CHAPTER 13

North America

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Main Messages

Policies and innovative market-based instruments are becoming more successful in improving environmental conditions in North America when they work in concert and in a political environment that allows for sound implementation. For example, the US Clean Air Act includes a cap-and-trade market mechanism to reduce sulphur dioxide (SO_2) emissions that costs less for each unit reduced than traditional environmental regulation. In addition, it is estimated that the Clean Air Act's direct benefit to human health and the environment will reach almost US$2 trillion by 2020, compared to the US$65 billion implementation cost. In Canada, Ontario's Green Energy and Green Economy Act supports a feed-in tariff that has contributed to the growth in renewable energy; wind production in Ontario, for example, increased from 15 megawatts in 2003 to more than 1 100 megawatts in 2009.

Pricing externalities and integrated land management have shown the potential to increase the sustainability of land-use practices in North America. Governments can efficiently diminish environmental impacts by paying land managers for implementing best management practices such as riparian buffers, reduced tillage and reduced fertilizer application. In the United States, taxes and other incentives have increased the total area conserved by local, state and national land trusts to almost 15 million hectares, while payment for ecosystem service programmes, such as farmland preservation programmes that bring together the various benefits to society of farmland and agricultural production, have permanently preserved another 92 million hectares. The US Conservation Reserve Program also pays farmers to withdraw land from production in order to restore soils, providing benefits estimated at US$1.3 billion per year, excluding carbon sequestration, ecosystem protection and other less easily quantified benefits.

The integrated watershed approach, in combination with technological instruments and economic incentives, has proved to be effective in addressing some complex water resource challenges in North America. Currently, the United States and Canada administer this approach through initiatives at the bi-national, regional or state/provincial levels rather than nationally. The Great Lakes and St Lawrence Cities Initiative, a cross-jurisdictional programme, has successfully increased water efficiency and reduced demand across the Great Lakes region.

Increasing renewable energy as a part of the total primary energy supply provides multiple benefits. Case studies from states and provinces in North America indicate that a comprehensive policy approach leads to rapid expansion of renewable energy production. However, development across jurisdictions has been uneven and current policy regimes are not adequate to realize the necessary paradigm shift to achieve a sustainable energy system. This shift will lead to significant reductions in greenhouse gas emissions, and increasing renewable energy production is an integral part of this transition. Research shows that by increasing renewable energy deployment globally, up to 85 per cent of all carbon dioxide (CO_2) emissions could be avoided by 2050 (IPCC 2011).

INTRODUCTION

As previously indicated, *GEO-5* shifts the GEO focus from identifying environmental problems to identifying solutions that governments can then prioritize. This chapter provides examples of a number of policy options and market mechanisms that have shown some success in improving environmental conditions in North America. They are organized by priority environmental theme and their success is related to how they may have helped to speed up the attainment of selected international environmental goals.

The priority themes and related global goals for the North American region of Canada and the United States were chosen during two regional GEO consultations (Table 13.1). In addition to the four priority issues of environmental governance, land use, freshwater and energy, this chapter also addresses the overarching theme of climate change, which is discussed within each of the four thematic sections.

Subsequently, the chapter reviews existing policy approaches, institutional arrangements and market mechanisms related to environmental and natural resources management. The aim is to identify relatively successful policy options that are currently being implemented to address each of the priority issues, and that would also address the related internationally agreed goals. To single out those with most potential to speed up the attainment of the associated goals, the resulting options were subjected to the following criteria, with policies selected if they met some, but not necessarily all, of these criteria:

- responds to, and/or reinforces or fosters interactions and synergies among the priority issues, policy options, regions and/or actors;
- has the potential for replication elsewhere;
- has the potential for scale-up;
- addresses drivers and pressures rather than end-of-pipe solutions;
- focuses on transboundary aspects of the issues and regional solutions;
- can operate as part of a cluster of policies that, if implemented together, are more beneficial than the sum of the separate policies.

Clusters of policy instruments were selected for each of the four areas, and to further refine the assessment, a select number of policies deemed to be the most successful were analysed according to their benefits and drawbacks, the perceived trade-offs of implementing them, and whether their effectiveness could be measured by any specific indicators. In addition, a number of case studies were identified to illustrate how the policies and instruments work in different contexts.

Ultimately, the policies selected are the result of the appraisal process involving a review of the literature and government data, multi-stakeholder consultations and expert opinion. Although the survey was thorough, the policy options were those that could be gleaned by this process and do not represent an exhaustive and comprehensive search; neither do they reflect relative importance compared to those that were not selected. Whether the policy would be effective in a different context and on a different scale is uncertain: for many policies, direct causal evidence of effectiveness is limited. The success of policy instruments depends on their historical, political, cultural, economic and social context. Moreover, each instrument should be evaluated relative to its environmental effectiveness across sectors; its politico-administrative effectiveness in terms of ease of environmental monitoring and validity for decision making;

