# CHAPTER 2

## Governmental Measures and Their Effectiveness

The countries of the world, with or without a global protocol, are already taking action to measure, limit, and reduce their greenhouse gas emissions. Admittedly, a global agreement represents an ideal tool for guaranteeing that GHG concentrations remain within the prescribed limits in order to reduce the probability of catastrophic events. By acting in concert, all countries are assured that their efforts will be matched by similar efforts in other countries and that they will not be alone in suffering the economic consequences of the imposed restrictions.

Barring a global treaty, many governments of industrialized countries will nonetheless wish to convince their populations that they are acting to limit or reduce GHG emissions, because there exists a political demand for such measures. In Canada, the adoption of measures to fight climate change is an important factor for nearly one in two voters.[54] Although it is secondary to concerns regarding the economy, health care, employment, and safety, this issue remains among the most important ones.

However, political gestures must be distinguished from real actions. Many politicians talk about climate change and make announcements committing themselves to limiting or reducing national emissions in the more or less distant future, knowing that another government will have replaced them when the time comes to act.

Beyond all the talk, measures adopted must be judged according to their results. Some measures are more effective than others when it comes to reducing emissions. Their economic and social impacts also vary.

## A. The Carbon Market

Most experts and scientists agree that the levying of a tax on carbon or the creation of a carbon market are two of the most effective mechanisms for limiting GHG emissions and for reducing the probability of climate catastrophes. These two mechanisms, similar in several ways, aim to establish a price for carbon, thereby allowing emitters to internalize the social cost of this substance.[55]

### How Does a Carbon Market Work?

A carbon market, also known by the more technical name of a cap-and-trade system for greenhouse gas emission allowances, is simple in principle. It consists of limiting the total emissions of a group of political jurisdictions by setting an emission ceiling and creating emission allowances corresponding to this ceiling. These emission allowances then become an indispensable requirement for legally emitting one tonne of carbon into the atmosphere. Governments are charged with setting the ceiling and managing the initial sale of emission allowances, either by distributing them free of charge or through an auction. This is the "cap" part of the equation.

**"Many politicians talk about climate change and make announcements knowing that another government will have replaced them when the time comes to act."**

Businesses, institutions, and industries must therefore procure these allowances by obtaining them free of charge from the government or by purchasing them on the carbon market (or carbon exchange). They can also, if they possess unused emission allowances, sell them on this same carbon market. This is the "trade" part of the equation.

The relative effectiveness of a mechanism like a carbon market lies in the decentralization of decisions regarding emission reductions. The government determines the ceiling of emissions allowed, but it does not decide who will emit what. It is the companies and institutions sub-

54. IPSOS, "Canadian Voters Say Managing Economy in Tough Times (76%), Fixing Healthcare (73%) and Creating Jobs (73%) Are Absolutely Crucial Policy Planks for Parties to Address to Win Their Vote," Press release, August 13, 2015.

55. See for example Catherine Potvin *et al.*, *Acting on Climate Change: Solutions from Canadian Scholars*, UNESCO-McGill Chair for Dialogues on Sustainability, March 2015. This initiative brings together 60 experts recommending either a carbon tax or a carbon market. See also OECD, *Effective Carbon Prices*, November 2013, p. 12. "The highest costs by far per tonne of $CO_2$ abated are associated with various capital subsidies and feed-in tariff systems […]. The lowest costs per tonne abated were for trading systems, in line with classical economic theory—a fact which confirms 'textbook suggestions' that trading systems (and broad-based carbon taxes) are the most economically efficient policy tools to mitigate climate change."

ject to the carbon market that decide if it is more advantageous to reduce their emissions or to procure more emission allowances.

This decentralized decision-making normally allows for the most optimal reductions to take place. In theory, companies are in the best position to evaluate the cost of reducing emissions and deciding to go forward or to purchase compensatory allowances. The carbon market mechanism allows the results of millions of individual evaluations to be communicated through the market price of emission allowances. Therefore, only the most effective reductions, and the ones that are less expensive than the price of emission allowances, will be carried out. The price of emission allowances will adjust itself as a consequence of the opportunities and constraints of each participant in the market.

**"The relative effectiveness of a mechanism like a carbon market lies in the decentralization of decisions regarding emission reductions."**

The economic impact of a carbon market is identical to the impact of a carbon tax, with one exception. As we shall see, the rate of the carbon tax is known. The price of an emission allowance is not, since it is set by the market. Nonetheless, in both cases, the immediate result is to increase the relative cost of carbon-intensive products like fuel, which favours reduced consumption as well as substitution toward other, less carbon-intensive products.

In order to control emissions and regulate the carbon market, governments deal directly with the sources of emissions that are companies and institutions. Although the price of emissions is integrated upstream of consumers, they are the ones who bear the true economic cost.[56]

## The Challenges of Setting Up a Carbon Market

In practice, setting up a carbon market requires that numerous elements be determined. The emissions of economic entities, necessarily defined arbitrarily (an industry, a specific company, or each factory?), must be measured, and reliable data be gathered on the emissions effectively released. In addition, it becomes necessary to control the availability of allowances equivalent to these emissions and to impose penalties on delinquent institutions and companies.

The ceiling must be established and gradually lowered. This task is more complex than it sounds. Companies can find themselves becoming less competitive and will then ask the government for help in one form or another. For example, governments can grant emission allowances free of charge to certain companies to keep their competitors, who are not subject to the same environmental rules, from enjoying an unfair advantage. Other industries will want to be entirely exempt from the carbon market. Any favouritism toward some will only increase the cost to be borne by the other industries and companies. A ceiling that is too ambitious runs the risk, in carbon-intensive sectors, of displacing economic activity toward other regions, a phenomenon known as "carbon leakage."

Another source of difficulty comes from the revenues from allowances. These can be used for various ends, or on behalf of various political clienteles, since governments have an incentive to use the resources at their disposal so as to favour their re-election. For example:

1. The government can use these funds to favour environmental projects in order to further reduce GHG emissions in addition to the carbon market. To this end, they will subsidize renewable energy or research and development into certain so-called green technologies.

2. The government can also choose to compensate certain industries or certain companies by giving them funds in the form of transition assistance. The funds will be paid out on condition that they adopt GHG reduction plans, the latest clean technologies, or other programs of this sort. In the case of compensations to businesses, as in the case of subsidies for environmental projects, the use of funds is often not very well controlled. The sums are allocated without clear objectives, without selection or call for tenders, and without management by results.

56. The demand for gasoline actually has very low price elasticity. The U.S. Energy Information Administration uses a short-term price elasticity of 0.02 in its models. See U.S. Energy Information Administration, Gasoline prices tend to have little effect on demand for car travel, December 15, 2014; Martijn R.E. Brons *et al.*, "A Meta-Analysis of the Price Elasticity of Gasoline Demand. A System of Equations Approach," Leibniz Information Centre for Economics, Tinbergen Institute Discussion Paper, No. 06-106/3, 2006; Molly Espey, "Gasoline Demand Revisited: An International Meta-Analysis of Elasticities," *Energy Economics*, Vol. 20, 1998, p. 277; Phil Goodwin *et al.*, "Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review," *Transport Reviews*, Vol. 24, No. 3, May 2004, p. 278.

Information regarding the projects that are funded is not always available, which raises doubts about the relevance or the fulfillment of these projects.[57]

3. Finally, the government can decide to compensate taxpayers by redistributing the sums collected through the mechanism of a tax reduction. What is collected as revenue for the emission allocations is therefore returned to consumers through lower taxes. We speak of "tax neutrality" when the amounts collected are exactly offset by reductions.[58]

Although carbon markets are simple in principle, in practice they raise tricky questions of equity and control. The transition from economic theory to practical application is very complex.

## An Existing Carbon Market: Quebec, California… and Ontario

The Western Climate Initiative (WCI) is a carbon market linking Quebec and California. Although 11 states and provinces participated in its creation,[59] only these two jurisdictions have implemented it. Recently, the government of Ontario announced its intention to set up a carbon market and join the WCI.[60]

The Western Climate Initiative aims to reduce the total emissions of the participating regions while mitigating the economic impact on consumers, revenues, and employment.[61] This initiative leaves a lot of latitude to participants to determine how to implement the market. A central organization was set up, however, to supervise emission allocation auctions and to oversee exchanges.[62]

The agreement reached between the participants excludes the agricultural, forestry, and waste management sectors in order to protect them.[63] Like all other organizations not subject to the carbon market, companies in these sectors can nevertheless put in place projects to reduce their emissions and obtain compensatory credits that can then be sold.[64]

Agriculture represents 8.3% of Quebec's emissions and 8% of California's (see Figure 2-1). For purposes of comparison, this is nearly as much as the combined emissions of the residential, commercial, and institutional sectors, which amount to 9.7% of total emissions in Quebec, and it's more than the emissions of the residential sector in California (7%). Since the agricultural sector generates less than 1.6% of Quebec's GDP,[65] it is a very GHG-intensive sector.

