K. (66%). A similar finding is true for electricity usage but with the roles of the U.K. (25%) and Texas (70%) reversed, and Canada at 42%.

In the industrial sector, Canada relies on three sources to supply 98% of demand: natural gas (56%), electricity (31%), and oil (11%). Using a minimum cutoff of 90% for the sum of these three sources, Texas (98.6%) and the U.K. (90.6%) are again similar to Canada, but also California at 95.9%. In fact Canada's use of natural gas matches California's (56%).

Although this approach to measure "closeness" to Canada ignored many of the differences between the regions involved, it still seems relevant to ask: Given this "closeness" between Canada, Texas and the U.K. in the residential sector and also California in the industrial sector, are there aspects of what is happening in these regions that could help formulate parts of an energy strategy for Canada?

On the issue of energy efficiency, we mention two recent developments in the U.K. The first concerns energy efficiency for buildings. The Green Deal is a financing program for existing buildings launched about two years ago. Through this program, private companies offer consumers energy efficiency improvements to homes, community spaces, and businesses with no upfront costs. Instead the costs for the improvements are charged later on the electricity bill. There was low demand for this program due to a number of financing and planning issues. A subsequent Green Deal Home Improvement Fund (GDHIF) has been more successful so far.

Starting in 1999, the Texas legislature passed the Energy Efficiency Rule for utilities to administer incentive programs to meet mandated energy efficiency goals. These energy efficiency resource standards were the first in the U.S. These programs are run using retailer power and energy efficiency providers, and the programs have several demand and efficiency goals (such as reduce system peak load, energy consumption, or energy costs). The utilities are obligated to meet their energy efficiency goals but have some flexibility in choosing the means to do so. The Public Utilities Commission of Texas stipulated a goal of reducing their customers' electricity use by 30 percent of the annual growth in demand, and later adjusted it to be based on peak demand.

California has consistently ranked high on utility-sector energy efficiency since the 1970s. Indeed, the California Public Utility Commission has required the state's four major investor-owned utilities (IOU) to set up programs and tariffs for energy efficiency. All of the IOUs in California have "decoupling", i.e., the separation of a utility's profit from its electricity sales. This means that the revenue for a utility is derived from a revenue target (as opposed to sales only) and rates are adjusted to meet that target. There is also additional revenue from performance incentives for improved energy efficiency.

Understanding the motivations, strengths and limitations of the programs and initiatives in other regions, including the three mentioned above, and always taking into account the differences between them and Canada, might provide clues for means to improve energy efficiency in Quebec and in Canada.

6

CONCLUSION

The issues surrounding an energy strategy for Canada and for Quebec are complex and interrelated. They involve not only energy but also economics, the environment, health, and security. The coverage we provide here is far from exhaustive; there are many topics that were only touched upon or not even mentioned. Rather the objective is to lay the basis for the discussions at the forthcoming Trottier Symposium. These discussions will inform the choice of subjects for future IET studies and public events, and aim to inform the choices that Quebec and Canada will make in the coming years.

The organizers invite you to attend the symposium and express your opinions.

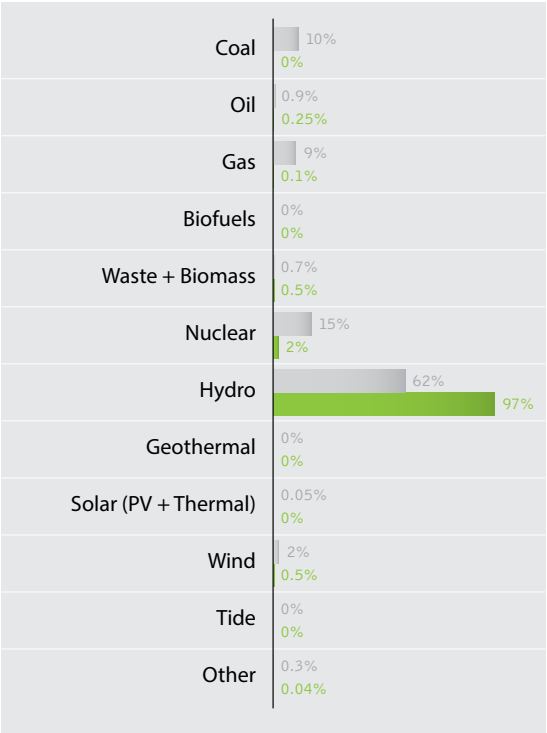
7

REGIONAL DATA

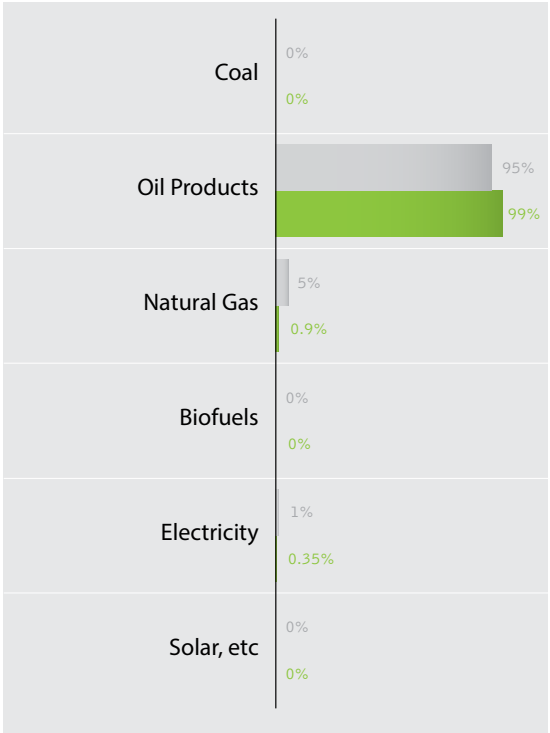
Canada

Quebec

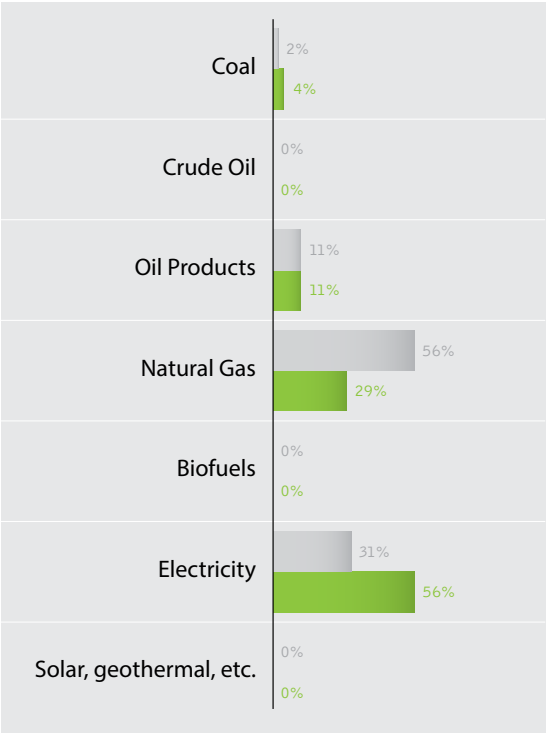
Electricity Production



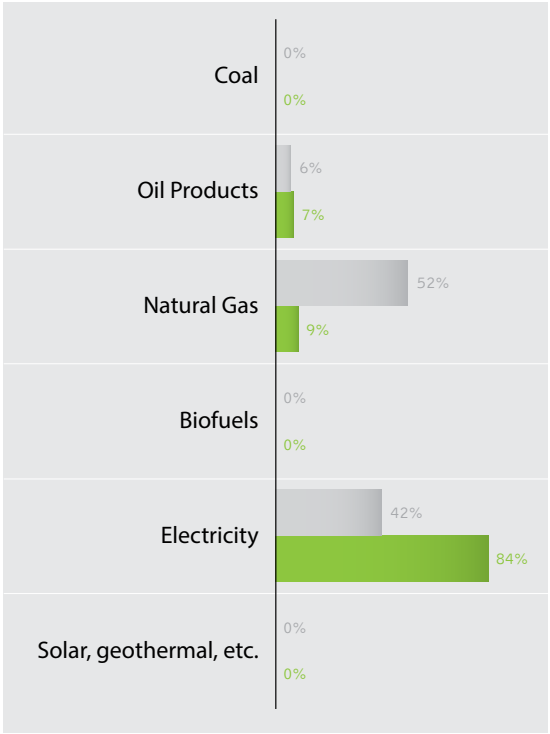
Transportation



Industry



Residential



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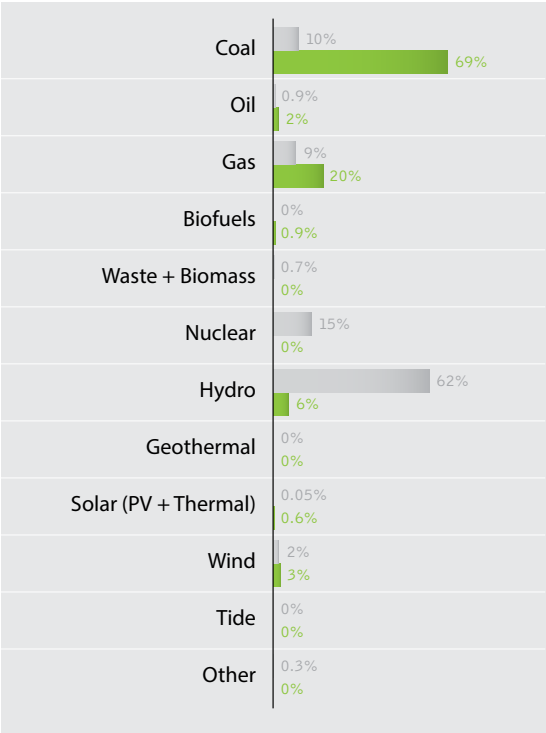
REGIONAL DATA

Canada

Australia

Electricity Production



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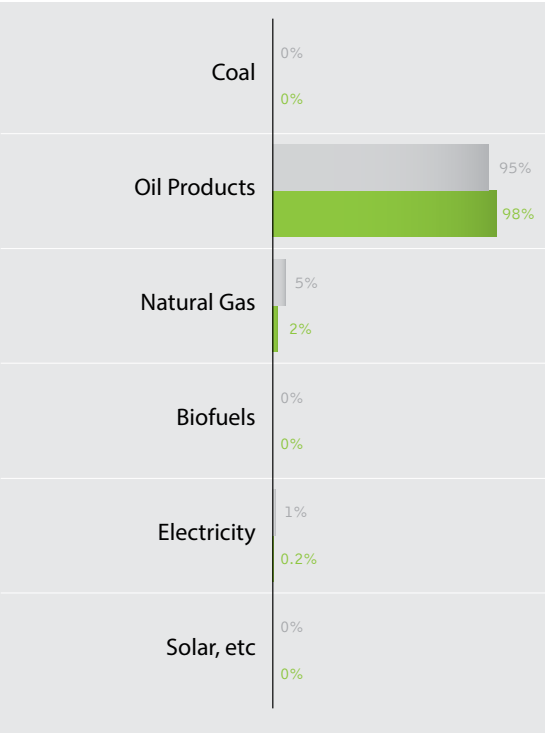
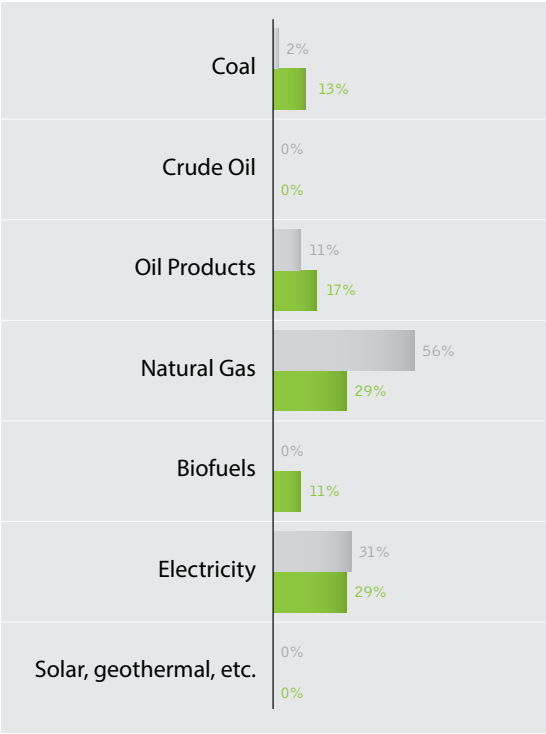