Table 13.1 Priority themes and related global goals

Environmental governance	
Nusa Dua Declaration (UNEP GC 2010) Paragraph 13	We acknowledge that the advancement of the concept of a green economy in the context of sustainable development and poverty eradication can significantly address current challenges, deliver development opportunities and multiple benefits for all nations.
Johannesburg Plan of Implementation (JPOI) (WSSD 2002) Paragraph 40b	Develop and implement integrated land management and water-use plans that are based on sustainable use of renewable resources and on integrated assessments of socio-economic and environmental potential.
Freshwater	
Johannesburg Plan of Implementation (JPOI) (WSSD 2002) Paragraph 26c	Improve the efficient use of water resources and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving or restoring ecosystems and their functions, in particular in fragile environments, with human domestic, industrial and agriculture needs, including safeguarding drinking water quality.
Land use	
Johannesburg Plan of Implementation (JPOI) (WSSD 2002) Paragraph 40b	Develop and implement integrated land management and water-use plans that are based on sustainable use of renewable resources and on integrated assessments of socio-economic and environmental potential.
Energy	
Johannesburg Plan of Implementation (JPOI) (WSSD 2002) Paragraph 40b	With a sense of urgency, substantially increase the global share of renewable energy sources with the objective of increasing its contribution to the total energy supply.

Glacier-fed Portage Lake in south-central Alaska. *© Dave Hughes/iStock*

its contribution to international goals and commitments; and its political feasibility. Whether there are resources adequate to implement a policy, what policy options can be most successfully applied in each region to help accelerate achievement of internationally agreed goals, and the potential for replication, scale-up and transfer are all research questions about which few rigorous studies, if any, exist.

North America is considered a global economic leader, although changes in regional demographics, rapidly emerging global economies and resource constraints all challenge the region's provision of public goods and services. At the same time, fragmented governance, policy instability, lack of clear targets and science policy, and the dilemma of whether to address global issues rather than seeking local solutions hampers the achievement of environmental goals (Chapter 1).

Environmental governance

Environmental governance in North America is best characterized as multi-faceted, partly reflecting the nature of the federal political systems, ideological flux, evolving socio-economic constraints, and the dynamics of environmental issues as well as the knowledge associated with them. Federal governments are no longer the primary leaders in setting the policy agenda or devising innovative policy instruments, yet they remain essential to the ultimate success of those policies, help ensure harmonization across jurisdictions and prevent the development of environmental inequities. In addition, there is a strong tendency to favour market-based instruments because of early successes, and to overlook traditional regulatory instruments. Finally, relative federal disengagement has opened the door to policy initiatives and innovations at the sub-national levels of states and provinces or municipalities, as well as to regional transborder cooperation. The latter is extensive and continues to expand, and its dynamics are further supported by the Commission for Environmental Cooperation, which oversees the environmental accord of the North American Free Trade Agreement (NAFTA).

The examples of policy options on environmental governance given in the following pages are suggested as ways of helping to address these current challenges. In addition, they could help speed up the attainment of Paragraph 13 of the Nusa Dua Declaration, which proposes advancing the green economy, and of paragraph 40b of the Johannesburg Plan of Implementation, which charges decision makers to "develop and implement integrated land management and water-use plans".

Freshwater

The United States and Canada respectively contain 6 and 5 per cent of global renewable water resources, ranking third and fourth overall among nations (FAO 2011). Because of its relative high quality and abundance, water in North America is often taken for granted, although more recently there is recognition of a looming water crisis. Freshwater issues that remain a challenge in some parts of the region include droughts and floods (Cayan *et al.* 2010; Easterling 2000), eutrophication (Smith *et al.* 2006), dams and river fragmentation (Chapter 4), saltwater intrusion (Barlow and Reichard 2010), contamination caused by hydraulic fracturing for natural gas extraction (Kargbo *et al.* 2010), non-point source pollution from agricultural (Ritter and Shirmohammadi 2001; Novotny 1999) and urban run-off (NRC 2008). Climate change may exacerbate these problems by altering both water supply and demand (Vörösmarty *et al.* 2010, 2000; Bates *et al.* 2008).

Since freshwater provides ecosystem services that are central to human health, it is critical to ensure a continued good-quality supply. This chapter provides a number of policy options to illustrate ways of speeding up the achievement of Paragraph 26c of the Johannesburg Plan of Implementation, which stipulates that the efficient use of water resources is to be improved and human needs and ecosystem requirements balanced.

Land use

Land use is a priority issue in North America because it presents both significant environmental concerns and great potential for sustainable development. The natural resource and agricultural sectors contribute significantly to employment and wealth generation; for example, more than 2 million people in the United States work in or support the forestry and agriculture industries (BLS 2011), and in Canada, gross domestic product (GDP) for agriculture, forestry, fishing and hunting totalled US$24.7 billion in 2010 (Industry Canada 2011). In addition, citizen engagement and people's high level of attachment to natural areas have moved land use up on the political agenda. These and other factors, such as fossil fuel extraction and urban development, apply significant pressure on land, often resulting in conflicts over its use. Policy options addressing

land use are suggested to help improve progress towards Paragraph 40b of the Johannesburg Plan of Implementation, which urges the development and implementation of integrated land management and water-use plans so as to use renewable resources more sustainably.