**"A ceiling that is too ambitious runs the risk of displacing economic activity toward other regions, a phenomenon known as 'carbon leakage'."**

Waste management is also a sector that is overrepresented in terms of emissions, since this single activity is responsible for 5.5% of total emissions in Quebec. The high intensity of GHGs, both in the agricultural sector and in the waste management sector, is due among other things to the fact that these two sectors produce GHG emissions that are more powerful than $CO_2$, like methane ($CH_4$).[66] However, emissions in the waste management sector have fallen by 41% in Quebec between 1990 and 2012, whereas those of the agricultural sector have increased by 3.9% over the same period.[67]

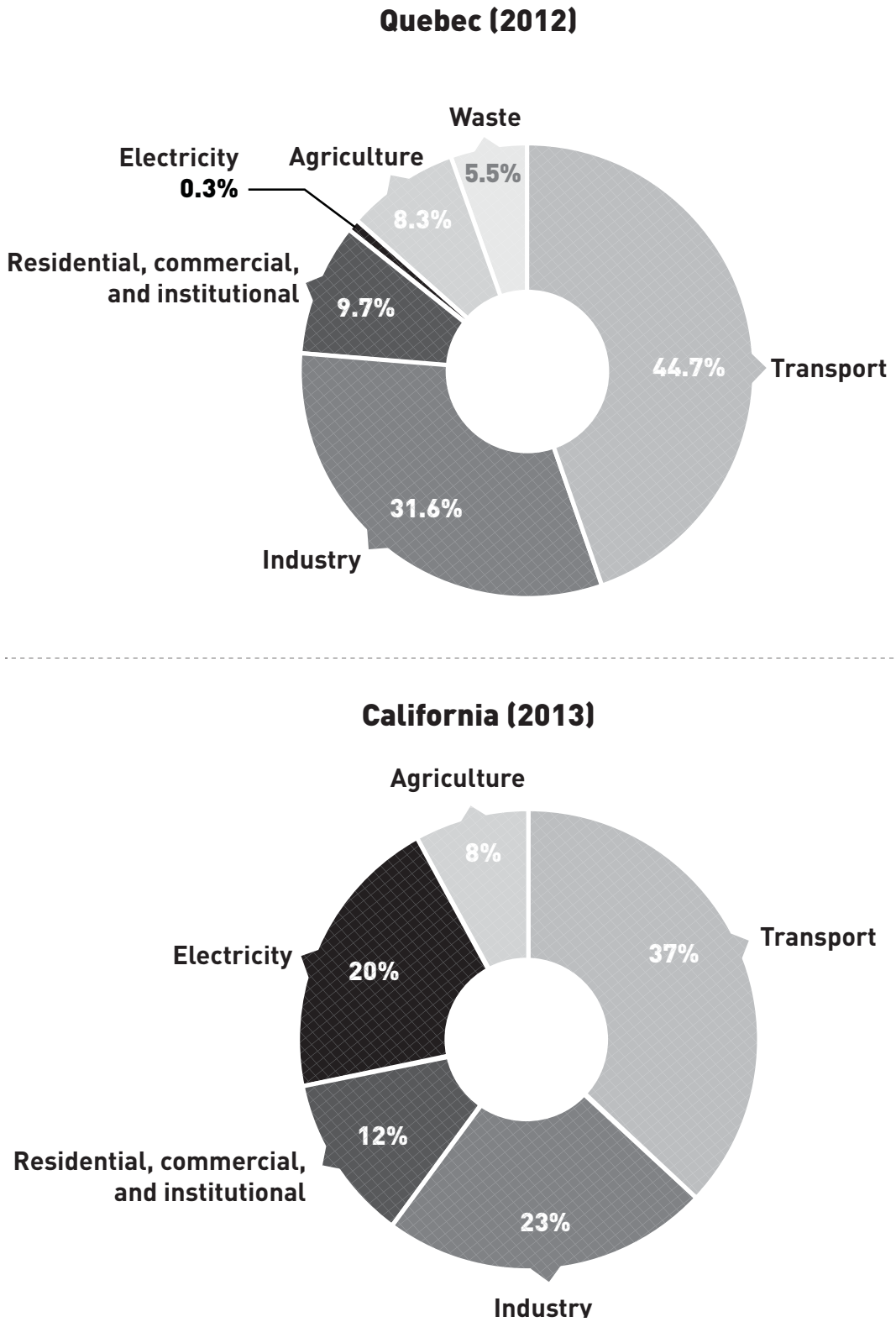
The exclusion of the agricultural, forestry, and waste management sectors from the areas covered by the carbon market therefore sets aside some significant sources of emissions.

The participating governments have a substantial amount of discretion in allocating free emission allowances to certain industries. They can also use the funds from auctions for various purposes, either to encourage

57. Auditor General of Quebec, *Fonds vert : gestion et aide financière*, Chapter 4 of *Rapport du vérificateur général du Québec 2014-2015*, Spring 2014, p. 3.
58. Tax neutrality is a principle that can be applied to a wide variety of public policies that involve revenue for the government. It can be applied to a carbon market, but also to a carbon tax, as is the case with the carbon tax that is in effect in British Columbia.
59. Western Climate Initiative, "Modèle recommandé pour le programme régional de plafonds-échanges de la Western Climate Initiative," September 23, 2008. These were Arizona, British Columbia, California, Manitoba, Montana, New Mexico, Ontario, Oregon, Quebec, Utah, and Washington State.
60. Government of Ontario, "Cap and Trade System to Limit Greenhouse Gas Pollution in Ontario," Press release, April 13, 2015.
61. Western Climate Initiative, *op. cit.*, footnote 59, p. 6.
62. Western Climate Initiative, Home.
63. Western Climate Initiative, *op. cit.*, footnote 59, p. 17.
64. Quebec Department of Sustainable Development, Environment and the Fight against Climate Change, Marché du carbone, Crédits Compensatoires.
65. The agricultural, forestry, and fishing and hunting sectors (NAICS code 11) represented a combined 1.6% of Quebec's GDP in 2014. Institut de la statistique du Québec, *Produit intérieur brut par industrie au Québec*, May 2015, pp. 12 and 14.
66. Nature Québec, "La part du secteur agricole dans les émissions de gaz à effet de serre," May 2011, p. 1; Environment Canada, Municipal Solid Waste and Greenhouse Gases, July 25, 2014.
67. Department of Sustainable Development, Environment and the Fight against Climate Change, "Inventaire québécois des émissions de gaz à effet de serre en 2012 et leur évolution depuis 1990," 2015, p. 11.

Figure 2-1

**GHG emissions in Quebec and California by sector of economic activity**




**Source:** Quebec Department of Sustainable Development, Environment and the Fight against Climate Change, "Inventaire québécois des émissions de gaz à effet de serre en 2012 et leur évolution depuis 1990," 2015, p. 8; California Environmental Protection Agency, Air Resources Board, "California Greenhouse Gas Emission Inventory – 2015 Edition," June 30, 2015.

energy efficiency, provide "green jobs," encourage renewable energy, or reduce the impact on consumers and industries.[68]

Since January 2015, companies that sell fuel are subject to the carbon market. They must procure allowances corresponding to the emissions of the products they sell, which means that they must compensate for the GHGs of their customers. Of course, this cost is included in the price of the fuels consumed, as if it were a carbon tax.[69] Although the data is still incomplete, it is estimated that the cost of the carbon market raises the cost of each litre of gasoline by around 4¢ in Quebec.[70] Over the longer term, the cost for consumers will depend on the cost of the emission allowances traded on the carbon market and the adaptation of consumers and companies.

**"It is estimated that the cost of the carbon market raises the cost of each litre of gasoline by around 4¢ in Quebec."**

### How Is the Price of One Tonne of Emissions Set in the Western Climate Initiative?

The price is set by the market, which is to say by the buying and selling of emission allowances, notably during auctions held by the participating governments. The governments always set a reserve price for each auction, below which they do not sell the emission allowances. This reserve price increases each year by 5% plus the rate of inflation. Figure 2-2 shows the price of emission allowances at the auctions held since December 2013.

What the carbon market's regulatory authorities determine, for their part, is the quantity of emission allowances given out free of charge or made available at auction. The quantity of total allowances is determined jointly by the WCI Inc. organization,[71] according to the assessments of the two participating jurisdictions and their reduction objectives for the year 2020.

The Quebec government decided to reduce the province's emissions 20% below its 1990 level by the year 2020.[72] California, for its part, adopted the far less ambitious target of returning to its 1990 level by 2020.[73] Figure 2-3 shows the evolution of GHG emissions in recent years and the forecast trends to be followed to hit the targets set for 2020.

Since the emission allowances are fully recognized in both regions, the GHG reductions forecast for California and Quebec could take place in either one. It is therefore possible, for example, for Quebec's emissions to fall less than expected, but for California's to fall more than expected in compensation, or the reverse. Given that Quebec's objectives are more ambitious, it might be more likely that emitters in this province will purchase more allowances in order to avoid draconian reductions.