Industry



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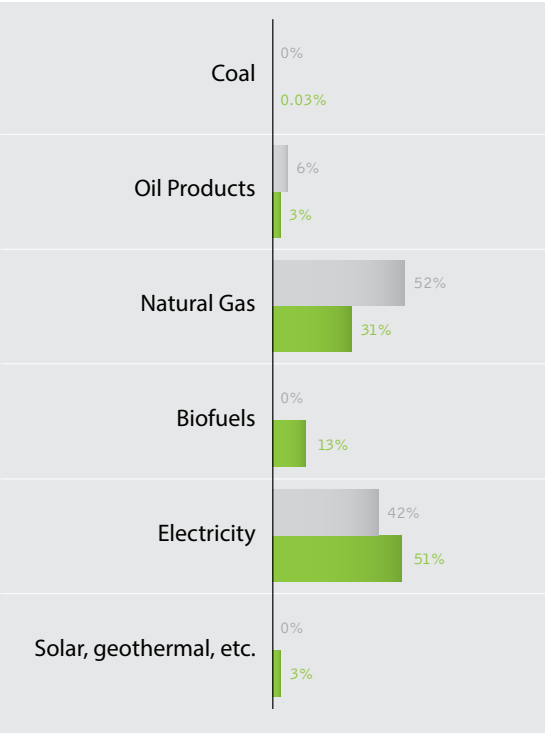
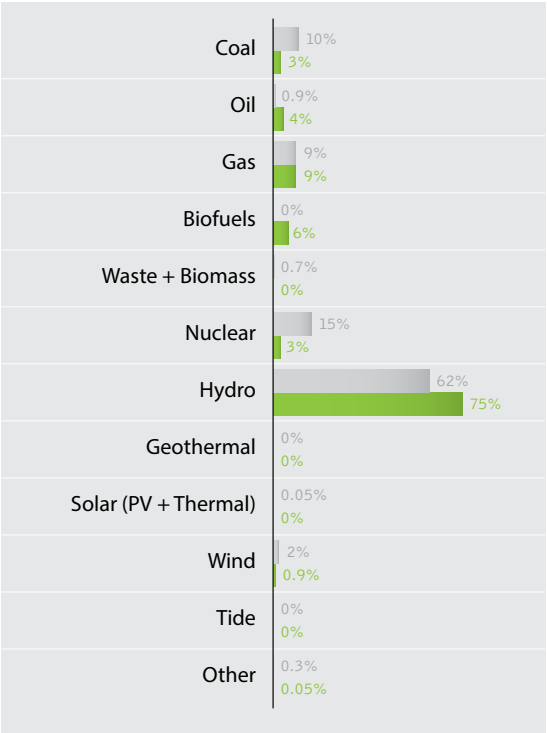


REGIONAL DATA

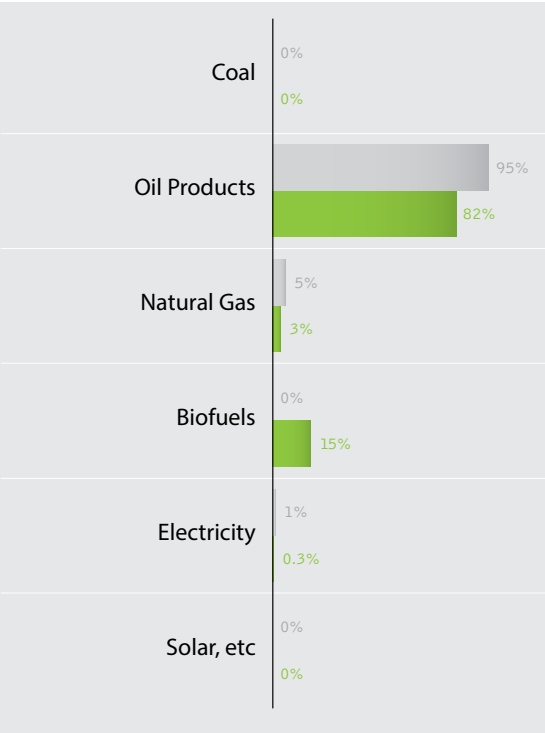
Canada

Brazil

Electricity Production



Transportation



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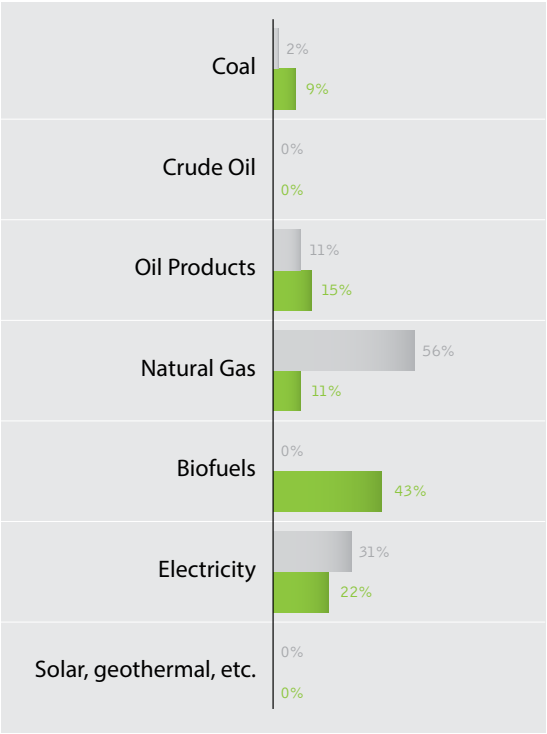

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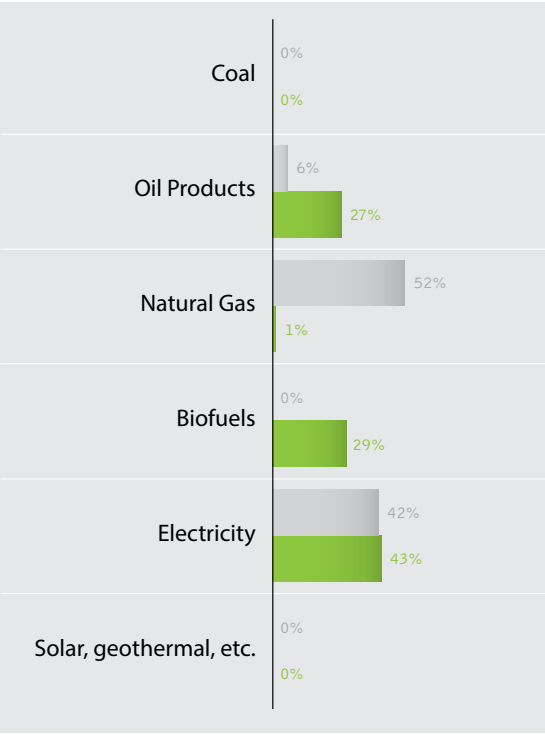


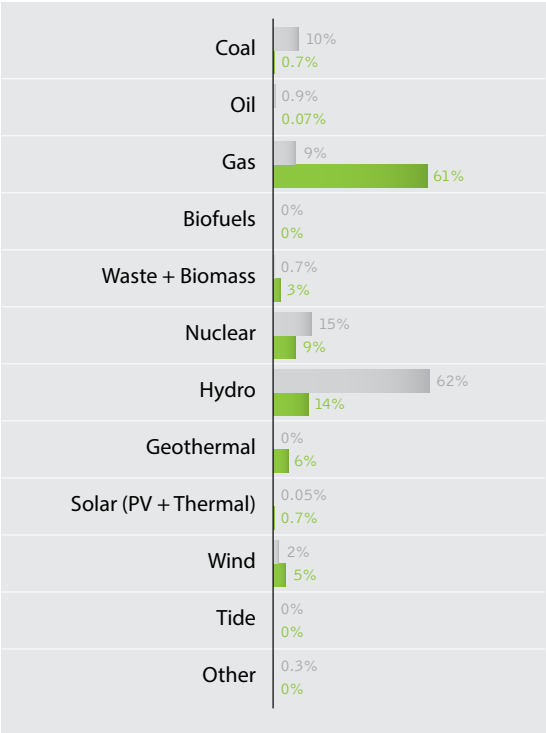
7

REGIONAL DATA

Canada

California

Electricity Production



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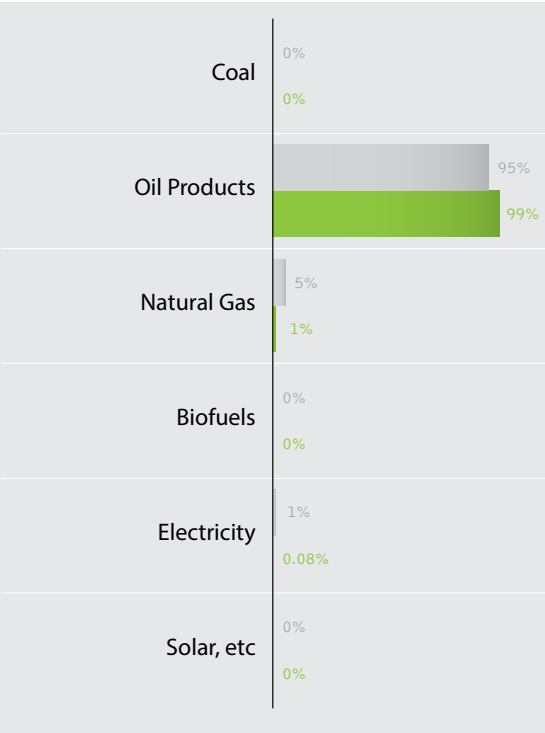

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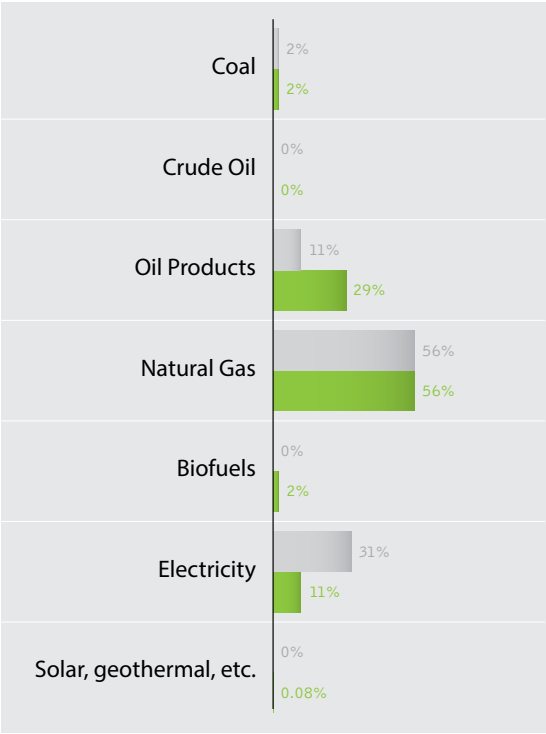