Energy

The international goal of urgently increasing renewable energy resources as a part of the total energy supply (Johannesburg Plan of Implementation, Paragraph 20e) was selected to address multiple challenges associated with the current energy system. These challenges include the contribution of fossil fuel combustion to climate change, elevated water consumption and air pollution. However, renewable energy also presents opportunities for sustainable development through increased employment and economic activity and is a necessary element in the transition to a green, sustainable economy. In addition, the processes required for site generation and transmission facilities present opportunities for increasing transparency and cross-agency cooperation, and would also benefit environmental governance and land use. Although the pace of change is still slow, the policy options for increasing renewable energy are examples of current tools applied in North America to speed up the transition to a sustainable energy system.

POLICY APPRAISAL

Environmental governance

North America has used a variety of policy approaches to environmental governance, beginning with regulatory policies, then gradually developing market mechanisms, complemented by measures designed to improve accountability and transparency. The region was a pioneer in cross-border governance, which dates back at least to the 1909 Boundary Waters Treaty, and in developing international environmental law and national parks, including cross-border parks. In the last 20 years, this governance has deepened cross-border ties through the creation of the Conference of New England Governors/Eastern Canadian Premiers on climate change and the Commission for Environmental Cooperation (CEC 2011; Johnson and Beaulieu 1996), and by reinforcing cooperation between provinces and states in managing the Great Lakes and St Lawrence River (Box 13.5), as well as on a variety of other issues, notably protection of waterbirds and sea mammals. The Georgia Basin/Puget Sound International Airshed Strategy in British Columbia and Washington State, for example, is currently the most active bilateral arrangement regarding air quality (Environment Canada 2011). For their part, the proposed creation of watershed boards across the entire Canadian/US border would represent a major leap in the International Joint Commission's regulatory potential (Schwartz 2006). Canada and the United States have also established several jointly protected areas that further harmonize policies.

North America has pioneered the use of many market instruments, now being used with increasing frequency, and there is evidence that some have succeeded in changing behaviour. Command-and-control mechanisms, however, still form the backbone of environmental policy. Because of recent improvements in measures designed to foster accountability and transparency, these increasingly used instruments strengthen the effectiveness of both market instruments and command-and-control mechanisms. Rarely are any of these used exclusively to address a particular environmental issue; it is more common to see a variety of instruments applied. For example, to address littering, many North American municipalities and states or provinces have laws that require a deposit on bottles and cans. This deposit provides a financial incentive – a market instrument – to return the items for recycling. In conjunction, bottles and cans in certain states must clearly display a recycling logo representing the type of material used and providing easy-to-understand and transparent information about recycling. Finally, various regions have banned the inclusion of bottles and cans in solid waste – a command-and-control form of regulation.

Market mechanisms

Market instruments have been used to address a variety of environmental issues in North America. The most recent have targeted air quality and climate change and include an acid rain reduction programme, a greenhouse gas emissions trading programme in the northeastern states and eastern provinces, and a carbon tax in Quebec (2007) and British Columbia (2008) (Box 13.1). Payment for ecosystem services is also gaining wider attention, although such schemes remain limited.

In 1995, the United States instituted a cap-and-trade emissions programme, stemming from amendments to the 1990 Clean Air Act (under Title IV), to reduce sulphur dioxide (SO_2) emissions, the major industrial pollutant responsible for acid rain. This programme is widely credited with reducing sulphur dioxide emissions more cheaply than traditional environmental regulation.

Montreal Metro entrance. In 2007, Quebec became Canada's first province to charge a carbon tax which is being directed towards energy-saving initiatives such as improvements to public transit. *© aetb/iStock*

Box 13.1 The Quebec and British Columbia carbon taxes

In 2007, Quebec became the first North American state or province to introduce a carbon tax. Energy companies are required to pay 0.8 cents for each litre of petrol distributed in Quebec and 0.938 cents for each litre of diesel fuel. Compared to other jurisdictions, however, this tax rate is very low. The revenue-neutral carbon tax in place in British Columbia since 2008 is much more ambitious. Rate increases were phased in, starting at a modest US$10 per tonne of CO_2-equivalent in 2008 and then increasing at a rate of US$5 a year to US$30 a tonne in 2012. The tax's revenue neutrality is achieved by allowing tax reductions for businesses as well as tax reductions for and payments to poorer sections of society. The comprehensive tax applies to all emissions from fossil fuels, accounting for approximately 70 per cent of the province's total emissions. Emissions from fossil fuels exported from British Columbia to other jurisdictions are exempt. In 2010, the tax began to apply to biodiesel as well (BC Ministry of Finance 2008). The new tax did not seem to have significant political repercussions – the provincial party that introduced it was re-elected.

Addressing drawbacks typically associated with carbon taxes may have enhanced its acceptability. This includes mitigating or eliminating the potentially regressive nature of carbon taxation (Metcalf and Weisbach 2008), with comprehensive coverage combined with targeted tax reductions, and reducing potentially large adaptation costs for carbon-intensive industries through a gradual phase-in of the tax (Nordhaus 2010).