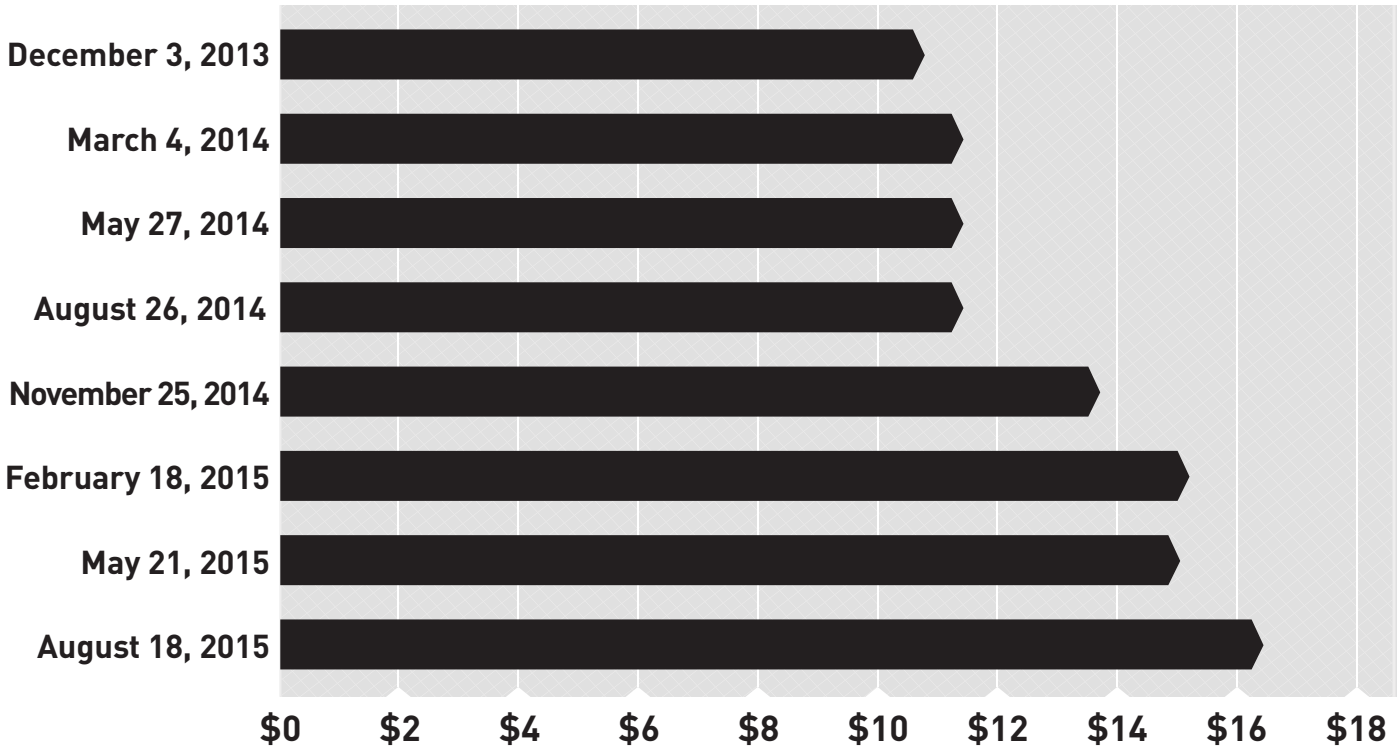
## B. The Carbon Tax

The second mechanism for incentivizing the reduction of GHG emissions is the levying of a carbon tax. This mechanism is favoured over a carbon market by a growing number of economists and other specialists on the matter, mainly because of its simplicity and its predictability.[74]

68. Western Climate Initiative, *op. cit.*, footnote 59, p. 13.
69. The fact that consumers bear the majority of the costs associated with a carbon market or a carbon tax reflects their lower price elasticity than that of producers faced with a common constraint to their industry as a whole, or even the entire economy. The reduction of aggregate demand following a price increase entails, for its part, a loss for producers. Among many others, we can consult the work of Robert N. Stavins, of Harvard University, who has attempted to measure the various impacts that a carbon market would have in the United States. Robert N. Stavins, "Addressing Climate Change with a Comprehensive US Cap-and-Trade System," *Oxford Review of Economic Policy*, Vol. 24, No. 2, 2008, pp. 298-321.
70. Given that a litre of gasoline emits around 2299 g of $CO_2e$ according to Environment Canada, we can estimate that a price of $10 per tonne of GHG is equivalent to a 2.3¢ tax per litre of gasoline. The average price of $17.98 obtained in the August 2015 auction corresponds to 4.13¢ per litre. Department of Sustainable Development, Environment and the Fight against Climate Change, "Ventes aux enchères no 4 d'août 2015 : Rapport sommaire des résultats," August 25, 2015; Environment Canada, Fuel Combustion, Mobile Combustion, June 21, 2013.
71. Western Climate Initiative, *op cit.* footnote 62.
72. Department of Sustainable Development, Environment and the Fight against Climate Change, *Le Québec en action vert 2020 : Plan d'action 2013-2020 sur les changements climatiques—Phase 1*, 2012, p. 5.
73. California Environmental Protection Agency, Air Resources Board, California 1990 Greenhouse Gas Emissions Level and 2020 Limit, May 6, 2015. The 2020 emissions limit is therefore set at 431 million tonnes of $CO_2e$.
74. Reuven S. Avi-Yonah and David M. Uhlmann, "Combating Global Climate Change: Why a Carbon Tax Is a Better Response to Global Warming Than Cap and Trade," *Stanford Environmental Law Journal*, Vol. 28, No. 3, 2009; Lawrence H. Goulder and Andrew R. Schein, "Carbon Taxes Versus Cap and Trade: A Critical Review," *Climate Change Economics*, Vol. 4, No. 3, 2013 : "[Exogenous pricing helps] prevent price volatility, [reduces] expected policy errors in the face of uncertainties, helps avoid problematic interactions with other climate policies and helps avoid large wealth transfers to oil exporting countries."; William D. Nordhaus, "Life After Kyoto: Alternative Approaches to Global Warming Policies," NBER Working Paper No. 11889, 2005; N. Gregory Mankiw, "One Answer to Global Warming: A New Tax," *The New York Times*, September 16, 2007.

Figure 2-2

**Price of the emission allowances traded on the WCI carbon market**




**Source:** Joint auction summary results reports published by Quebec's Department of Sustainable Development, Environment and the Fight against Climate Change and the California Air Resources Board (starting in November 2014, the two agencies publish the reports jointly).

## How Does a Carbon Tax Work?

The levying of a carbon tax represents a mechanism similar to a carbon market in that it allows for limiting GHG emissions without imposing arbitrary limits on each emitter. It consists of taxing the economic inputs that produce greenhouse gas emissions, like fossil fuels: coal, natural gas, and products derived from oil. In principle, this additional cost allows emitters to internalize the social cost of carbon.

As in the case of a carbon market, a carbon tax is a mechanism that allows for the decentralization of emission reduction decisions. The government determines the tax rate, and it lets companies and individuals make their own decisions. Faced with higher costs for carbon-intensive goods, there will be a tendency to consume less and to substitute other goods that emit less GHGs.

The government therefore does not decide who will emit what. Contrary to the carbon market, it does not even set the overall emissions allowed. The only lever upon which it can act is the rate of the tax, which can be raised or lowered in order to achieve an emissions objective.

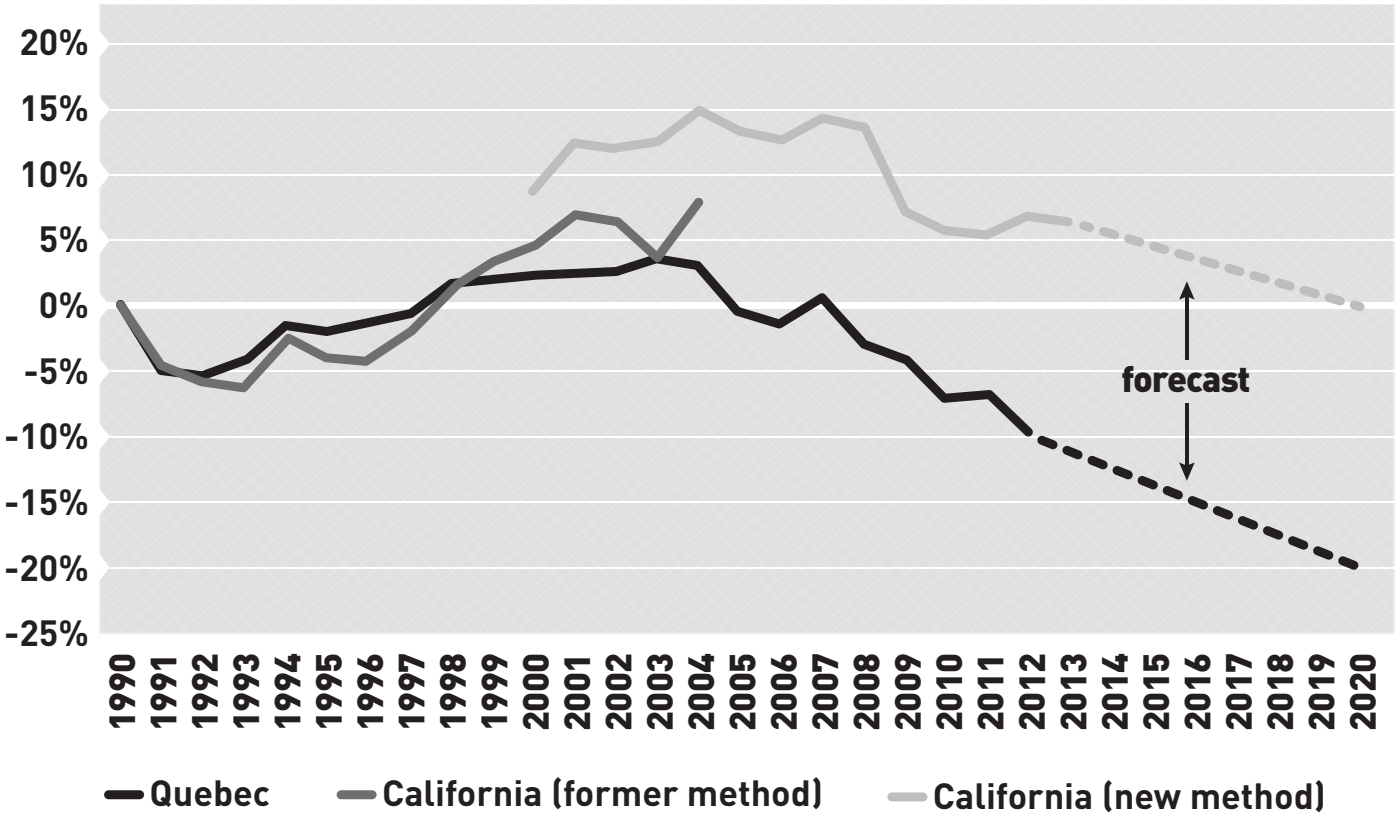
**"Given that Quebec's objectives are more ambitious, it might be more likely that emitters in this province will purchase more allowances in order to avoid draconian reductions."**

## The Challenges of Setting Up a Carbon Tax

The main challenge to the implementation of a carbon tax is political, for the simple reason that it is a mechanism that has the label "tax" attached to it, contrary to a carbon market. Even though the two concepts are similar in terms of economic impact, the carbon tax is perceived more as a fiscal lever. The 2008 federal election, in which the Liberal Party of Canada proposed a carbon