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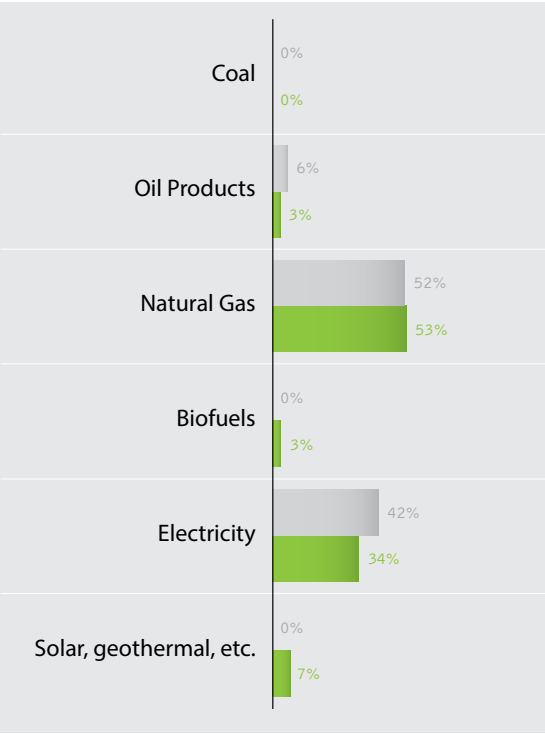
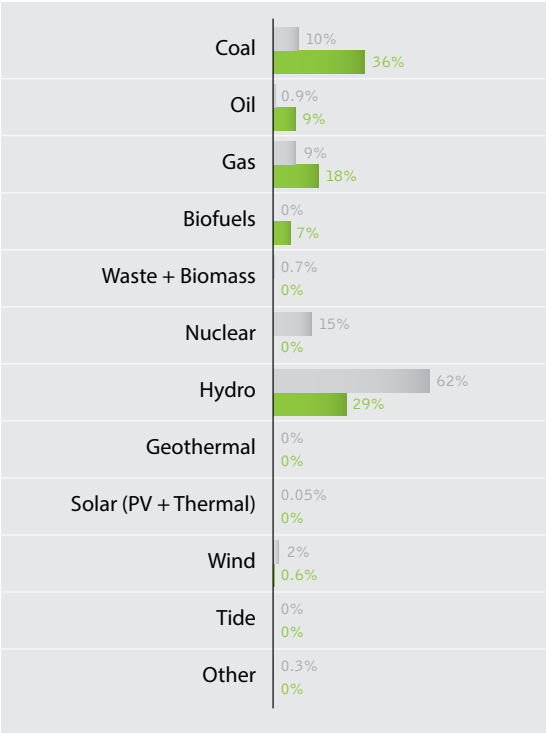


REGIONAL DATA

Canada

Chile

Electricity Production



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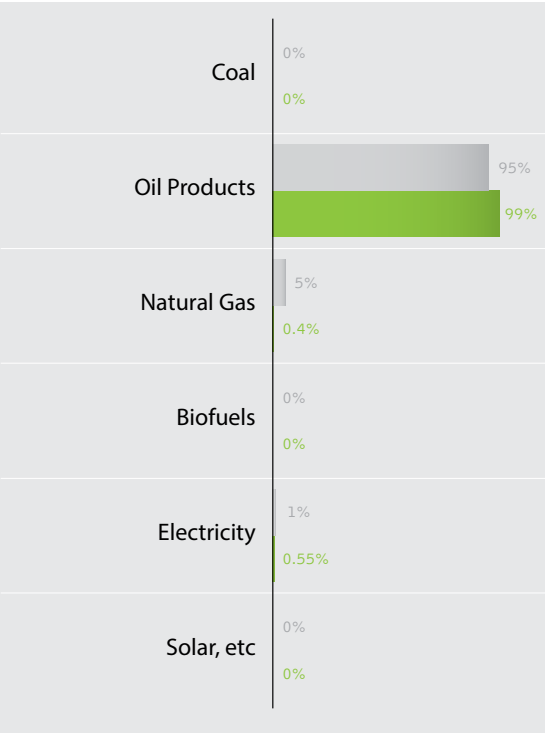

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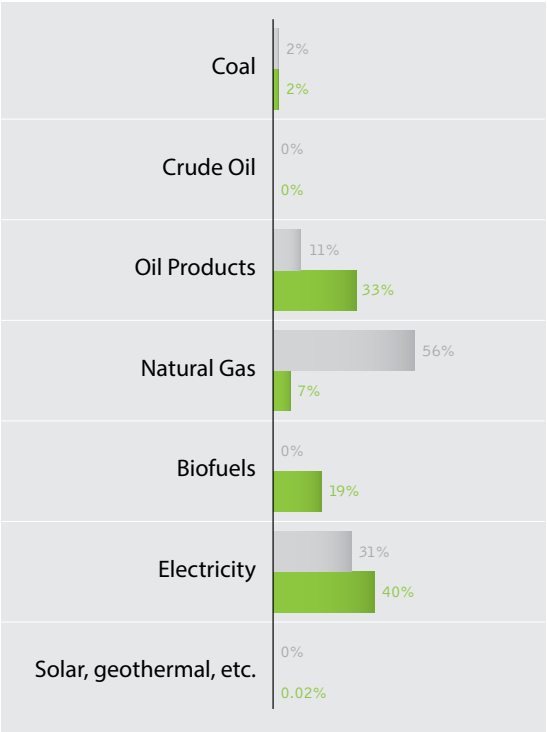

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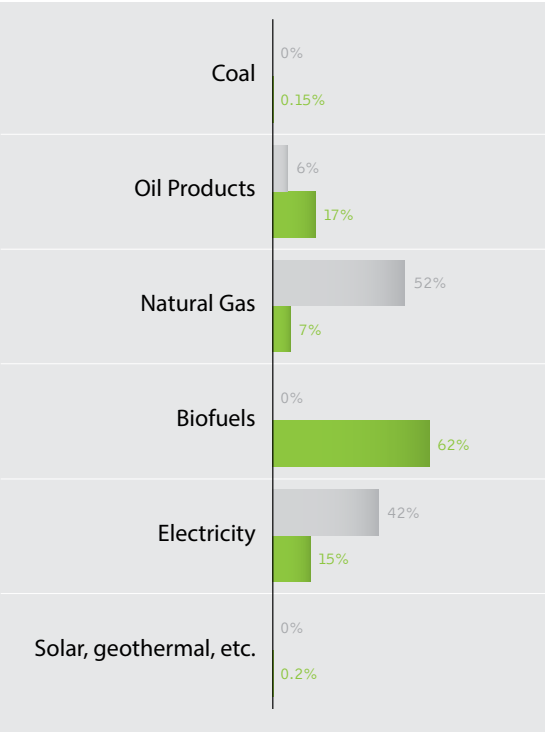

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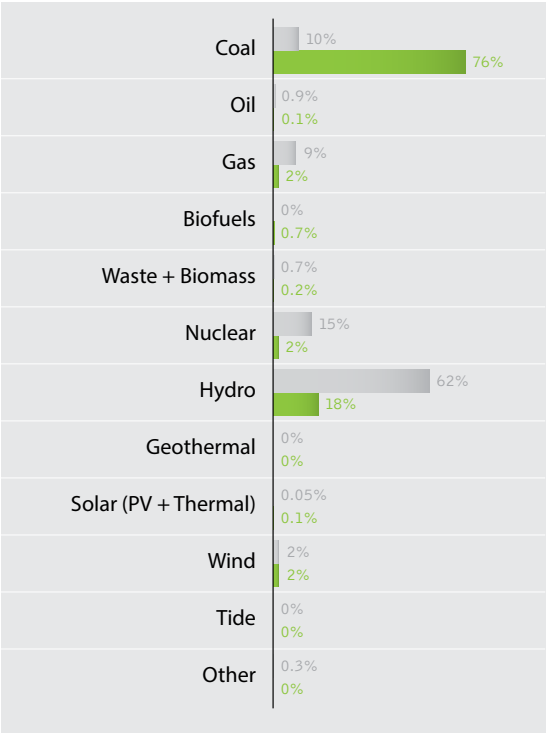
REGIONAL DATA

Canada

China

Electricity Production



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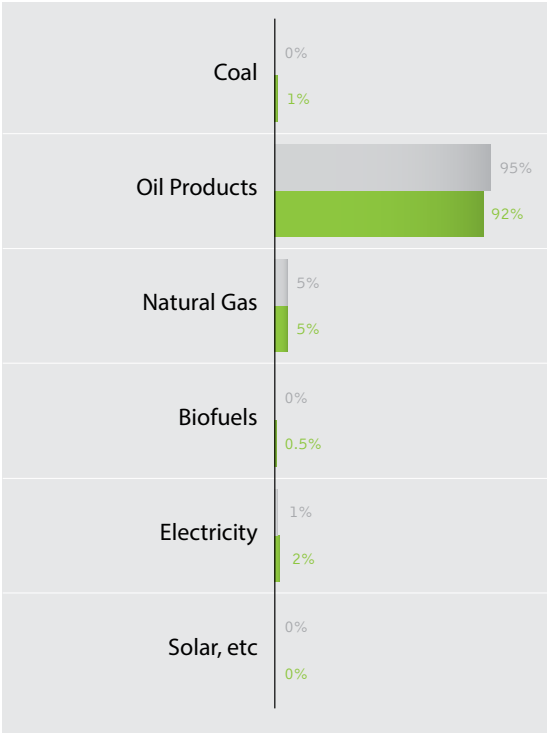

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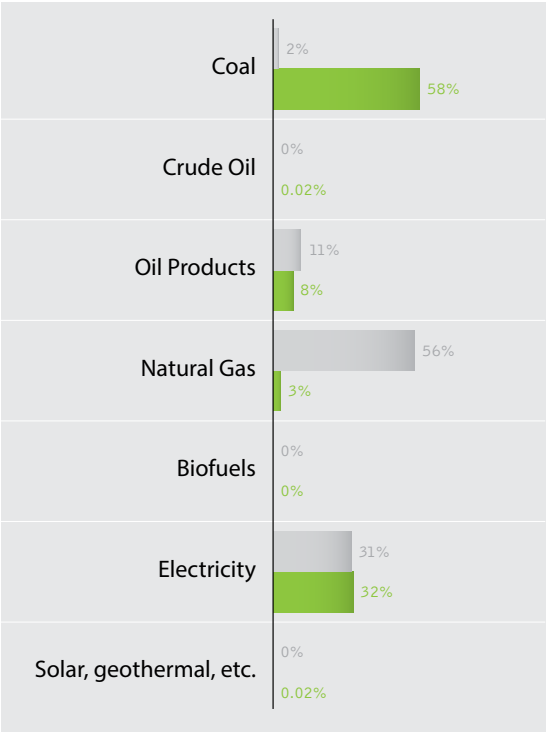

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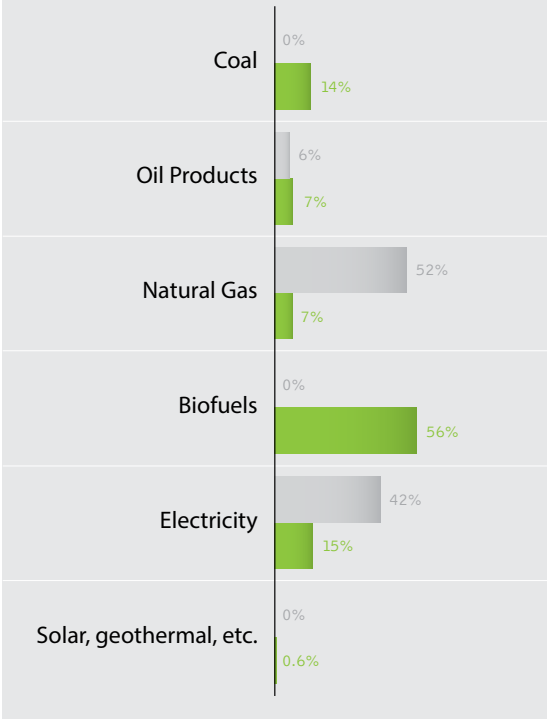