Early projections of the average cost for the first phase of the programme ranged from a high of US$307 per tonne of sulphur dioxide removed to US$180 per tonne (1995 dollars). Ellerman *et al.* (2000) estimated that the actual costs were closer to the low end of the projections, in the range of US$186–210 per tonne. In addition, a 2011 US Environmental Protection Agency (EPA) review of the direct benefits to human health and the environment of the Clean Air Act estimates that these will reach almost US$2 trillion by 2020 while implementation costs are US$65 billion – a benefit-cost ratio of 30:1. This was probably due to the flexibility afforded to producers to find low-cost compliance measures, although other factors such as unanticipated technical improvements, lower transport costs and increases in coal production and use efficiencies also played important roles (Chestnut and Mills 2005). Although the costs of many regulatory programmes tend to be overestimated while they are being developed, recent research found that this has been especially the case for market-based programmes (Harrington *et al.* 2008).

The success of the sulphur dioxide trading programme has in part prompted several jurisdictions in Canada to increase the use of market-based instruments. As of 2007, the Alberta greenhouse gas emissions trading system, for example, requires large industrial emitters that have been established more than eight years to reduce the intensity of greenhouse gas emissions by 12 per cent per year relative to a 2003–2005 baseline (Can LII 2011), and purchase carbon offsets or else pay a tax of US$15 per tonne of CO_2-equivalent. While the programme may result in reduced emissions compared to the business-as-usual alternative, it has been heavily criticised for permitting overall increases in carbon emissions by only targeting emissions intensity. In this sense it is not a typical cap-and-trade programme.

A less developed scheme, but one that is emblematic of the readiness of some states and provinces to compensate for perceived federal inaction, is the Western Climate Initiative, which combines seven US states and four Canadian provinces. This has been working since 2007 to develop policies to address climate change, including a regional, economy-wide cap-and-trade programme and forest offset mechanisms (Anderson *et al.* 2010). Only some of the initiative's members – California, Quebec and British Columbia – are currently taking preparatory steps towards implementing this programme in 2012.

Water trading between Canada and the United States and efforts to allocate water efficiently and equitably among various users have triggered considerable political controversy, even before the United Nations acknowledged access to clean water and sanitation as a fundamental human right in 2010. Trading water rights, from farms to cities, for example, can be viewed as making farmland unproductive and favouring urban dwellers over rural residents. In addition, many civil society organizations see the privatization of some water rights as incompatible with the principle of universal and equal access to water.

Water markets, or transferrable water rights, are generally most developed in regions where water allocation is based on first-in-time, first-in-right or the doctrine of prior appropriation (Kenney 2005). In the United States, water markets are prevalent in the arid western states, and in Canada, water trading occurs in Alberta and to a lesser extent in British Columbia and the Territories. The benefits of water trading include the reallocation of water from lower- to higher-value economic uses or from areas where the marginal value is low to where it is high. For instance, where urban users pay much higher rates for water than do rural and agricultural users, trading makes both water buyers and sellers better off economically. There are numerous drawbacks, however. For example, the market value of water may not correspond to its *in situ* environmental value. Moreover, the impact on local water may be externalized to third parties, including changes to the local economy and environmental effects from reduced local water availability (Hanak 2003). Other drawbacks pertain to the very principle promoted by some groups that water should remain a public good and therefore should

not be commoditized and traded for profit, the ability of private parties to monopolize the water resources market, and the distortion of the water trading market due to substantial water subsidies for the agricultural sector.

Subsidies and tariffs for clean energy, agricultural production and industrial goods can facilitate the adoption of new, less polluting technologies or projects that enhance energy conservation. Subsidies for installing water-efficient fixtures or the California subsidy programme on residential solar installation, which encourages distributed electrical generation as well as emission-free power production, are two such examples. The Ontario Feed-in Tariff programme, enabled by the 2009 Green Energy and Green Economy Act (Box 13.2), offers stable prices for energy provided by renewable sources and supports Ontario's objective to phase out coal-fired electricity generation by 2014. This programme has contributed to greater reliance on renewable energy sources in Ontario, such as wind power, which increased from 15 megawatts in 2003 to more than 1 100 megawatts in 2009 (Government of Ontario 2009).

While subsidies may help promote technological change, they have also been criticized for increasing the risk of pollution, encouraging overconsumption, and fostering the rapid depletion of natural resources (ten Brink 2011). Agricultural subsidies have come under the greatest scrutiny not only because of their pervasive environmental effects on land use, but also for their negative impact on the agricultural sector and exports of developing countries. Both Canada and the United States also continue to provide large subsidies for the production of non-renewable energy, often in the form of low tax rates for capital investment (Kenny *et al.* 2011; Congressional Budget Office 2005), despite the commitment to the contrary made by the G20 economies in 2009 in Pittsburgh (G20 2009). While some potentially environmentally harmful subsidies may have social or other worthwhile objectives, many may not be equitable, may no longer fulfil their original purpose, or may have unintended outcomes as a result of market distortions. There are many instances where subsidies have either directly or indirectly distorted the market or caused unintended consequences: for example, declining block rate structures for water use, where marginal costs decrease as a function of the total amount of water used, encourage overconsumption.