Figure 2-3

**Evolution of GHG emissions for WCI participants and their targets for 2020**




**Source :** California Environmental Protection Agency, Air Resources Board, "California Greenhouse Gas Inventory for 2000-2013 – by Sector and Activity," April 24, 2015, p. 2; California Environmental Protection Agency, Air Resources Board, "2020 Statewide Greenhouse Gas Emissions and the 2020 Target," May 27, 2014, p. 1; California Environmental Protection Agency, Air Resources Board, "California Greenhouse Gas Inventory (millions of metric tonnes of CO2 equivalent) – By IPCC Category," November 19, 2007, pp. 22-23; Department of Sustainable Development, Environment and the Fight against Climate Change, *Inventaire québécois des émissions de gaz à effet de serre*, various editions.
**Note:** The data before 1990-2004 in California are not comparable to those from 2000-2013. The most recent data are for the year 2012 for Quebec and 2013 for California.

tax offset by income tax reductions, provided a convincing illustration of the unpopularity of such a proposition.[75]

The major obstacle when it comes to the effectiveness of a carbon tax is the risk of carbon "leakage." If a government adopts such a tax, but its neighbours do not, a portion of emissions will in all likelihood simply be displaced from this region to the others, which will reduce its emissions record without actually reducing overall emissions—among others the emissions associated with imported goods. The phenomenon is illustrated by drivers living near the border who will be tempted to gas up on the other side.[76]

Since it is overall GHG emissions that influence the climate, the displacement of certain emissions neutralizes in part the effectiveness of a carbon tax. In an ideal scenario, all countries of the world would levy the same tax at the same time, at a relatively low rate. The improbability of this scenario leads rapidly to imbalances between countries, to higher rates in countries that adopt the tax and lower effectiveness in reducing emissions. William Nordhaus of Yale University calculated that given the participation of only 50% of countries, the economic costs associated with a tax would be 250% higher than an optimal tax.[77]

75. Bernard Simon, "Canada's Dion to step down as Liberal leader," *Financial Times*, October 21, 2008.
76. Philip Cross, "The carbon tax illogic," *Financial Post*, January 13, 2015.
77. William D. Nordhaus, *A Question of Balance—Weighing the Options on Global Warming Policies*, Yale University Press, 2008, p. 19.

Finally, other technical challenges of implementation can arise, similar to those of a carbon market, if the government tries to exempt certain economic sectors or particular companies.

## An Example of a Carbon Tax: British Columbia

The province of British Columbia introduced a carbon tax in 2008.[78] From $10 per tonne of GHG emissions at the time, this tax grew to $30 in 2012 following four annual increases of $5 each. At the current rate, it corresponds to 6.67¢ per litre of gasoline and 7.67¢ per litre of diesel.[79] The tax generates total revenues of $1.2 billion for the government.[80]

What is particular about this carbon tax is that it is revenue neutral. In other words, British Columbia's Ministry of Finance has a mandate to reduce other taxes by an amount equal to the revenues brought in by the carbon tax. This objective is fulfilled primarily through personal and corporate income tax rate reductions. A tax credit for low-income families was also introduced to compensate these households. The effect on the province's economy also seems to have been quite small, and even positive overall, thanks to the income tax reductions that have offset the levying of the carbon tax.[81]

Between 2007, which was before the carbon tax came into effect, and 2012, fuel consumption in British Columbia fell by 17.4%. During this same period, fuel consumption went up by 1.5% in the rest of Canada. GHG emissions per capita were reduced by 10% in British Columbia versus a reduction of 1.1% in the rest of Canada.[82] But are these results really a consequence of the carbon tax?

Economists generally recognize that the price elasticity of demand for fuel, which measures the reaction of consumers to a price variation, is very low.[83] A tax of 6.67¢ per litre, which represents an increase of less than 6%, would entail a reduction of far less than 6%. A government that wanted to appreciably reduce transportation-related GHG emissions would have to increase the price of gas considerably in order to entail a substantial modification of behaviours.[84]

Other considerations must therefore also be taken into account in order to understand the reduced fuel consumption in British Columbia. There was for instance the considerable decline of the forestry industry, a major economic sector, after the 2008 housing crisis. The explanation of a temporary reduction in fuel consumption due to other factors appears all the more justified given that since 2012, the data show a rapid increase in fuel consumption. Indeed, the recent data indicate that British Columbia now consumes more than it did before the carbon tax, both overall and per capita, as demonstrated by Philip Cross, the former chief economic analyst at Statistics Canada.[85]

> **"The major obstacle when it comes to the effectiveness of a carbon tax is the risk of carbon 'leakage'."**

Other criticisms have been heard underlining the possibility of carbon leakages, among other things due to truckers and other drivers filling up beyond the province's borders.[86] This phenomenon seems to have doubled since the introduction of the carbon tax, which has not been the case in Ontario or Quebec. The carbon tax will continue to be a topic of debate, but its effect now appears marginal in the explanation of long term trends.

## How Is the Carbon Tax Rate Determined?

The rate of the carbon tax is set by the government. For example, the British Columbian government set the rate of its tax at $30 per tonne of GHG emissions. What is uncertain is the level of emissions and the likelihood of carbon leakage. The government that adopts such a tax must therefore determine a rate that will lead to an ef-

78. Government of British Columbia, *Carbon Tax Act*, Chapter 40, October 21, 2015.
79. British Columbia Ministry of Finance, How the Carbon Tax Works.
80. British Columbia Ministry of Finance, *Budget and Fiscal Plan 2015/16 to 2017/18*, February 17, 2015, p. 60.
81. Stewart Elgie and Jessica McClay, "BC's Carbon Tax Shift after Five Years: Results—An Environmental (and Economic) Success Story," *Sustainable Prosperity*, 2013, p. 7.
82. *Ibid.*, pp. 2 and 4.
83. *Op. cit.*, footnote 56.
84. This relation is true, unless a carbon tax has an effect that is different from a regular price increase. Some claim, however, that the "salience" of a carbon tax, namely its impact on behaviour, is greater than that of a regular gasoline tax. This concept of "salience," difficult to measure, and criticized, is the explanation offered by two University of Ottawa researchers. Nicholas Rivers and Brandon Schaufele, *Carbon Tax Salience and Gasoline Demand*, Working Paper No. 1211E, Department of Economics at the University of Ottawa, August 2012.
85. Philip Cross, *op. cit.*, footnote 76; Terence Corcoran, "No B.C. carbon tax miracle on 120th St.," *Financial Post*, January 13, 2015.
86. Jock Finlayson, "B.C.'s carbon tax hurting businesses," *The Vancouver Sun*, August 1st, 2013; Robert P. Murphy, "British Columbia's Carbon Tax and 'Leakage' Into the U.S.," Institute for Energy Research, July 6, 2015.

fective reduction of emissions corresponding to its targets without entailing too large a displacement of economic activities with heavy emissions.

## C. Fuel Taxes in Canada

The carbon tax in British Columbia and the additional charges related to the carbon market in Quebec do not appear explicitly as taxes on sales slips. However, they increase producers' costs, and consequently retail prices as well. It is therefore consumers who bear the economic cost by paying more for a litre of gas, just like a regular tax. Yet gasoline is already heavily taxed in Canada.

**"British Columbia's Ministry of Finance has a mandate to reduce other taxes by an amount equal to the revenues brought in by the carbon tax."**

The base price of gasoline is determined by the market, which is to say by the price of crude oil and the profit margins of intermediaries (refining, transportation, retail). To this base price are added the taxes levied by the various levels of government.[87] The 10¢ excise tax levied by the federal government since 1995 is fixed. All provinces also levy fixed taxes on fuels.[88] To this are added municipal taxes levied by Vancouver (11¢ per litre), Victoria (3.5¢), and Montreal (3¢) (see Figure 2-4). Federal and provincial sales taxes are added to this total, and are therefore also applied to the excise taxes of the three levels of government.[89]

Since certain taxes are fixed and others are proportional to price, the amount of taxes paid on each litre of gasoline and the proportions of these taxes vary constantly, as do the revenues governments collect from them. In 2014-2015, the federal government registered revenues of $5.528 billion from energy taxes,[90] primarily the excise tax on gasoline and diesel.

As can be seen in Table 2-1, federal, provincial, and municipal gasoline taxes represented revenues of $11 billion for governments in 2014. If we add in sales taxes, these revenues totalled $16.3 billion. Diesel taxes, for their part, brought in $3.2 billion to governments in 2014. Including sales taxes on this fuel, total revenues amounted to $5.3 billion. In all, governments therefore collect nearly $22 billion in various fuel taxes.

The taxes act like any mechanism aiming to internalize the cost of GHG emissions for fuel consumers, even though this was not the intention that led to their adoption. They were imposed in order to generate revenue for governments or to finance the maintenance of the road network, certainly, but they also entail a reduction in fuel consumption. Based on the emissions of one litre of gasoline, we can therefore deduce that the federal excise tax and the provincial fixed taxes on fuels correspond to a carbon tax of between $83 and $128 per tonne of GHGs,[91] as illustrated in Figure 2-5. In the cities of Montreal and Vancouver, it reaches levels equivalent to a carbon tax of $141 and $155 respectively.

The imposition of a mechanism whose goal is to put a price on GHG emissions, like a carbon tax or a carbon market, therefore cannot be done without taking into account the taxes already in effect.