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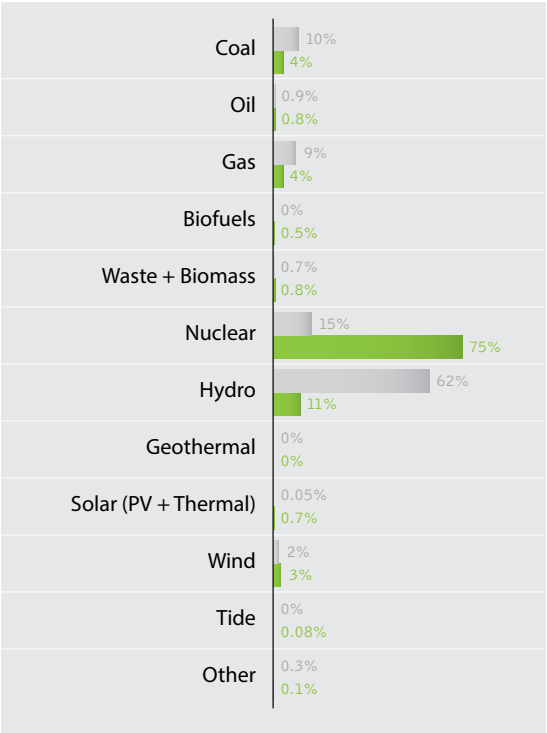
REGIONAL DATA

Canada

France

Electricity Production



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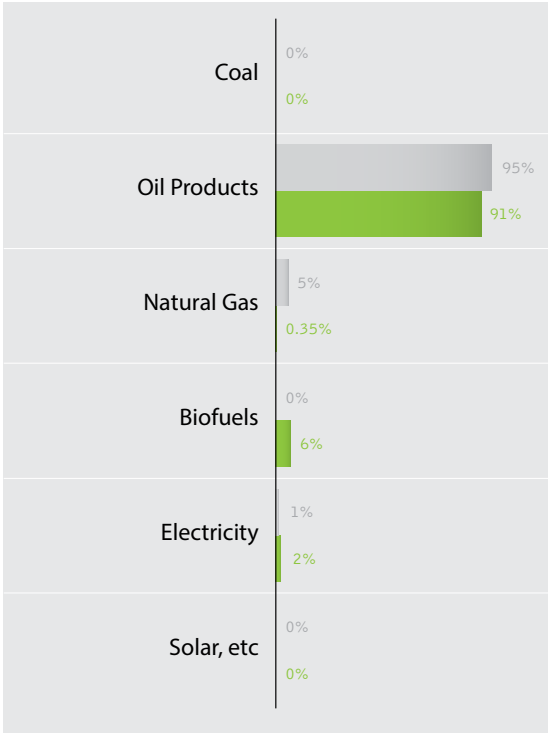

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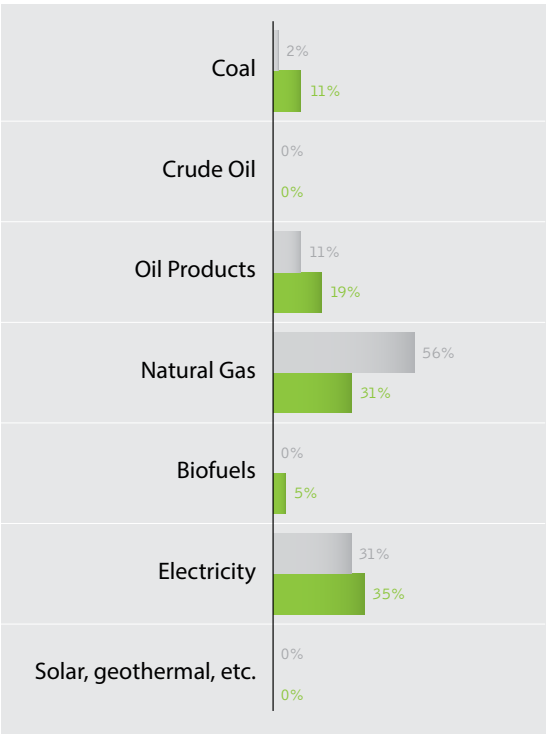

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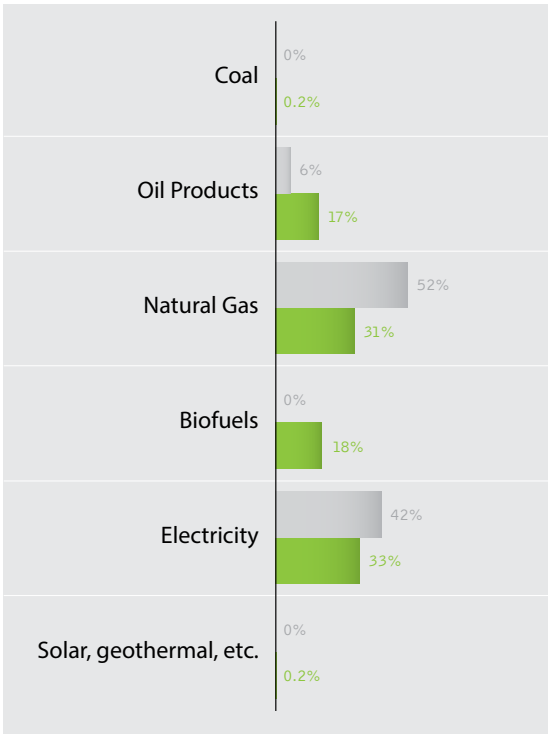


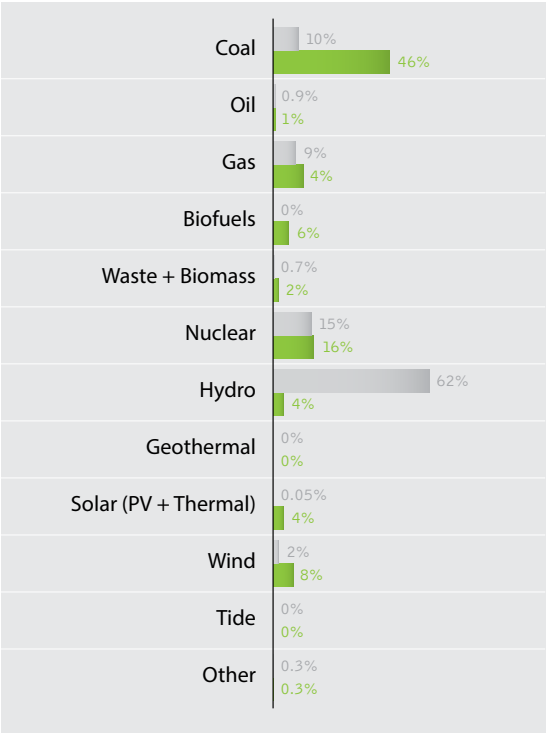
7

REGIONAL DATA

Canada

Germany

Electricity Production



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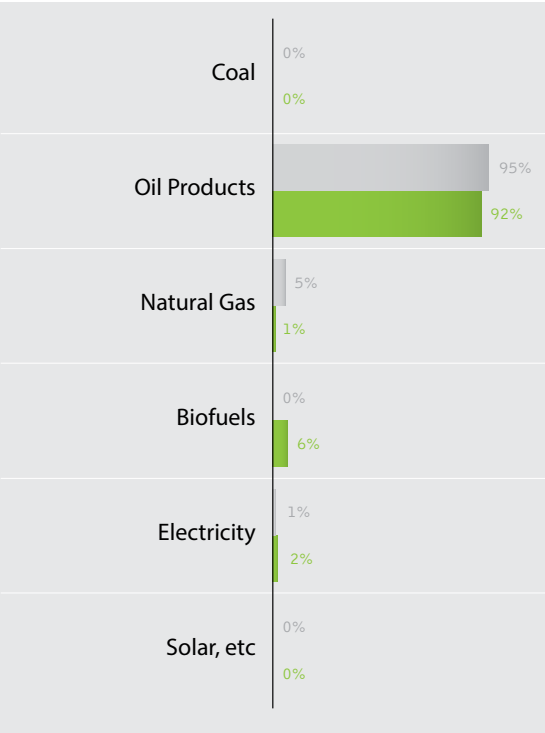

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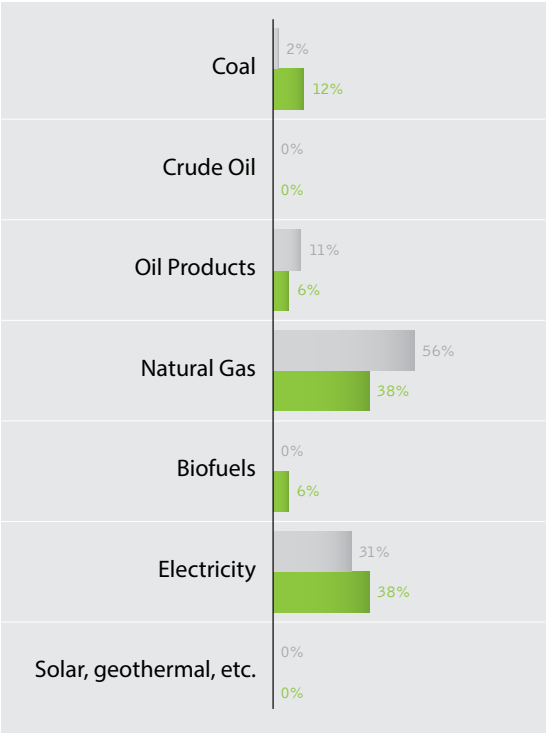

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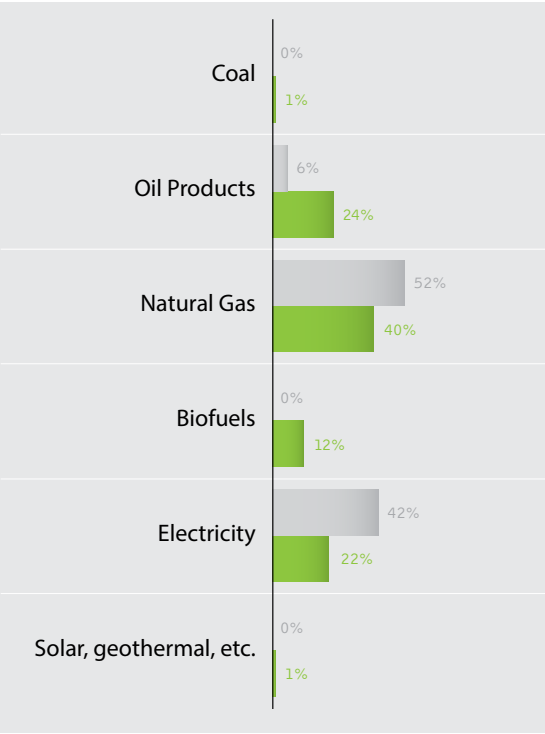
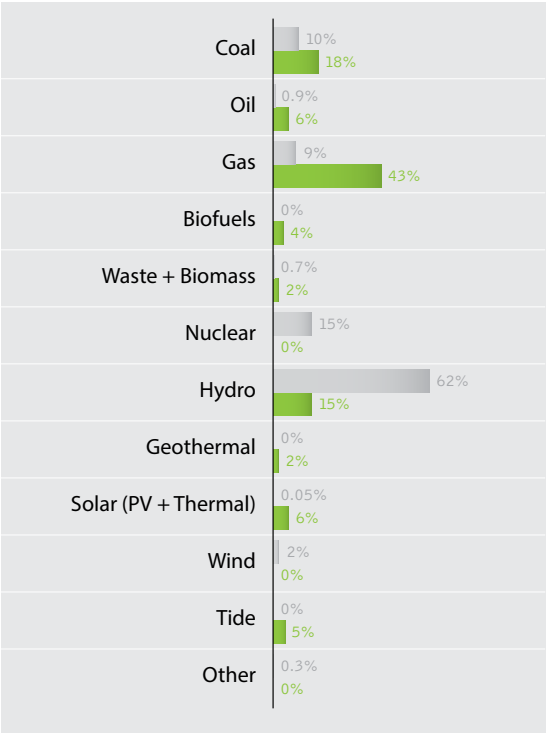