Payment for ecosystem services, which in one form or another has been used for years but has lately triggered considerable renewed interest, is designed to safeguard or increase the provision of an ecosystem service for which there is high demand but currently no market mechanism. The US Conservation Reserve Program, which provides continuous direct payments to farmers for withdrawing land from production and engaging in soil restoration, is a long-standing and successful example. The US Economic Research Service (ERS) conservatively estimates the programme's benefits to be US$1.3 billion per year, excluding carbon sequestration, ecosystem protection and other less easily quantified benefits (Hellerstein 2010). Other significant ecological benefits include the reversal of landscape fragmentation, maintenance of regional biodiversity, creation

Box 13.2 Ontario: a comprehensive approach to energy

The provincial energy system in Ontario has undergone a number of reforms in the last 30 years. The province had a vertically integrated monopoly until the mid-1990s, but in 1998 moved towards a more market-based model. In 2004, policies were again revised and a hybrid model put in place, in which overall system planning was under one agency; nonetheless, the direction was still towards a market-based model. During this same period, major interruptions occurred with the infrastructure, including the overhaul of seven of 20 nuclear power plants, leading to increased use of coal-fired generation, resulting in major emissions increases with concerns over both the health effects and greenhouse gases. In turn, these concerns led to political pressure and in 2004 the province decided to phase out coal generation as part of a strategy to address climate change and reduce the human impacts and health-care costs of air pollution (Winfield *et al.* 2010).

To achieve the goal, Ontario implemented a variety of conservation and renewable energy initiatives, including the Green Energy and Green Economy Act, a broad-based instrument that enabled the province to implement a comprehensive system of renewable energy feed-in tariffs in 2009. The Ontario feed-in tariff programme provides stable long-term contracts and generation prices specifically tailored for wind, solar, micro-hydro and biomass projects. It also provides a consolidated siting authority, smart grid provisions and additional benefits to attract community energy initiatives and First Nations involvement. The act provided the comprehensive package of policies that created incentives, stimulated new methods to move energy to markets and streamlined the project permission process.

The results of the Green Energy and Green Economy Act have been impressive. The Ontario Power Authority has received supply applications for the production of 10.4 gigawatts of wind power and 6.7 gigawatts of solar photovolatic power; by 2011, there were approximately 3.0 gigawatts of renewable electric power under contract. The provincial power authority also estimated that the renewable energy sector had created 13 000 direct and indirect jobs through the most recent contracts awarded (Mabee *et al.* 2012). The Ontario model is currently being considered in other Canadian provinces including British Columbia and Nova Scotia (Yatchew and Baziliauskas 2011; Ontario Ministry of Energy 2010; Power Authority of Ontario 2010).

of wildlife habitat and favourable changes in regional carbon flux (Gleason *et al.* 2008; Haufler 2005; Dunn *et al.* 1993). The Environmental Quality Incentives Program and the Conservation Security Program of 2002 are two more recent and wide-ranging programmes that seek to reward farmers for sound land management from a multi-functionality perspective. For the same budgetary outlay, the ERS found that environmental performance could improve 12-fold, including an estimated 17 per cent reduction in soil erosion – saving about 36 million tonnes of soil valued at about US$2 per tonne, although the value of reducing sheet and rill erosion alone could be as high as US$332 million when in-stream sediment decreases are included. In addition, nitrogen leaching declined by 14 per cent, nitrogen run-off by 13 per cent, phosphorus run-off by 15 per cent, soil productivity losses by more than 300 per cent, wind erosion by 21 per cent, carbon emissions by 7 per cent, pesticide leaching by 9 per cent, and pesticide run-off by 7 per cent (Cattaneo *et al.* 2005). The US Department of Agriculture has formed an Office of Environmental Markets (previously the Office of Ecosystem Services and Markets formed in 2008) to create guidelines for developing these kinds of market-based policies (USDA 2011).

In Canada, continuous direct payment programmes based on a multi-functionality approach remain uncommon. Some provinces are already using payment for ecosystem services to make it more attractive for farmers to maintain stream habitats, while at the national level efforts are under way to find approaches for comparing the value of services provided by forests (Anderson *et al.* 2010). The implementation of such schemes faces numerous methodological, political and ethical challenges as well as capacity, cost and time constraints, and their long-term impact is still unclear. In general, payment for ecosystem services needs to be complemented with land-use planning frameworks to be effective (Calbick *et al.* 2003).

One innovative and promising economic approach aims to reduce the financial risk of switching to more environmentally sound practices and does not necessarily involve any payment. For instance, in the Canadian province of Prince Edward Island, farmers were offered insurance against the perceived risk that reducing fertilizer use might also reduce yields. In the majority of cases, no payment was needed since reducing fertilizer use did not reduce yields: this was because fertilizer use was already so high that using less had little effect (Cheverie 2009).

Command-and-control mechanisms

The use of public authority to preserve a given resource has a long and successful history. Changing private ownership to public or government ownership and a state-controlled protective regime can eliminate incentives to appropriate the benefits of overexploitation. Indeed, North America pioneered the establishment of the first national parks. This strategy presupposes extensive political and administrative enforcement of the status of these resources, which is more readily available in highly developed economies. Although its effectiveness remains to be seen, the Quebec Water Law of 2009, which considers water a common heritage of the Québécois nation, is a recent and noteworthy example of this type of instrument (Government of Quebec 2009).