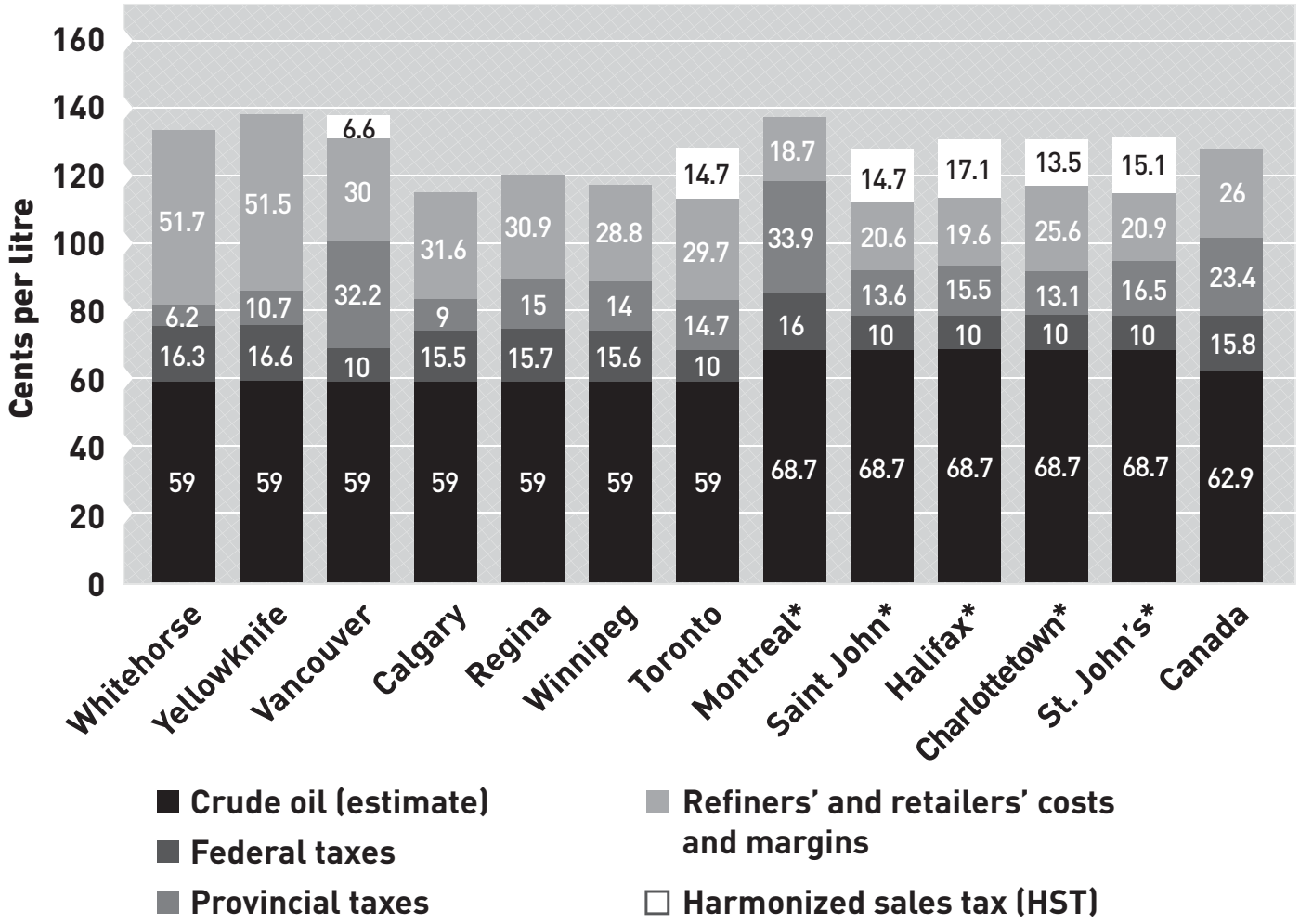
## D. Subsidies and R&D in the Field of Green Energy

Governments also act by subsidizing various initiatives related to the fight against climate change, like research and development activities, the production or use of renewable energy, the purchase of electric cars, or energy efficiency measures. In Canada, numerous examples exist. The federal government lists 224 subsidy and financial incentive programs regarding energy efficiency administered by Natural Resources Canada.[92] Moreover, the provincial governments are also active in several areas.

87. The price of gasoline has been the subject of numerous analyses. Natural Resources Canada published a bi-weekly Fuel Focus bulletin on gasoline containing a wealth of relevant information. Available at http://www.rncan.gc.ca/energie/prix-carburant/4594.
88. Provincial excise taxes are set in relation to the price of gasoline and are calculated in cents per litre. However, their application varies, with certain regions seeing their taxes go up or down. In Quebec, for example, a reduced rate applies to border regions like the Gaspé Peninsula and Magdalen Islands and the Outaouais. To complicate the collecting of the provincial excise tax even more, regions contiguous to an American state or located close to a peripheral region sees the tax vary for service stations according to distance. Revenue Quebec, "Table of Fuel Tax Rates in Québec, by Region in force as of April 1, 2015," April 2015.
89. Natural Resources Canada, Government taxes on gasoline, September 15, 2014; CAA Quebec, How is the price of a litre of gasoline determined?; Marc-André Pigeon, Federal Taxes on Gasoline and Heating Fuels, Library of Parliament of Canada, September 16, 2005.
90. Department of Finance Canada, *Annual Financial Report of the Government of Canada Fiscal Year 2014–2015*, 2015, p. 17.
91. The conversion from cents per litre to dollars per tonne of GHGs is based on the emission of one litre of gasoline for light-duty gasoline vehicles as indicated by Environment Canada. Environment Canada, *op. cit.*, footnote 70. The U.S. Energy Information Administration also provides equivalencies. U.S. Energy Information Administration, Frequently Asked Questions, How much carbon dioxide is produced by burning gasoline and diesel fuel? July 7, 2015.
92. Natural Resources Canada, Grants and Financial Incentives, April 1st, 2014.

Figure 2-4

**Composition of the retail price of gasoline in several Canadian cities, 2014**




* Regulated markets; calculations are based on the average price for the year 2014.
**Source:** Natural Resources Canada, *Fuel Focus: Understanding Gasoline Markets in Canada and Economic Drivers Influencing Prices—2014 Annual Review*, January 23, 2015, p. 2.

## R&D

Research and development of solutions to reduce GHG emissions is sometimes carried out by private companies, sometimes by public companies like Hydro-Québec or Ontario Power Generation, and sometimes by university research centres.

Various research centres and companies supported by governments concentrate on questions of clean energy,[93] like the NSERC/Hydro-Québec Industrial Research Chair in Energy Efficiency in Electrical Machines for Small Scale Renewable Energy Production Systems at Concordia University.[94] Collegiate initiatives also receive support, like the Industrial Research Chair for NSERC Colleges in Sustainable Energy Technology and Energy Efficiency.[95]

The federal government had also launched the Clean Energy Fund Program, which received $205 million for various research projects, including $CO_2$ capture and storage projects. The sums granted had been completely used up by March 31, 2012.[96]

93. Prime Minister of Canada, PM announces energy innovation projects across Canada, May 3, 2013.

94. Natural Sciences and Engineering Research Council of Canada, Chairholder Profile, Pragasen Pillay.
95. Natural Sciences and Engineering Research Council of Canada, Chairholder Profile, Martin Bourbonnais.
96. Natural Resources Canada, Clean Energy Fund Program, June 11, 2014.

Table 2-1

## Government revenues from excise and sales taxes on fuel, 2014

| REVENUE (MILLIONS OF DOLLARS) | TAXES ON GASOLINE | TAXES ON DIESEL |
|---|---|---|
| **Federal government** | **4,263.8** | **646.8** |
| **Newfoundland and Labrador** | **161.3** | **85.1** |
| **Prince Edward Island** | **26.2** | **16.0** |
| **Nova Scotia** | **152.5** | **75.3** |
| **New Brunswick** | **110.6** | **109.8** |
| **Quebec** | **1,646.9** | **833.9** |
| **Ontario** | **2,325.0** | **596.7** |
| **Manitoba** | **229.4** | **54.9** |
| **Saskatchewan** | **316.5** | **108.6** |
| **Alberta** | **605.8** | **298.8** |
| **British Columbia** | **1,009.1** | **366.8** |
| **Territories** | **2.6** | **14.0** |
| **Municipalities** | **281.8** | **18.6** |
| **Total fuel taxes** | **11,131.7** | **3,225.3** |
| **Total sales taxes** | **5,189.8** | **2,045.8** |
| **Total government revenue** | **16,321.6** | **5,271.1** |
| **Total revenue** | | **21,592.6** |

**Source:** Kent Marketing Services and Canadian Fuels Association, data provided to authors on demand.

Other subsidy programs exist, for example:

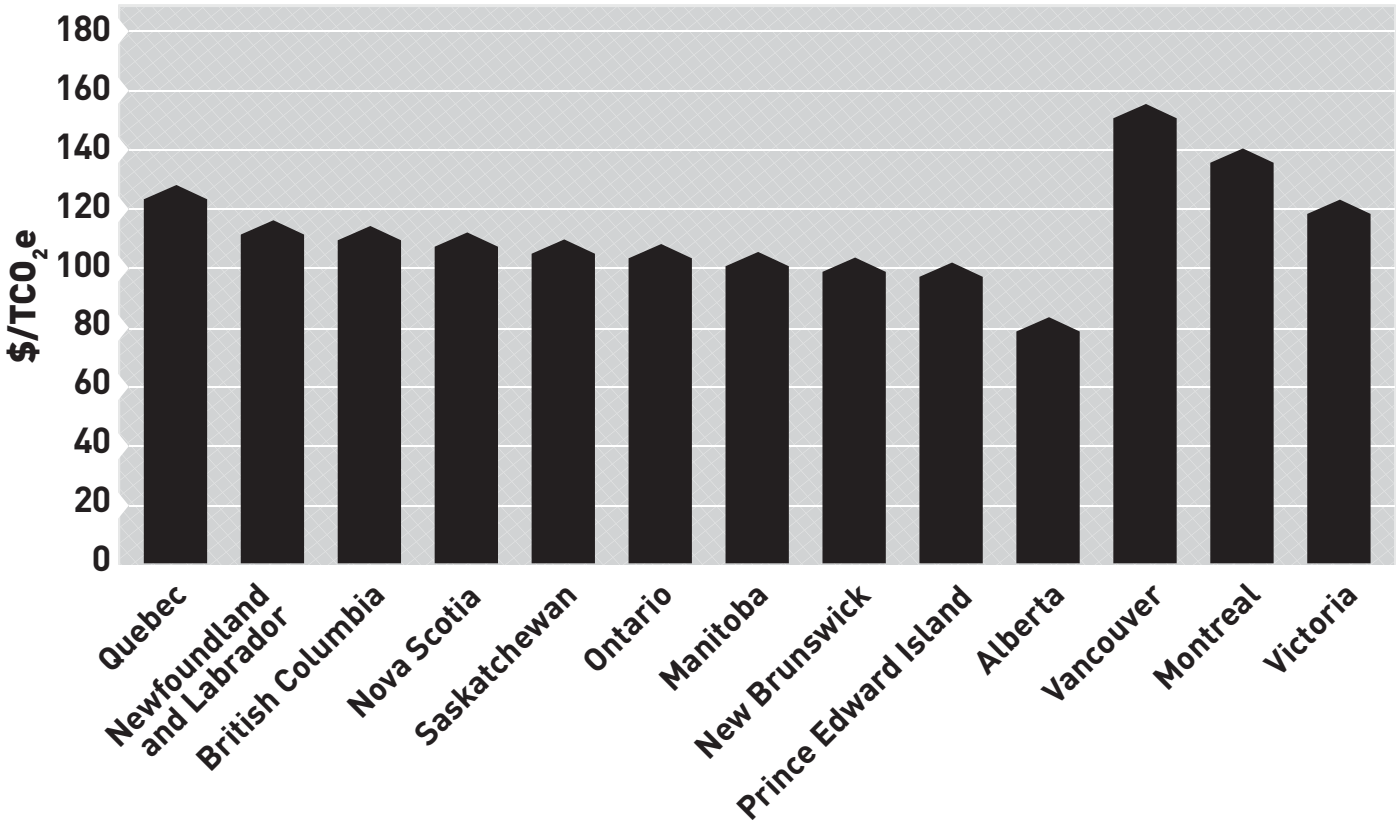
- The Program of Energy Research and Development (PERD) whose mandate is specifically to provide financial assistance to research and development "designed to ensure a sustainable energy future for Canada."[97]
- The ecoENERGY Innovation Initiative, whose goal "is to support energy technology innovation to produce and use energy in a cleaner and more efficient way." This initiative, according to the federal government, "is a key component of the Government of Canada's actions to achieve real emissions reductions."[98]