REGIONAL DATA

Canada

Italy

Electricity Production



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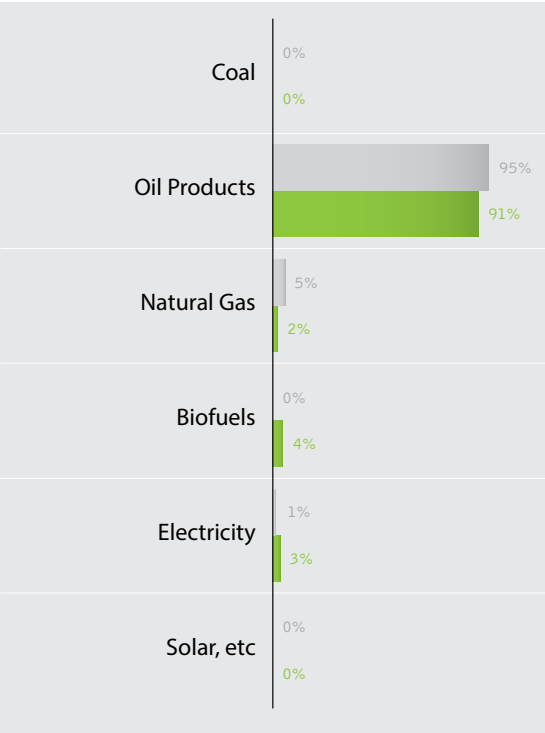

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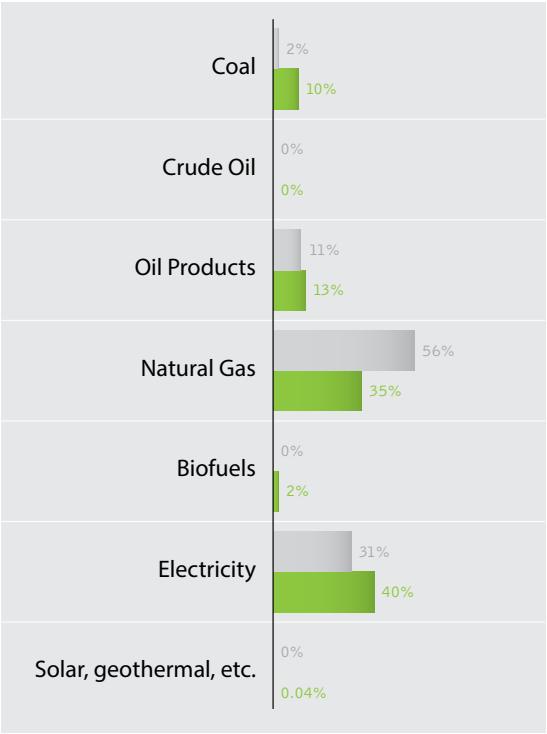

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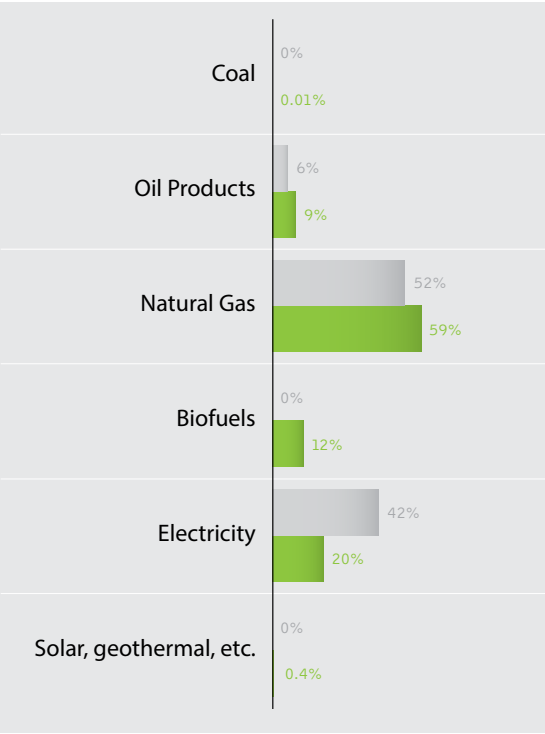
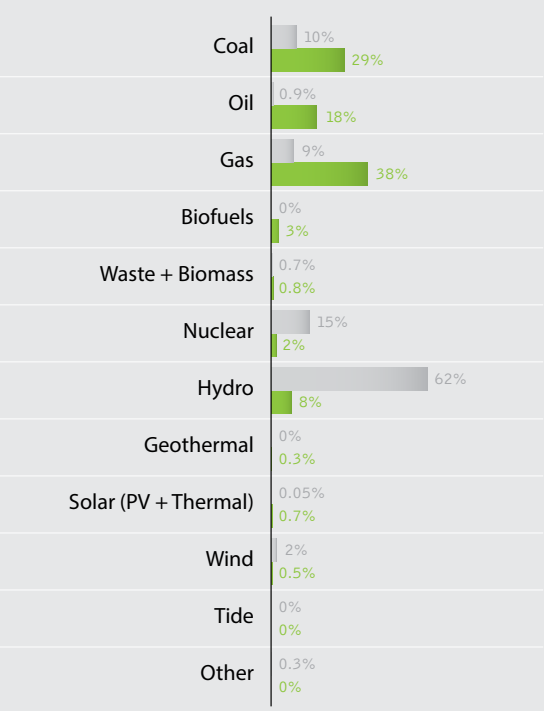


REGIONAL DATA

Electricity Production



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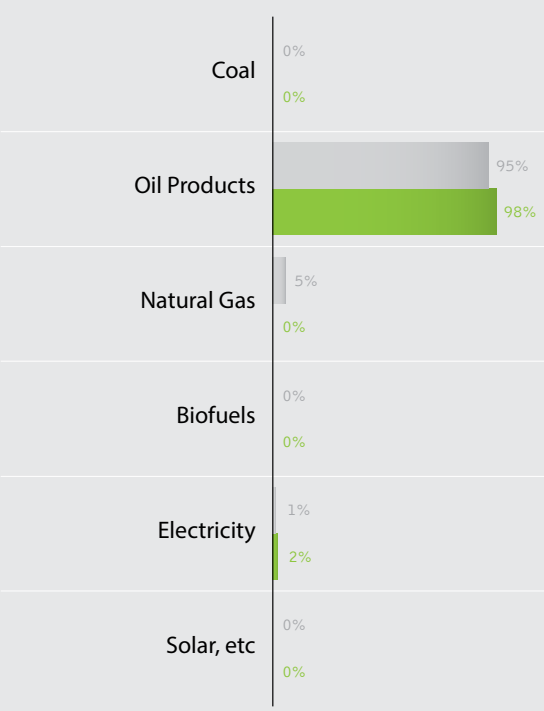

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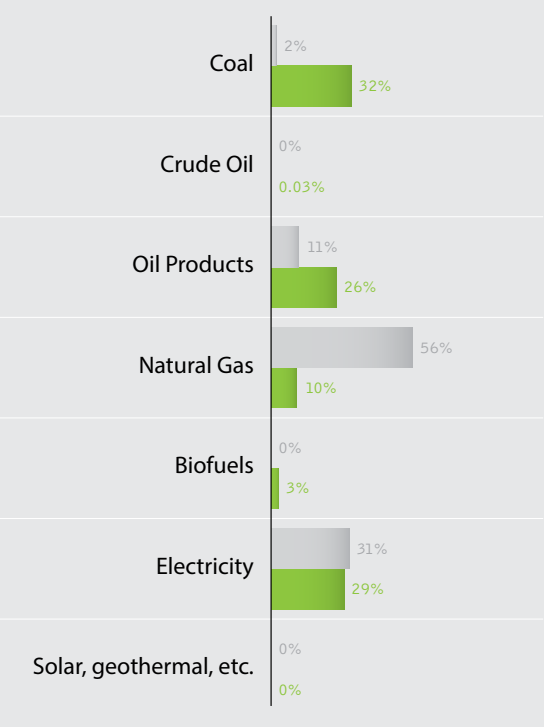

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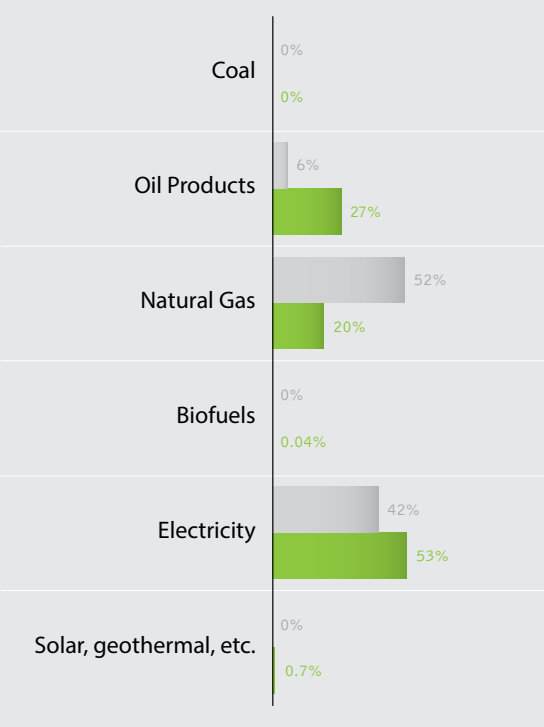
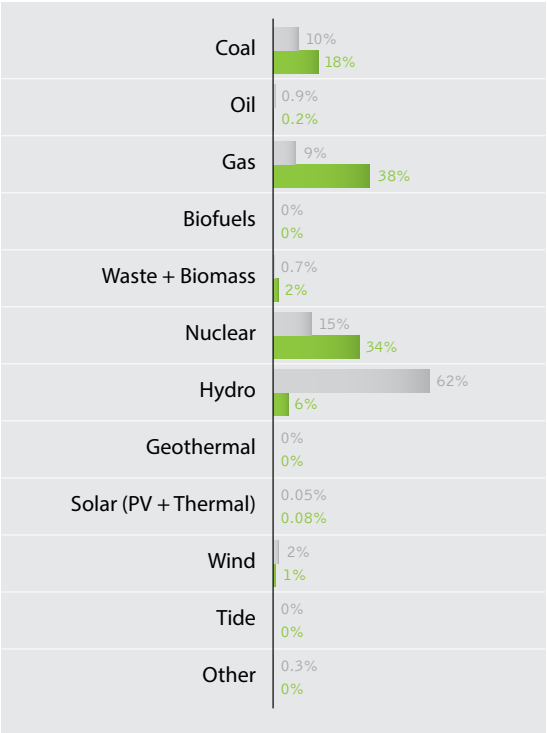


REGIONAL DATA

Canada

N.-Eastern US

Electricity Production



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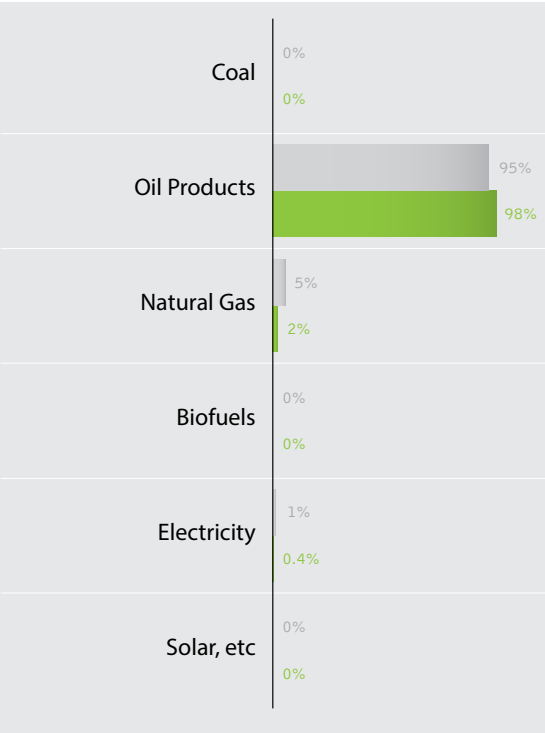