Command-and-control mechanisms are often preferred when there are significant threats to human health, when a specific requirement needs to be monitored and enforced, when absolutely no additional environmental harm is permitted, and when simplicity and consistency are desired. In practice, market-based and command-and-control style regulations are often combined to meet an environmental objective. The ban on leaded petrol in the United States, for example, was accompanied by a trading mechanism during the phase-out period so that refineries could meet the declining production allowance in a cost-effective manner.

Although such instruments have become politically challenging to put together, particularly in the United States, there are several noteworthy examples of their successful use, such as standards for drinking water, clean air, toxic chemical releases and fuel; various types of prohibitions including on littering and the introduction of invasive alien species; and requirements on recycling, for example. Canada has the authority to regulate toxic substances, several fuels including diesel and petrol, and a number of fuel quality parameters, including sulphur levels. Greenhouse gas and air pollution regulations have also been implemented in Canada and the United States for new vehicles and engines. With regard to air quality control more generally, Canada monitors and regulates air pollutants through the Canadian Environmental Protection Act and has established National Ambient Air Quality Objectives, although air quality remains the primary responsibility of provinces. In the United States, the Corporate Average Fuel Economy (CAFE) standard regulates the fuel economy of new light-duty vehicles.

One of the drawbacks of these instruments is their weak resilience. When regulations induce changes in behaviour, such as when penalties for failure to obey them are high enough,

Bicycle commuters in San Francisco, California. *© Can Balcioglu/iStock*

these changes usually depend on the continuous enforcement of regulations. Many governments at various levels have tried to green their operations, but the results have often been disappointing and have remained limited as long as they were perceived as top-down mandates and did not change the incentive structure. However, the positive experience of the US Forest Service since 2008, which sought to instil not only a conservation ethic but also a consumption ethic by changing organizational incentives and promoting bottom-up efforts, is instructive in this regard (Jones-Crabtree *et al.* 2008).

Accountability and transparency

Policy instruments designed to increase accountability and transparency seek to make information on environmental performance and the environmental impacts of resource use more widely available to facilitate decision making as well as mobilize a variety of stakeholders. Certainly the best known and most widely disseminated of these policy tools is the requirement for environmental impact assessments, which, when first included in the 1969 US National Environmental Policy Act, mandated preliminary interdisciplinary assessments of the likely environmental impacts of major federal projects (Hironaka 2002). It required US federal officials to include environmental values in a federal decision-making process dominated by technical and economic, if not political, considerations. An environmental impact assessment also requires the identification and evaluation of reasonable alternatives to a proposed federal action, as well as input from concerned stakeholders. Canada adopted its own act in 1992, following previous provincial initiatives. This has since evolved considerably, notably in terms of its target, which goes beyond federal and even publicly funded projects, but also in terms of its scope, with the introduction of sectoral and strategic assessments, and methods that include social variables. Although often criticized for its cost, the delays it can cause, and for ignoring the value of not doing anything at all (null decision), it remains one of the most effective tools for making sounder environmental decisions as well as improving participation.

The requirement to report on polluting emissions is another example of information dissemination that can become an effective policy tool. Canada has a National Pollutant Release Inventory and has implemented a Greenhouse Gas Emissions Reporting Program, while in the United States the EPA requires the reporting of greenhouse gas data and other relevant information from large sources and suppliers. This reporting is now required in 19 US states, and companies will need to report federally on their 2010 emissions in 2011. The US Toxics Release Inventory programme provides stakeholders with information about chemical releases for better decision making. The drawbacks of such instruments include the limited effectiveness of relying on blame-and-shame alone when inventory requirements are not tied to specific obligations. Thus, this instrument is best seen as a complement to market-based or command-and-control approaches.

Providing basic information on the environmental impact of individual citizen behaviour is another useful policy instrument.

A healthy male Peary caribou — listed by COSEWIC as being endangered — stands on guard in the High Arctic. *© Paul Loewen/iStock*

The US EPA and Department of Energy instituted the EnergyStar labelling programme to recognize appliances that perform at or above category benchmarks for energy efficiency. It confers a simple efficiency label to a product, but not detailed information about its energy consumption or the anticipated operating costs. The benefits include its simplicity, which led to the rapid improvement of product efficiency by manufacturers who wanted to qualify for the EnergyStar label (Howarth *et al.* 2000). In addition, the creation of third-party advisory bodies has proved useful in balancing the needs of science and politics, and provides a means of enhancing policy resilience, that is, the capacity of given policy objectives and means to persist in the face of external challenges. Nationally, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), where federal and provincial bodies work together with private ones to diagnose problems and recommend action, has protected wildlife conservation from the vagaries of political cycles.

North America has also pioneered the institutionalization of public participation, which helps increase the likelihood of a policy's implementation. Examples include the Great Lakes agreements (Box 13.5), the Commission for Environmental Cooperation's process of citizen submission on enforcement matters, and environmental public hearings, as through Quebec's Environmental Public Hearing Office. Specifically, Articles 14 and 15 of the North American Agreement on Environmental Cooperation (NAAEC) provide a non-adversarial process that allows citizens to file assertions that a Party of the NAAEC (Canada, Mexico or the United States) is failing to enforce its environmental law effectively. In some cases, this process can lead to a record. Political checks and declining funding for the Commission for Environmental Cooperation, which had held constant over the years, have however threatened its effectiveness.