97. Natural Resources Canada, Program of Energy Research and Development, July 5, 2013.

98. Natural Resources Canada, The ecoENERGY Innovation Initiative, October 17, 2014.

Figure 2-5

**Carbon taxes implicit in excise taxes**




**Source:** Environment Canada, Fuel Combustion, Mobile Combustion, June 21, 2013 and authors' calculations.

The results of supported R&D projects are difficult to evaluate. Nonetheless, they are part of a process of constant innovation which leads to improvements in the energy intensity and carbon intensity of the economy, concepts which will be examined in some detail in the following chapter. Moreover, the Copenhagen Consensus Center asked several renowned economists to evaluate which social objectives should be prioritized on a planetary level, and the conclusion arrived at was that in the case of climate change, R&D represented the most efficient allocation of funds.[99]

## The Production and Use of Renewable Energy

The GHG emissions associated with the production of electricity vary depending on the primary energy source that is transformed into electricity. Hydroelectric and nuclear power plants have negligible carbon footprints, whereas coal-fired power plants generate substantial amounts of emissions.

**"Economists generally recognize that the price elasticity of demand for fuel, which measures the reaction of consumers to a price variation, is very low."**

99. Isabel Galiana, "Benefits and Costs of the Climate Change Targets for the Post-2015 Development Agenda," Copenhagen Consensus Center, 2014.

Other sources of less traditional energy, like solar and wind energy, arouse the interest of certain governments because they could lead to emission reductions.[100] This is why the production of electricity from so-called renewable energy sources is widely subsidized.

This is the case of the federal government's ecoENERGY for Renewable Power program, launched in 2007. This program grants subsidies of one cent per kilowatt-hour (kWh) to the production of electricity. The projects, which are subsidized for ten years, can use "wind, low-impact hydro, biomass, photovoltaic and geothermal energy." In all, the 104 qualified projects will receive $1.4 billion by 2021, and they represent 4,500 megawatts of installed power.[101]

**"In all, governments collect nearly $22 billion in various fuel taxes."**

It is provincial programs, though, that involve the largest sums. The Feed-In Tariff Program offered by the Ontario government for the production of renewable energy entailed a loss of $4.9 billion in 2014.[102] This program will contribute to there being an installed power of renewable energy of 10,700 megawatts by 2018. This enormous expense is borne, however, by Ontario consumers who are seeing their electricity bills grow. This cost is very real, whereas the results in terms of GHG reductions have not been clearly evaluated.[103]

Quebec, for its part, encourages renewable energy through contracts awarded by Hydro-Québec. The cost of these opaque programs is not rigorously evaluated, but it amounts to approximately $695 million a year, according to our calculations.[104] Once again, it is residential consumers and businesses footing the bill. Of course, given that the production of hydroelectricity accounts for 97% of total Quebec production,[105] the other renewable energy sectors have practically no impact on the province's GHG emissions.

These subsidies are among the most expensive, and therefore the least efficient, ways of reducing GHG emissions.[106] In particular, they have significant economic and social consequences. By raising the costs of electricity for the consumers who finance them, these subsidies generate energy poverty among the most vulnerable households. They also hurt the competitiveness of companies that see their rates go up. The European experience is telling. Several countries have had to shrink the subsidies they give out to producers of renewable energy.[107]

Finally, in terms of using renewable energy, subsidies exist for replacing oil heating systems with electrical heating systems[108] and for encouraging companies to turn away from fossil fuels.[109] Energy efficiency programs have also been set up by various government bodies and public corporations. For example, the Rénoclimat program targets the residential sector, offering financial support for renovations.[110]

## Electric Car Subsidies

The electrification of transportation seems like a promising avenue for reducing the personal transportation sector's large and growing emissions. Here too, however, the assessment of existing programs is controversial. For example, in the case of the electrification of public transit, we're talking about emission reductions for methods of transportation that are already responsible for less emissions per passenger, with little room for improvement.

In the case of subsidies for the purchase of electric passenger vehicles, the effective reductions are very small. Over its lifecycle, an electric vehicle emits no GHGs dur-

100. Electricity generated by solar and wind energy also emits GHGs, when the entire lifecycles of technologies are taken into account. Daniel Nugent and Benjamin K. Sovacool, "Assessing the Lifecycle Greenhouse Gas Emissions from Solar PV and Wind Energy: A Critical Meta-Survey," *Energy Policy*, Vol. 65, 2014, pp. 229-244.
101. Natural Resources Canada, ecoENERGY for Renewable Power, June 29, 2015.
102. Independent Electricity System Operator, Global Adjustment - Archive, Global Adjustment Values – 2005-2014. This figure is approximate because the real cost of the program is not provided by the Ontario government, for which it was in fact reproached by the Auditor General in its 2013 report. See Auditor General of Ontario, *2013 Annual Report of the Office of the Auditor General of Ontario*, 2013, p. 309.
103. Auditor General of Ontario, *2011 Annual Report of the Office of the Auditor General of Ontario*, 2011, pp. 89, 94 and 119.
104. Youri Chassin and Guillaume Tremblay, "The Growing Cost of Electricity Production in Quebec," Economic Note, Montreal Economic Institute, June 2013.
105. Montreal Economic Institute, *Canada's Energy Profile in 40 Questions*, Question 27, 2014.
106. OECD, *op. cit.*, footnote 55.
107. Brady Yauch, "Governments rip up renewable contracts," *Financial Post*, March 18, 2014. The German Auditor General looked into the Energiewende (Energy Revolution) policy and concluded that it is poorly planned: See Stefan Maas, "Energiewende - schlecht geplant?" *Deutschlandfunk*, August 20, 2014.
108. Quebec Department of Energy and Natural Resources, Heating with Green Power.
109. Quebec Department of Energy and Natural Resources, Programme d'aide financière pour des projets d'efficacité énergétique et de conversion.
110. Quebec Department of Energy and Natural Resources, Rénoclimat.

Table 2-2

**Cost of reducing one tonne of GHG emissions using different approaches**

| | NORWAY | QUEBEC |
|---|---|---|
| **Electrification of transportation (Cost per tonne avoided)** | **$6,925.00** | **$1,560.00** |
| **Carbon market (Cost per tonne avoided)** | **$10.39 (European carbon market*)** | **$17.98 (Western Climate Initiative)** |
| **Number of tonnes avoided for the same amount** | **666.4** | **86.8** |

* The average exchange price for an emission allowance for one tonne of CO2 for 2015 at the time of writing was 7.40 euros per tonne, and the Bank of Canada's average exchange rate from January to September 2015 was 1.4043 Canadian dollars per euro.
**Sources:** Youri Chassin and Guillaume Tremblay, "Do We Need to Subsidize the Purchase of Electric Cars?" Economic Note, Montreal Economic Institute, November 2014; Quebec Department of Sustainable Development, Environment and the Fight against Climate Change and the California Environmental Protection Agency, "Système de plafonnement et d'échange de droits d'émission de gaz à effet de serre du Québec et programme de plafonnement et d'échange de la Californie—Vente aux enchères no 4 d'août 2015 : Rapport sommaire des résultats," August 25, 2015; Bank of Canada, Monthly Average Exchange Rates: 10-Year Lookup; EEX, Results EUA Primary Auction Spot—Download, Emission Spot Primary Market Auction Report 2015.

ing its use, but its manufacture leads to emissions that are twice as high as the manufacture of a traditional automobile.[111]

Norway is perceived as the country at the forefront of the electrification of transportation, with around 75,000 electric vehicles on the road in September 2015.[112] The numerous programs providing financial support to owners of electric vehicles include financial purchase assistance, a sales tax exemption, toll exemptions, and free parking areas. Each tonne of GHGs avoided, however, cost $6,925 in various subsidies, not including the GHGs emitted during the manufacture of the battery.[113] If Quebec imitated Norway, as it seems to want to do,[114] the government would pay out the equivalent of $1,560 in subsidies for each tonne of GHGs avoided.[115] By including the GHGs emitted during the manufacture of the battery, the results climb to over $100,000 per tonne of GHGs avoided in Norway[116] versus $1,910 for Quebec.