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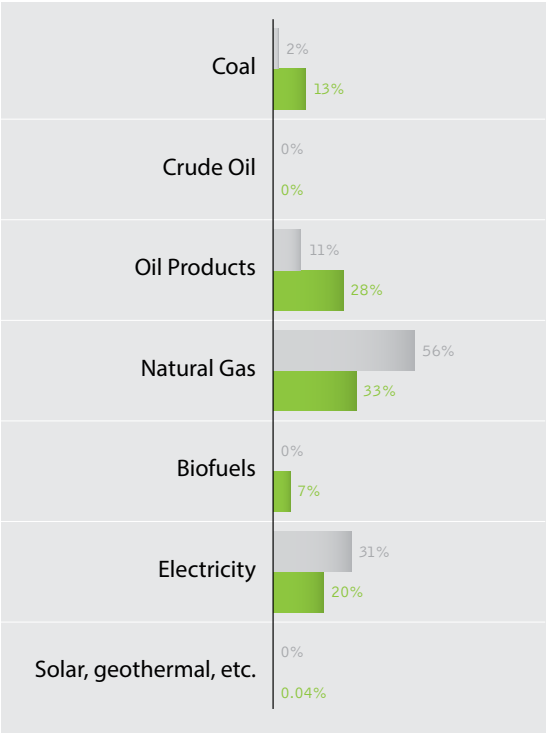

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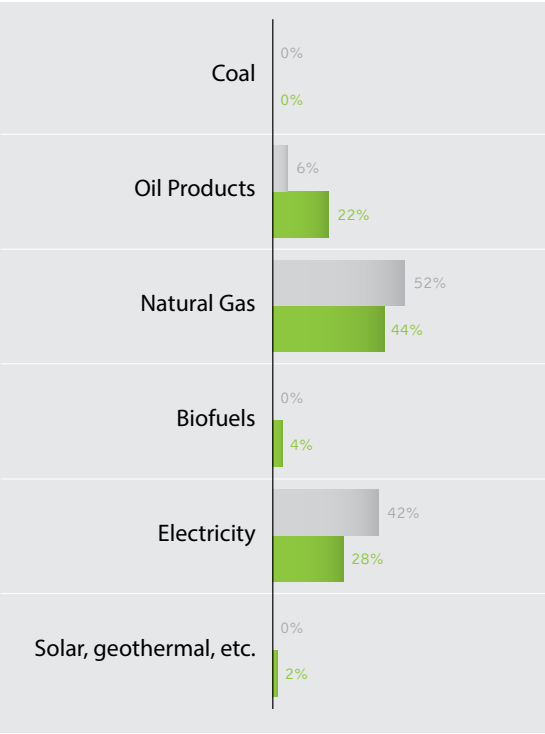
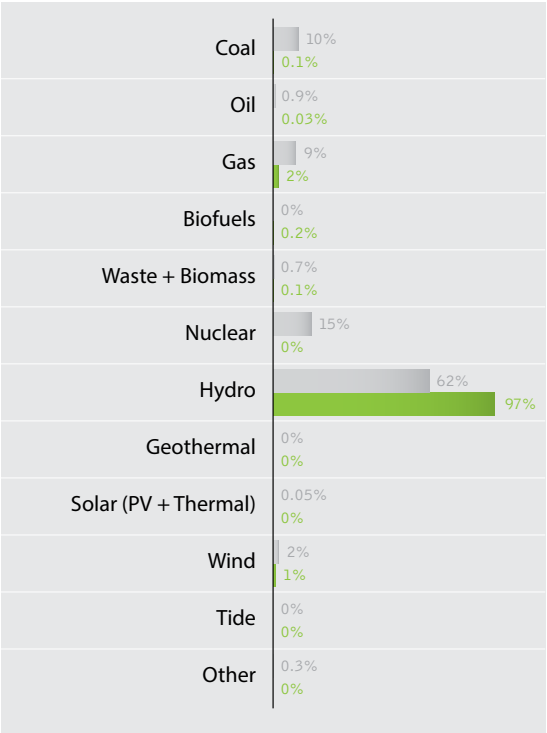


REGIONAL DATA

Canada

Norway

Electricity Production



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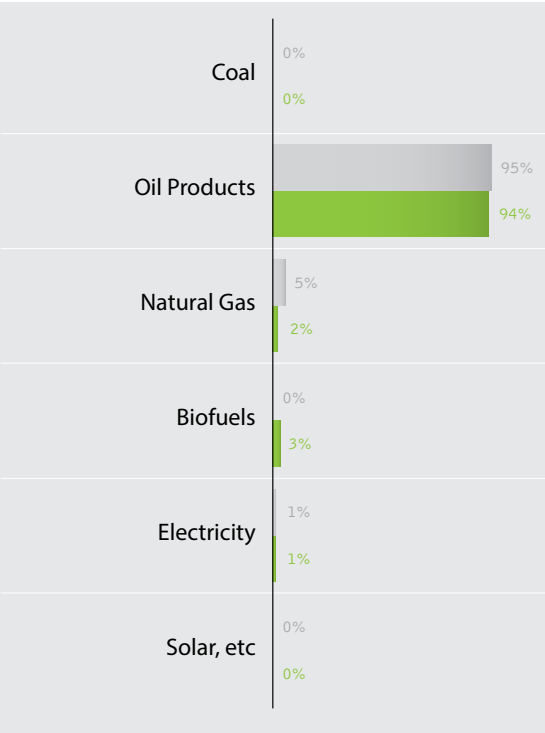

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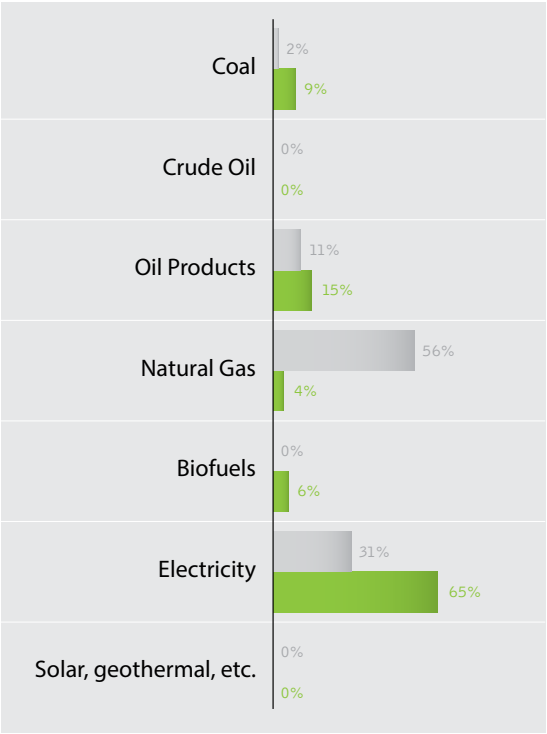

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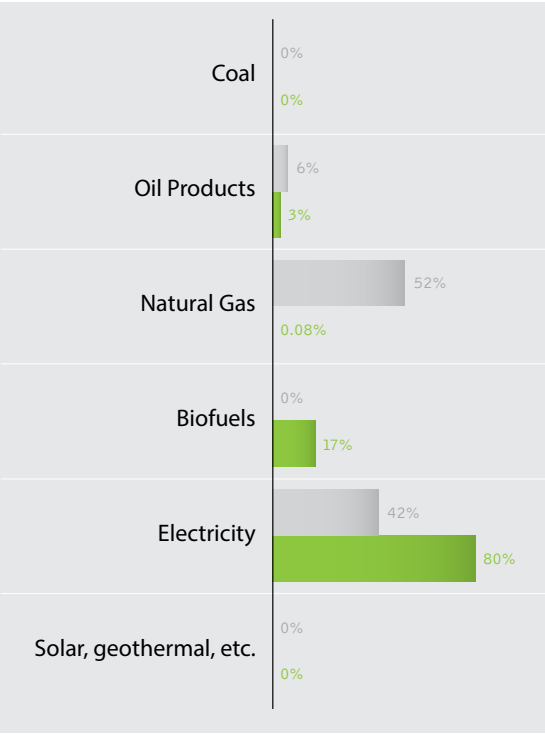
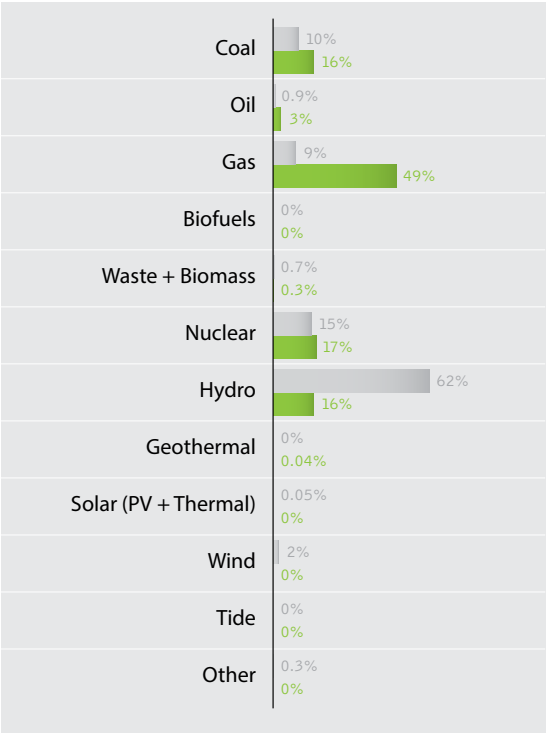


REGIONAL DATA

Canada

Russia

Electricity Production



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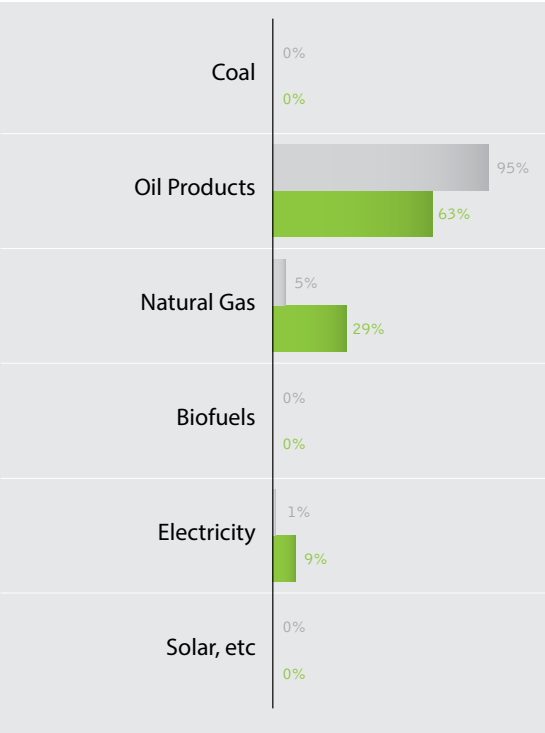