A noteworthy development, reflecting a trend seen in other countries, has been the use of the Office of the Auditor General to evaluate and publicize the degree of implementation of national or sub-national commitments. Canada created a Commissioner of the Environment and Sustainable Development in 1995, and Quebec followed suit in 2006, with both enjoying a fair degree of autonomy. This role will be enhanced by the recent adoption of various sustainable development strategies, both at the federal and provincial/state levels, aiming to make environmental decision making more transparent and accountable. It is too early to assess effectiveness, however, and the lack of uniform sustainable development indicators hampers comparisons between the approaches adopted.

The acceptability, nature and effectiveness of various policy instruments depend on a number of internal and external factors that vary from state to state, province to province and region to region. In the end, successful policies rely on a mix of instruments and incentives. Although market approaches have raised considerable interest and have proved to be efficient in some cases, the enduring value of traditional command-and-control regulation, associated with disclosure requirements, has been most effective in changing the behaviour of major polluters (Harrison and Antweiler 2003).

Land use

One of the most important obstacles to sustainable land use in North America remains the fragmentary nature of land management. Forests, rangelands, croplands and urban, suburban and peri-urban lands are all part of the same landscape mosaic from which people derive survival and quality of life. Often, activities within one land type affect the state of others, as well as other ecosystem services such as air and water quality. Such impacts are often referred to as externalities, as the true costs and benefits of the impact are borne by parties external to the those who control and benefit from the activity. Even within a given land-use type, management responsibilities can be dispersed across several distinct bodies according to the type of activity taking place or to the component that is under consideration – water, fish and wildlife, fossil fuels or recreation, amongst others. In forest planning, for example, forestry, oil and gas, recreation, and the provision of ecosystem services are often managed by entirely separate bodies, even though all activities take place within the forest.

In North America, many land-use policies are gaining support and are now considered to be highly effective in motivating sustainable land use. These policy options work in tandem, providing informational and functional support to achieve the desired goals. This section discusses three policy clusters that have been demonstrated in reality or suggested in theory to be the most promising to coordinate land management and promote sustainable resource use and social, economic and environmental harmonization in North America. These policy clusters are:

- implementing integrated land management plans to encourage and enable sustainable resource use;
- incorporating the true costs and benefits of ecosystem services when developing policy mechanisms; and
- improving planning for and sustainability of public lands.

Implementing integrated land management plans

To speed up achievement of the international goal of sustainably developing and using land in North America, integrated planning is crucial, requiring policies with clear agreed goals and specific targets. Land-use policies need to be set at the appropriate geographic scale – state, province, county and city level – although watersheds or other ecologically relevant geographic scales may be the most logical units for determining a resource-use sustainability plan. Specific targets should be set to obtain the highest benefits for the least social and economic costs. Institutional barriers such as centralized yet fragmented governmental structures should be overcome to allow a regional emphasis, and stakeholders should be allowed to participate in spatial planning. Both regulatory and incentive-based policies can be enacted to encourage target attainment. These policies should motivate individuals and corporations to act in accordance with the established plans. In addition, policies should be developed to encourage the resource sectors to maintain and enhance ecosystem resilience for future generations as well as limit the erosion of ecosystem services.

Jurisdictions throughout North America have adopted many of these policy instruments, to different degrees. For example, in British Columbia, resource companies, environmental groups and coastal First Nations have successfully carried out an ecosystem-based integrated land-use planning exercise, the 2006 Great Bear Forest Agreements, through a collaborative process (McGee *et al.* 2010), although the recent economic downturn has made financing participatory and multi-agency programmes more difficult for state/provincial and local governments. As fiscal issues may become more challenging in the near future, creative financing and regulatory measures coupled with financial incentives could become more important. At the same time, agencies will have more time to develop plans as the pace of industrial, commercial and housing development slows. Planning today may have long-reaching impacts as the economy returns to normal.

States, provinces, counties and cities have taken action to encourage smarter land use through innovative policy mechanisms. These initiatives address many of the challenges related to an optimal land-use pattern while respecting property rights, the need for equity and low-income housing, employment concerns, resource protection and environmental issues. For example, in the United States, the State of Maryland uses a series of incentives in its Smart Growth programme (Box 13.3). The programme rewards people for relocating close to their place of employment, capitalizes on state money for infrastructure by providing it only within planned growth areas (priority funding areas), targets conservation funding to contiguous land and high-conservation-value land within clearly identified Rural Legacy areas, and subsidizes urban redevelopment through its brownfield redevelopment programme. Smart Growth focuses

Vancouver's Sky Train, a light-rail rapid public transit system, contributes towards the achievement of British Columbia's ambitious greenhouse gas reduction targets. *© Wade Jabbour*

on long-term regional considerations of sustainability, valuing community, public transport, employment and housing choices, preserving natural resources and promoting equity.

Similarly in Canada, the Province of Ontario has developed a greenbelt around the City of Toronto (Box 13.4) and protected open space and working lands from further conversion through zoning regulations. Agricultural retention can have economic, cultural and amenity benefits as well as environmental ones. British Columbia has designated an Agricultural Reserve, while Vancouver promotes development near its Sky Train stations. Rather than continue investments in roads and highways that promote an automobile culture, metropolitan areas like Toronto and Vancouver are focusing scarce investment on public transport and transit-oriented development with multiple benefits.