We can see just how inefficient electrification of transportation policies are in fighting climate change by comparing the costs per tonne of GHGs avoided with the price of an emission allowance on the carbon market. Table 2-2 summarizes these comparisons and shows that the sums involved in the electrification of transportation can be used to reduce emissions much more efficiently.

**"These subsidies are among the most expensive, and therefore the least efficient, ways of reducing GHG emissions."**

## E. Regulations

Governments also adopt laws and regulations concerning GHG emissions and fuels. For example, the government of Canada adopted a law on fuel consumption standards for motor vehicles.[117] The regulation imposes on automobile manufacturers an average fuel consumption for the vehicles they make.[118] Fuel savings are also a concern for drivers, especially when the price of gas is high. Automobile manufacturers therefore have a strong incentive to produce vehicles that are more and more fuel efficient, as we shall see in Chapter 3.

111. Troy R. Hawkins *et al.*, "Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles," *Journal of Industrial Ecology*, Vol. 17, No. 1, 2013, pp. 53-64.
112. Gronnbil, EVs in Norge, September 2015.
113. Because of the battery, the manufacture of an electric vehicle produces twice the emissions as the manufacture of a gasoline-powered vehicle. Troy R. Hawkins *et al.*, *op. cit.*, footnote 111.
114. Government of Quebec, Propelling Quebec Forward with Electricity, A Responsible Action Plan Providing Structure and Direction.
115. Youri Chassin and Guillaume Tremblay, "Do We Need to Subsidize the Purchase of Electric Cars?" Economic Note, Montreal Economic Institute, November 2014.
116. This is due to the small number of kilometres driven by the owners of electric vehicles in Norway.
117. Government of Canada, *Motor Vehicle Fuel Consumption Standards Act*, 1985.
118. Martin Croteau, "Ottawa impose de nouvelles normes sur la consommation de carburant," *La Presse*, November 27, 2012.

The composition of gasoline is also regulated, for instance regarding the addition of at least 5% of ethanol in ordinary gasoline due to a federal regulation.[119] This renewable fuel is made primarily from corn and wheat in Canada, but it can be also made from other agricultural materials or from forestry waste.[120] This is a renewable fuel that emits less GHGs.

**"We can see just how inefficient electrification of transportation policies are in fighting climate change by comparing the costs per tonne of GHGs avoided with the price of an emission allowance on the carbon market."**

However, we now know that the production of biofuels like ethanol from grains is very harmful both economically and environmentally. When its production, its lower energy density, and the performance it allows are all taken into account, ethanol does not provide any notable benefits in terms of reducing GHG emissions.[121] Furthermore, because a significant amount of it is made from cultivated grains, the use of ethanol leads to price increases for basic foodstuffs on global markets and entails negative financial and human consequences for the poorest populations, and also increases the use of land for agriculture.[122] Indeed, the Canadian government recognizes that the benefits of this regulation are outweighed by its costs.[123] The appreciable increase in its production in recent decades is therefore accompanied by numerous negative effects.

An original regulation adopted in Alberta in 2007 seeks to reduce the intensity of GHG emissions. The Specified Gas Emitters Regulation (SGER) applies to facilities emitting 100,000 tonnes or more of GHGs and requires them to reduce their emissions by 12% per unit of production compared to their average level for the period from 2003 to 2005. This target will be 15% next year and 20% in 2017. If these objectives are not met, a facility must offset its emissions with credits or by contributing to the Climate Change and Emissions Management Fund at a cost of $15 per tonne of GHGs. The current price will be gradually increased to $30 by 2017.[124]

This kind of regulation is not identical to a carbon market in its effects. Because it does not limit the level of emissions, but only their intensity, it cannot guarantee an absolute reduction. However, like other kinds of regulations, the SGER encourages private companies to measure their emissions and adopt industrial processes that are less carbon-intensive.

## F. The Economic Impact of Governmental Measures

Governmental measures to fight climate change necessarily generate negative economic effects. Indeed, economic theory shows that since GHG emissions into the atmosphere constitute an externality, economic activity does not take them into account without regulation to this effect. Imposing limits on emissions or putting a price on them necessarily imposes an economic constraint that would not otherwise exist. Under this constraint, companies and individuals will have to make different choices than the ones they consider optimal and would have made barring such regulation.

The Montreal Economic Institute already published a *Research Paper* dealing specifically with the cost of an accelerated energy transition, as advocated by the environmentalist groups Équiterre and Vivre en ville[125]. The annual cost of $6.4 billion for the Quebec economy represented $1,875 per household. In a poll carried out be-

119. Environment Canada, Renewable Fuels Regulations, July 14, 2015; Petro-Canada, Looking for a Fuel That Fits Your Needs?
120. Natural Resources Canada, What is ethanol? November 19, 2014.
121. Erica Gies, "As Ethanol Booms, Critics Warn of Environmental Effect," *New York Times*, June 24, 2010; Xiaoyu Yan *et al.*, "Effects of Ethanol on Vehicle Energy Efficiency and Implications on Ethanol Life-Cycle Greenhouse Gas Analysis," *Environment Science Technology*, Vol. 47, No. 11, 2013, pp. 5535-5544; OECD, *op. cit.*, footnote 55: "The estimated carbon prices in the *road transport* sector also show considerable variation. The costs per tonne of $CO_2$eq abated are *very* high in certain cases; exceeding EUR 1000 per tonne for some policies related to the promotion of biofuels."
122. Rafael E. De Hoyos and Denis Medvedev, "Poverty Effects of Higher Food Prices: A Global Perspective," World Bank, Policy Research Working Paper 4887, 2009, p. 23; Indur M. Goklany, "Could Biofuel Policies Increase Death and Disease in Developing Countries?" *Journal of American Physicians and Surgeons*, Vol. 16, No. 1, 2011, pp. 9-13.
123. The federal government's cost-benefit analysis indicates that the present value of the estimated benefits amount to $1.1 billion based on the reduction of GHG emissions. As for the present value of the costs, these are estimated at $4.8 billion. Environment Canada, Federal Renewable Fuels Regulations: Overview, April 21, 2015.

124. Alberta Environment and Parks, Industrial Emissions Management, October 13, 2015.
125. Youri Chassin and Germain Belzile, *Can We Get Rid of Oil? The Costs of an Accelerated Energy Transition*, Research Paper, Montreal Economic Institute, December 2014.

fore the appearance of this publication, only 12% of Canadians were ready to pay over $1,500 a year in order to reduce oil consumption in Canada.[126]

Several activist groups have found it difficult to convince populations to consent to significant economic sacrifices in order to fight climate change. This explains why they now prefer to state that the fight against climate change will not harm the economy, and would even have a positive effect on economic growth.[127] Unfortunately, their reasoning is incomplete and illogical.[128] This kind of analysis generally stresses the creation of subsidized jobs, without however taking into account the jobs destroyed by the taxes that serve to finance these subsidies. Sometimes, reductions of oil imports are stressed, but without mentioning that these imports serve a purpose in transportation, nor that the alternative has a necessarily higher economic cost.

Recognized institutions, though, make the opposite argument in order to convince governments to intervene more. In short, they state that there is a large cost associated with future mitigation efforts in the absence of immediate actions. This argument speaks to the economic costs inevitably associated with the binding reduction of GHG emissions. A report produced as part of the World Bank's initiative on climate change mentions, for example, that:

> The International Energy Agency (IEA) has warned, and numerous energy system modelling exercises have confirmed, that unless urgent action is taken very soon, it will become extremely costly to reduce emissions fast enough to hold warming below 2°C.[129]

It is therefore dishonest to declare that the economic constraints imposed to fight against climate change would not immediately harm the economy. The new economic activities that are developed in response to subsidies, regulations, or fiscal levers will certainly add to economic growth. They will not, however, fully offset the economic activities lost elsewhere in the economy due to these same measures. In other words, if it is possible to achieve greater economic vigour under some new constraint, it is necessarily possible to achieve it without this constraint, and economic agents will do so anyhow.

Certain actions with beneficial economic effects, even in the short term, also have the effect of reducing GHG emissions. When one saves expensive energy through energy efficiency, the investment can be cost-effective.[130] Reducing GHG emissions from a source can also reduce other polluting emissions and thereby improve air quality.[131] In such cases, the potential benefits themselves justify the costs of the required investments, without the need to impose any constraints. The reduction of GHG emissions associated with these measures thus constitutes an additional benefit of economic or environmental decisions that are profitable in themselves—a side effect of sorts.

**"The production of biofuels like ethanol from grains is very harmful both economically and environmentally."**

While there is no doubt about the short-term cost of government constraints, it can nonetheless be economically beneficial to impose some in order to reduce GHG emissions in the long term.[132] Governmental measures can therefore be deemed useful or necessary if the benefit of reducing emissions in terms of general well-being and future economic prosperity is superior to the negative economic impact of such measures.

This is a classic cost-benefit analysis, but one that includes an appreciable degree of uncertainty. Current scientific knowledge is based on several hypotheses and models to establish estimates that are the best guidelines for the adoption of public policies. Technical—but crucial—variables included in the models are constantly being studied to specify the estimates made by scientists and economists: demographic and economic

126. Léger, "A Study of Canadian Support for Measures to Reduce Oil Consumption," Opinion poll carried out on behalf of the Montreal Economic Institute, November 2014.
127. Philippe Bourke, "Remettre les changements climatiques à l'ordre du jour," *La Presse+*, September 11, 2015; Greenpeace, *Green Is Gold: How Renewable Energy Can Save Us Money and Generate Jobs*, 2013; Pembina Institute and David Suzuki Foundation, *Climate Leadership, Economic Prosperity: Final Report on an Economic Study of Greenhouse Gas Targets and Policies for Canada*, 2009.
128. The rhetoric of green growth and low mitigation costs is criticized within the scientific community. See for example Kevin Anderson, "Duality in Climate Science," *Nature Geoscience*, October 12, 2015.
129. World Bank, *Turn Down the Heat: Confronting the New Climate Normal*, 2014, p. xviii. The IPCC also explicitly recognizes this reality. See R. K. Pachauri *et al., Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, 2014, p. v.
130. World Bank and ClimateWorks Foundation, *Climate-Smart Development: Adding Up the Benefits of Actions That Help Build Prosperity, End Poverty and Combat Climate Change*, 2014, pp. 1 and 8.
131. Johannes Bollen *et al., Co-Benefits of Climate Change Mitigation Policies: Literature Review and New Results*, OECD, Economics Department Working Papers No. 693, April 2009, p. 6.
132. This may be the case due to the temporal myopia of actors, or because GHG emissions are a negative externality. See William D. Nordhaus, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*, Yale University Press, 2015.

trends, carbon intensity, the absorption of the oceans, anthropogenic radiative forcing, equilibrium climate sensitivity, etc. The Annex to this *Research Paper* provides, for the interested reader, an overview of the uncertainty associated with the IPCC's approach and the work of economists, as well as the impact of this uncertainty on cost-benefit analyses.