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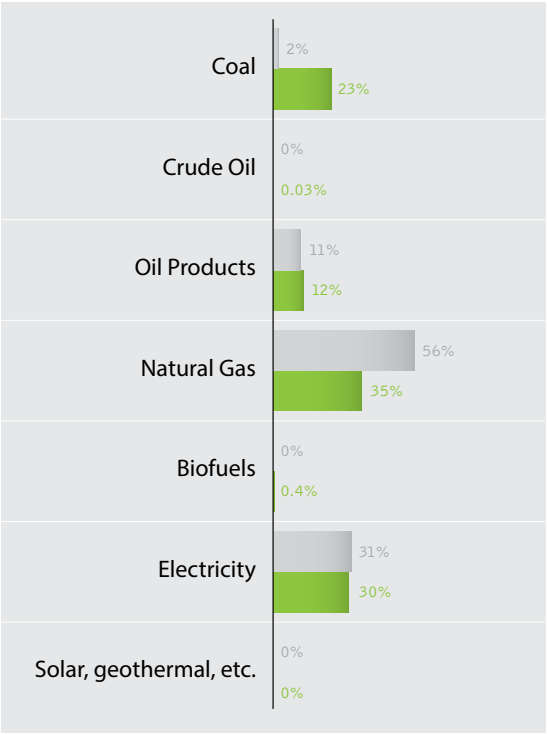

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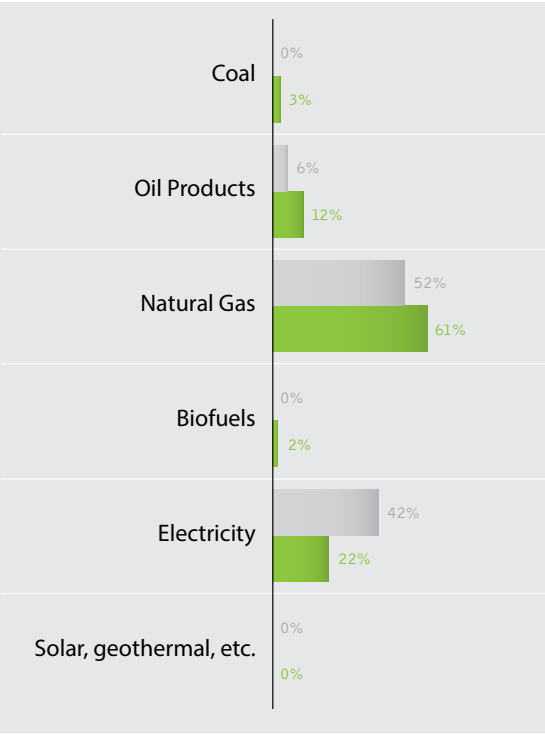
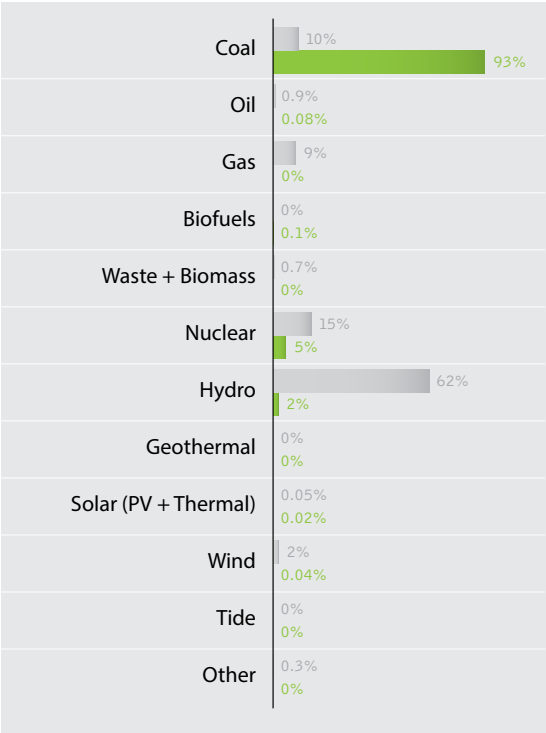


REGIONAL DATA

Electricity Production



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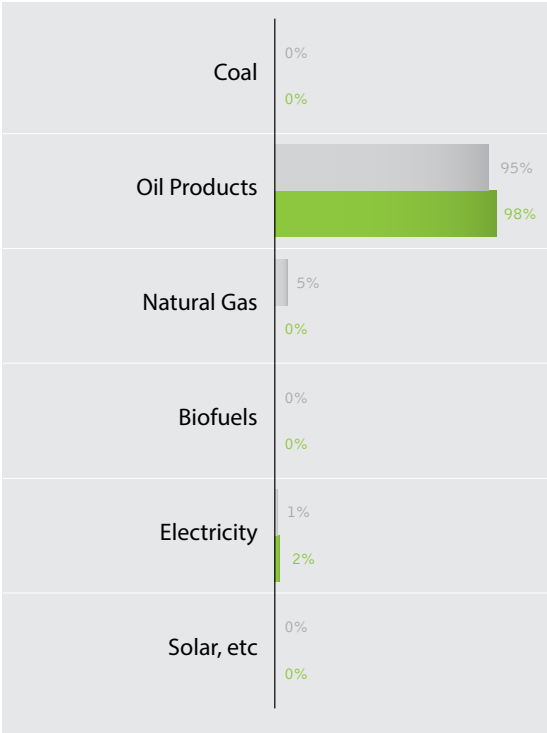

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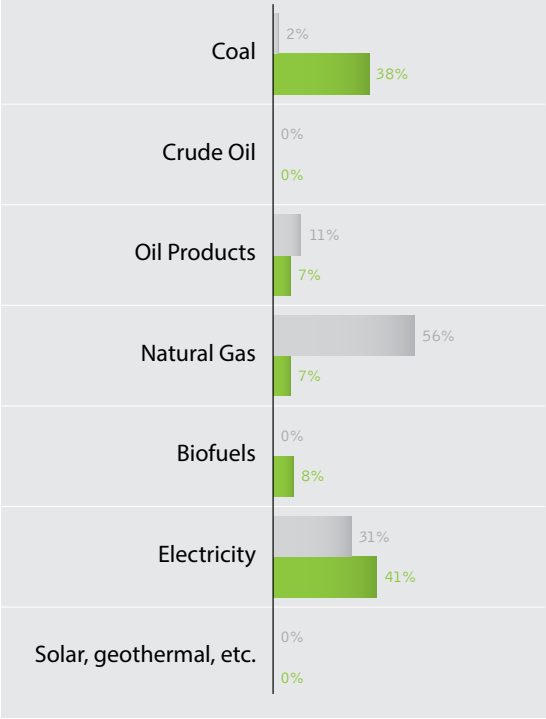

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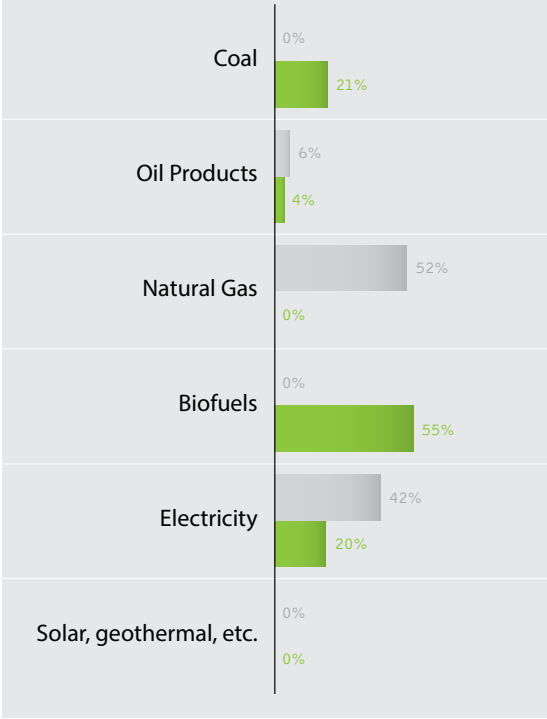
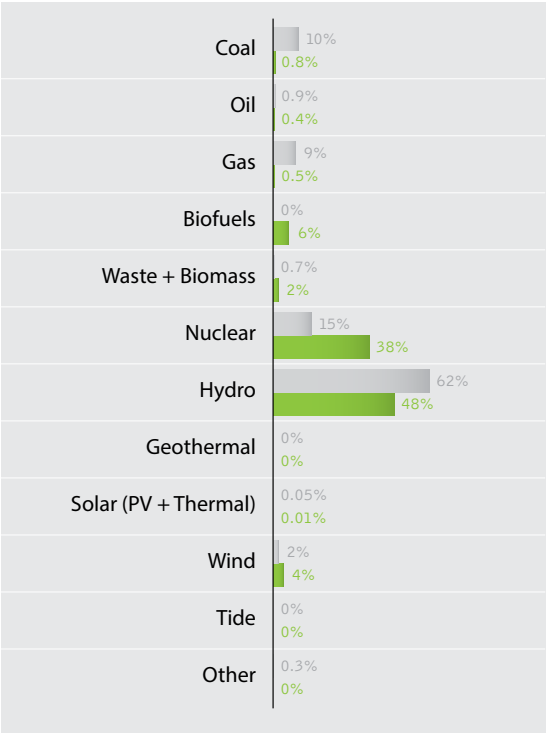


REGIONAL DATA

Canada

Sweden

Electricity Production



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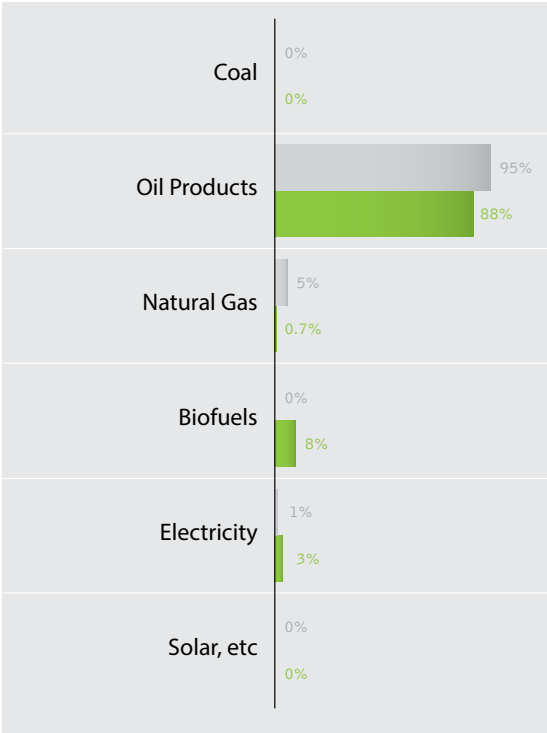

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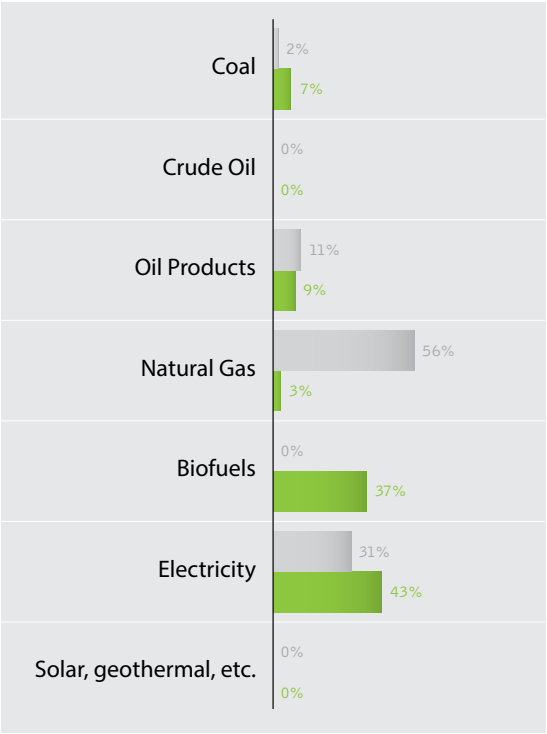