Uncertainty is not a justification for inaction, though, since the estimated probability of major catastrophes in case of a large amount of warming is not zero. The prudent approach, in such a case, is to take on insurance, just as we insure ourselves against disasters that, while certainly improbable, have consequences that are terrible.[133]

Unfortunately, very few studies quantify the socio-economic harm associated with increases of more than 3°C in order to determine the costs of global warming, as shown by the IPCC's reviews.[134] And the estimates we do have are sometimes controversial. The British economist Nicholas Stern attempted to determine the costs of climate change and concluded that it would be more expensive not to act. His eponymous report,[135] however, was heavily criticized.[136] Among his critics is William D. Nordhaus of Yale University. He demonstrates that the conclusions of the Stern Report are highly dependent on certain unrealistic hypotheses like the discount rate and a specific utility function.[137] Beyond this economic jargon, Nordhaus's conclusion is that the Stern Report is too alarmist.

Nordhaus's argument is based on Richard Tol's review attempting to measure the costs and benefits of climate change in the long term. His conclusion, which is in agreement with the recent studies addressing this question, is that warming on the order of 1°C to 2°C would probably generate positive effects overall.[138] He takes into account the numerous studies attempting to show that modest global warming, of the kind we will experience from now until the end of the century, will entail among other things an increase in agricultural productivity.[139] However, he also states that the overall impact of climate change will be negative in the longer term, when the 2°C threshold is surpassed.[140] This estimate contradicts the omnipresent rhetoric, according to which every negative event is perceived as a symptom of climate change, and shows the importance of a more qualified assessment.

Given the uncertainty surrounding this question, it is likely that the debates surrounding the evaluation of the consequences of climate change will remain lively.

**"This kind of analysis generally stresses the creation of subsidized jobs, without however taking into account the jobs destroyed by the taxes that serve to finance these subsidies."**

## G. Three Principles for Sound Public Policies

Circumstances in each country influence the political debate and the solutions that are adopted. Even without proposing one-size-fits-all solutions, certain lessons can be drawn from existing experiments that could inspire the world's governments. At least three interrelated principles stem from this exercise: effectiveness, tax neutrality, and a minimal economic burden.

### The Effectiveness of GHG Reduction Policies

Among the broad range of so-called "green" policies for sustainable development or the fight against climate change, there are a number of initiatives that sometimes have only a tenuous link with the goal of reducing GHG emissions. Yet sound public policy should always be effective, and in the context of climate change, effectiveness means reducing GHG emissions.

133. Martin Weitzman, "Some Basic Economics of Climate Change," in Jean-Philippe Touffut, *Changing Climate, Changing Economy*, Edward Elgar, 2009; Robert S. Pindyck, "Climate Change Policy: What Do The Models Tell Us?" *Journal of Economic Literature*, Vol. 51, No. 3, 2013, pp. 860-872.
134. Douglas J. Arent *et al.*, "Key Economic Sectors and Services," in Christopher B. Field *et al.* (eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part A: Global and Sectoral Aspects, Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, 2014, p. 690.
135. Nicholas Stern, *The Economics of Climate Change: The Stern Review*, Cambridge University Press, 2007.
136. Martin Weitzman, "A Review of *The Stern Review on the Economics of Climate Change*," *Journal of Economic Literature*, Vol. 45, No. 3, 2007, pp. 730-724.
137. "An examination of the Review's radical revision of the economics of climate change finds, however, that it depends decisively on the assumption of a near-zero time discount rate combined with a specific utility function. The Review's unambiguous conclusions about the need for extreme immediate action will not survive the substitution of assumptions that are consistent with today's marketplace real interest rates and savings rates." William D. Nordhaus, "A Review of the 'Stern Review on the Economics of Climate Change'," *Journal of Economic Literature*, Vol. 45, No. 3, 2007, pp. 686-702.
138. Richard S. J. Tol, "The Economics Effects of Climate Change," *Journal of Economic Perspectives*, Vol. 23, No. 2, 2009; Richard S. J. Tol, *Economic Impacts of Climate Change*, Economics Department, University of Sussex, Working Paper Series, No. 75-2015, 2015.
139. *Idem*; William D. Nordhaus, *op. cit.*, footnote 132, p. 83.
140. *Op. cit.*, note 138; William D. Nordhaus, *op. cit.*, footnote 132, p. 141.

The corollary of the principle of effectiveness is that reductions should be obtained at the lowest possible cost. If better results can be achieved at the same cost, the policy that was implemented is necessarily not as efficient as it could have been.

To ensure that policies are effective, it is crucial to assess the programs and actions arising from them. Without this type of assessment, it is not possible to tell the good policies from the bad. Yet continuous policy improvement should be vital in an uncertain context in which the results of each action need to be maximized.

For politicians, though, such assessments can be a harsh test. There is sometimes a wide gap between government talk and government actions. Announcing ambitious goals costs little, but fulfilling them can sometimes be much harder if it requires going back on other promises or displeasing certain social actors. The environment and the fight against climate change are two themes about which there has been plenty of political posturing. Serious evaluations would reveal that results may fail to measure up.

## The Tax Neutrality of Measures with a Financial Impact

Governments that introduce carbon taxes or carbon markets to limit GHG emissions should avoid treating the revenue thereby generated as additional funds that are available to finance new programs. Even if the new spending is connected to fighting climate change, the revenue from carbon pricing results in poorer households and harms the competitiveness of business.

Like British Columbia's carbon tax, any financial instrument should be revenue neutral. Reductions in personal or corporate income taxes, lower social security contributions, or even an increase in refundable tax credits for low-income households are ways of keeping consumers' purchasing power from falling. In this way, tax neutrality is a way of mitigating the adverse economic impacts of these taxes, especially for the less fortunate, since energy taxes are often regressive.[141]

When governments seek to keep this revenue, we run the risk that these extra funds will be used to finance ineffective projects or to compensate companies or industrial sectors that have the ear of government, or that they will be diverted from their intended purpose. When new funds replace other spending in projects that would have existed anyway, these funds are being indirectly diverted from their goals.

## Keeping the Economic Impact to a Minimum

Reducing economic growth would be counterproductive in the fight against climate change. On the contrary, adequate resources are needed to sustain the innovations required for reducing emissions. A level of economic activity suppressed by too many rules and taxes would not generate the tax revenue that governments expect nor the corporate sales income from which R&D is financed. As we shall see in Chapter 4, economic prosperity is also a vital factor in the absolutely necessary adaptation to climate change.

**"To ensure that policies are effective, it is crucial to assess the programs and actions arising from them."**

In addition to tax neutrality, other aspects of policy should be adjusted with the aim of limiting the adverse economic impact from binding emission reductions. The simplicity of regulations, for example, provides a more straightforward way of complying and gives companies clearer rules. Complicated rules are often contested in court or are applied arbitrarily, creating uncertainty that is inimical to economic prosperity.

In the economic jargon, tax levers create "economic distortions," meaning that they alter people's decisions. In the context of carbon pricing, the aim is precisely to create a distortion, but only in the single area of GHG emissions. The potential for unwanted distortions must therefore be reduced. For example, the various sectors of the economy should be treated as equally as possible. However, this central principle bumps up against the reality of certain industries being more exposed to international competition, in particular from companies that are not subject to similar regulations, and governments do not want to see these industries disappear.

Other constraints must necessarily be considered, to abide both by the effectiveness principle and by the principle of limited economic impact. First of all, gasoline prices already consist largely of taxes, as we have seen. We also need to look at current policies elsewhere. Otherwise, an overly demanding policy will lead to carbon leakage through the relocation of high-emis-

141. Congressional Budget Office, "Trade-Offs in Allocating Allowances for $CO_2$ Emissions," Economic and budget issue brief, 2007; John Hills, *Getting the Measure of Fuel Poverty: Final Report of the Fuel Poverty Review*, CASE report 72, 2012, p. 8.

sion industrial activity. This leakage may artificially improve the emissions record of a given jurisdiction without, however, reducing emissions worldwide.

Given the need to limit distortions, and due to the constraints that exist, governments cannot very well impose a very high price on carbon. Generally speaking, a key strength of a carbon tax or carbon market is precisely that it can limit distortions other than those being sought. The simplest and least expensive emission cuts are selected by market interactions. Reduction targets do not have to be fleshed out through action plans detailing the means to be adopted in every institution and every business.

**"Tax neutrality is a way of mitigating the adverse economic impacts of these taxes, especially for the less fortunate, since energy taxes are often regressive."**

This is what makes these market mechanisms so powerful: Their effectiveness is maximized and their economic impact is minimized (although it may be high in absolute terms if the carbon price is high). When the amount of the tax is known for the years to come, for example by announcing planned annual increases in advance, it gives the various economic sectors an incentive to innovate, to invest in R&D, and to find solutions. This does not mean that companies are not doing this already. Governments are not alone in acting to meet political demands from their electors. Companies also attempt to meet the demands of their consumers, as we shall see in the next chapter.

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