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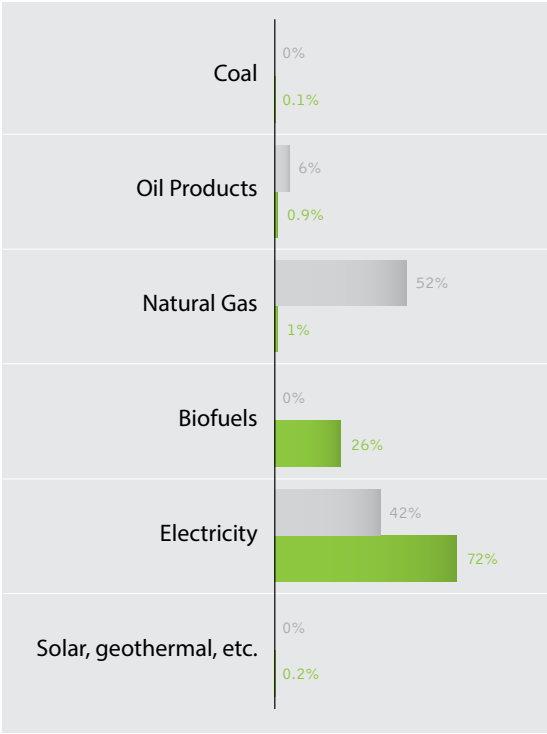

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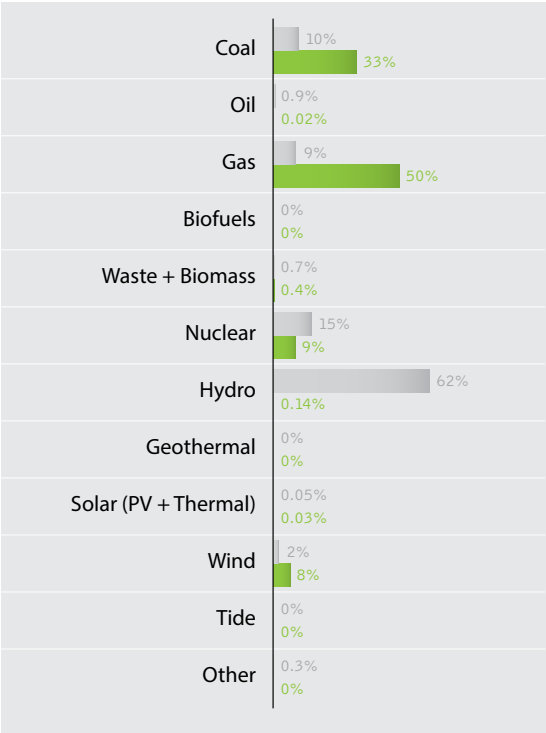
Electricity Production



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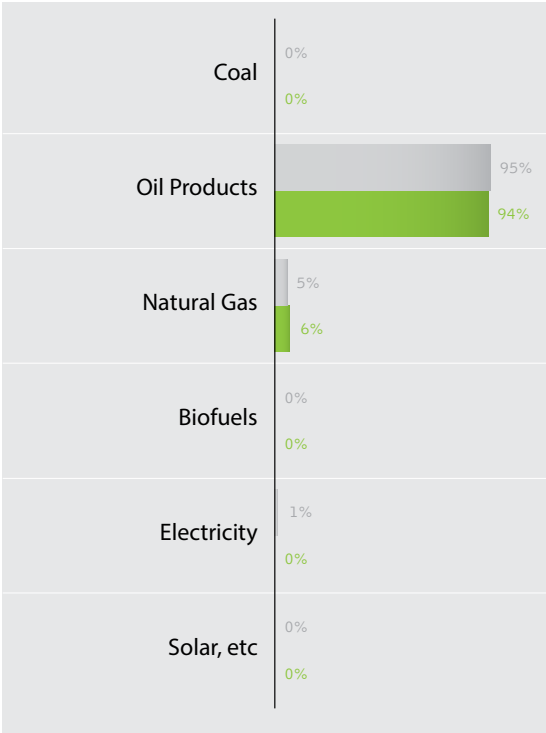

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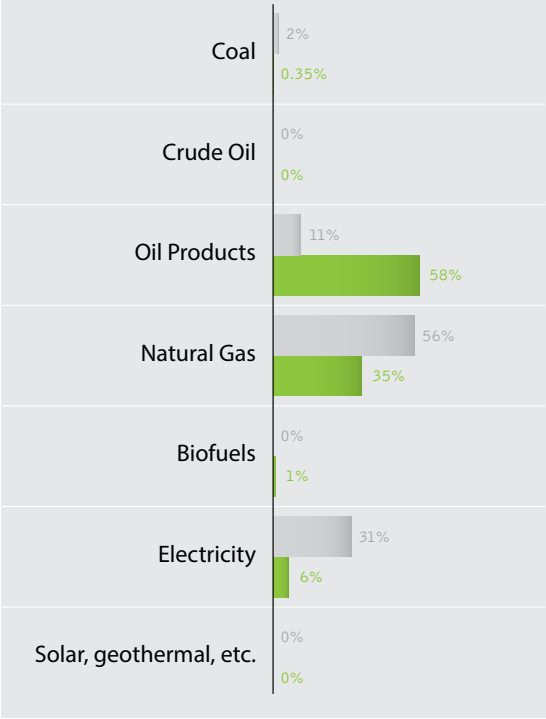

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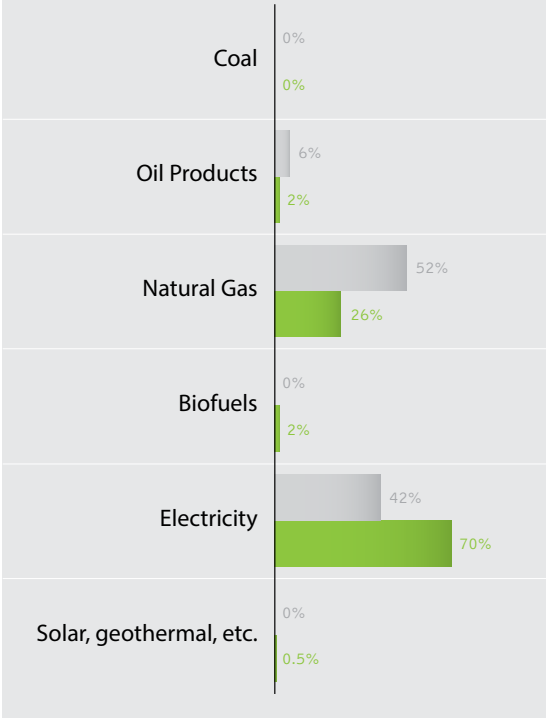
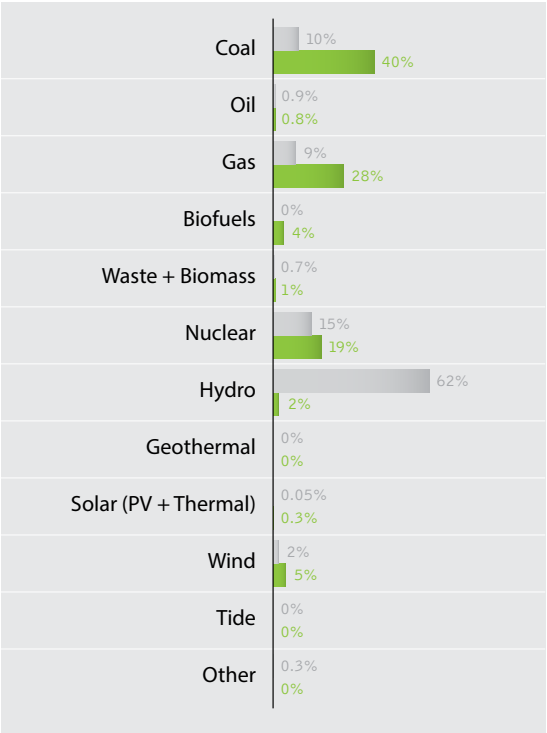


REGIONAL DATA

Canada

UK

Electricity Production



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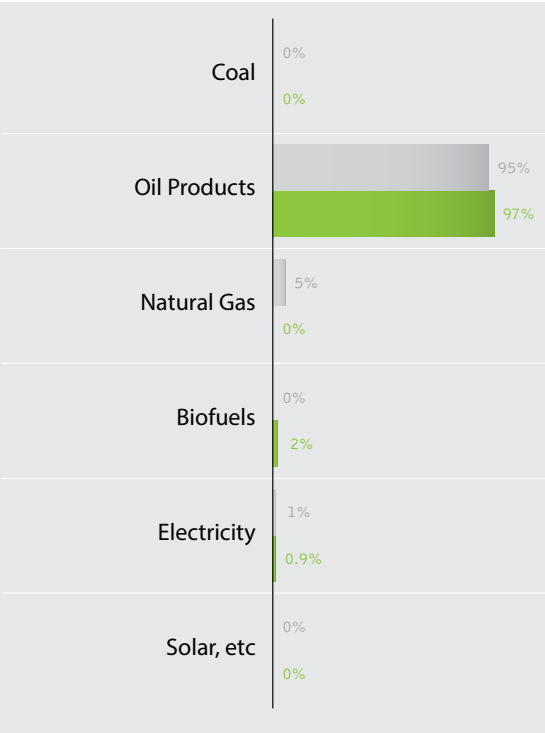

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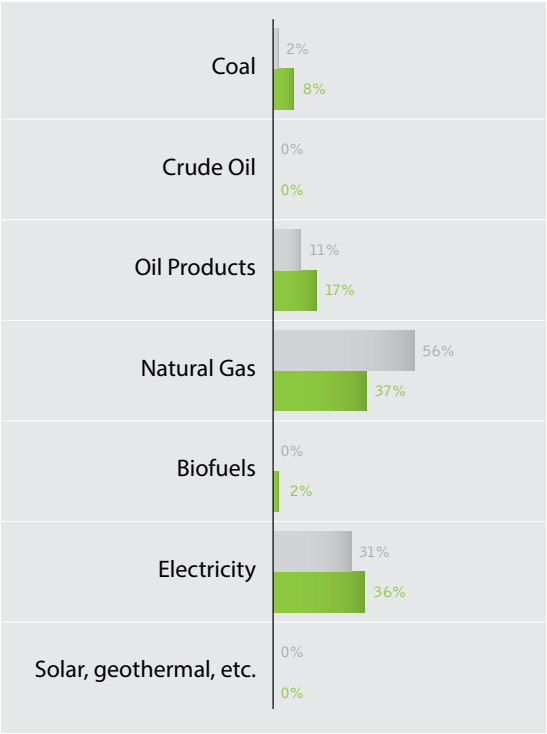

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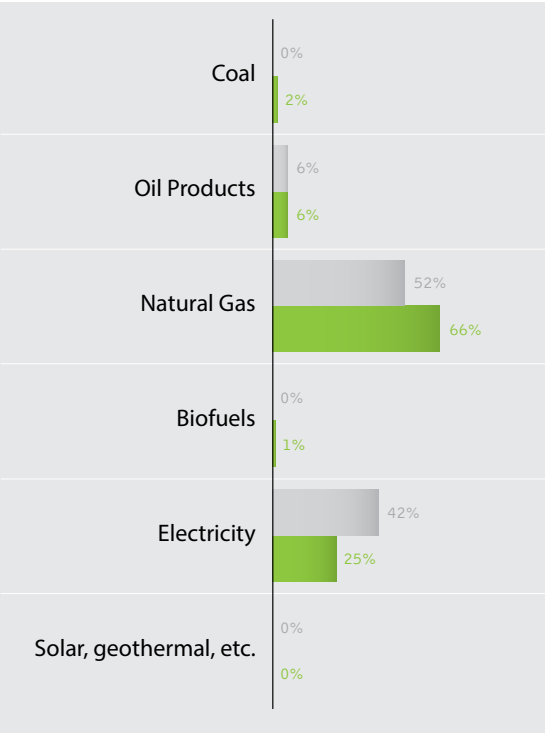

8

REFERENCES

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