Incorporating the value of ecosystem services in private sector decision making

Market mechanisms, financial incentives and regulatory approaches have moved people to adopt better land-use practices. However, policies intended to benefit society can have unintended consequences. They often require the conversion of forests, grasslands and wetlands to other uses, which results in loss of habitat and biodiversity, impaired water quality, increased flooding, eroded soils and loss of resource-based industries and employment. Governments can help diminish such environmental effects through a number of policy initiatives. The most efficient and least controversial remains the establishment of mechanisms through which users of an ecosystem service, such as water quality, who are willing to pay for the service, compensate land managers for implementing best management practices such as riparian buffers, reduced tillage and reduced fertilizer applications. Taxes and other incentives in the United States have increased the total area conserved by local, state and national land trusts to almost 15 million hectares. Payment for ecosystem service programmes, such as working lands (agricultural and forest) preservation programmes that bring together the various economic and ecological benefits that these lands provide to society, have permanently preserved another 92 million hectares in the United States.

Cap-and-trade systems, such as the one in place for wetlands in the United States (Spieles 2005), can also be established when the users of the ecosystem services are dispersed or even do not yet exist, as in the case of acting in the interests of future generations. Caps need to be established, as in the case of the policy of no net loss of wetlands in the US Clean Water Act, and the magnitude and nature of compensation needs to be determined. While requiring considerable resources of time and effort to establish and implement, the pay-off from a societal point of view is that the market is then able to determine the most efficient means of respecting the cap through a system of trading (Yamasaki *et al.* 2010; Salzman 2005). In the more than 500 wetlands mitigation banking schemes that generate US$3 billion dollars, and the more than 110 habitat banks generating US$370 million in the United States (Madsen *et al.* 2010), land developers include the cost of wetland mitigation when pricing potential land acquisitions. They understand that purchasing land with wetlands will cost more in the end than land without them; either they protect the wetland or are required to restore wetlands elsewhere. Governments can implement programmes to encourage wetland restoration projects that developers can pay for and use to mitigate any wetlands destroyed in their own development projects.

Where potential projects are too fragmented, as is often the case with conservation on working lands, and markets for environmental payments run the risk of remaining excessively

Suburban sprawl outside Austin, Texas. *© Jodi Jacobson/iStock*

thin, governments can opt for more direct financial intervention, such as the Conservation Reserve Program in the United States (as mentioned in the section on market mechanisms, above), under which landowners enter into contracts with the government to implement best management or conservation practices to achieve environmental goals.

Improving sustainability on public lands

In both Canada and the United States, which are endowed with diverse and abundant land resources, the government owns a substantial amount of that land: 89 per cent of the land mass in Canada and 35–40 per cent of it in the United States. While human capital in both countries remains a tremendous asset, many economic sectors continue to generate wealth through natural resource use. Therefore, federal government policies on its own land can have a large impact.

In the United States, principles of multiple use and sustained yield dominated for many years, then in 1993 President Clinton established a goal of achieving sustainable forest management of all US forests by the year 2000. And in 1995, through the Montreal Process and the Santiago Declaration, the United States committed to a process of developing and evaluating national indicators of sustainable forest management. As a result, during the passage of the Federal Ecosystem Management Initiative, its emphasis shifted to ecosystem management with plans focused on long-term sustainability rather than on management to maximize short-term yield (Cortner and Moote 1999; Yaffee *et al.* 1996). However, planning has proven problematic and litigious, and recently, a revised planning rule has been proposed for the nation's public lands. The latest planning rule under consideration stresses the restoration and maintenance of forests and grasslands; the protection of water quality and ecological integrity of riparian areas; habitat provision for plant and animal diversity and species conservation; multiple uses including recreation and industrial applications; public involvement in the planning process including community consultation and all levels of government entities; the use of the best available scientific information to inform the planning process; and the development of a more efficient and adaptive land management planning process (USDA 2012).

While the planning rule is being revised, some groups argue that, instead of a governmental planning approach to help the forest, some type of certification processes for land and management practices should be implemented. Examples of such processes include those used by non-governmental groups including the Forest Stewardship Council and the Marine Stewardship Council's fisheries certification programme (Glickman 2008). Indeed, the province of Quebec's revised Forest Act, which sets the stage for integrated land management with significantly increased responsibilities at the regional level, legislates for wood products from all public forests to be eco-certified by 2013.

Public-private partnerships have become increasingly important as current government funds and staffing are inadequate to assess resources, coordinate sustainable management, and accommodate the increasing demands of multiple users. Public-private partnerships are difficult to foster unless sufficient motivation exists on all sides, as within federal agencies and among their staff, long-term traditions can be difficult to alter without appropriate changes to incentives and reward structures.

Case studies on innovative land-use policies

The policies, underlying conditions and case studies presented here demonstrate that multiple policy instruments can speed up efforts to achieve the internationally agreed goal of implementing integrated land management and water-use plans to ensure the sustainable use of renewable resources (Johannesburg Plan of Implementation Paragraph 40b). In the case of the State of Maryland (Box 13.3), policies leveraged the state's funds to encourage built infrastructure in planned priority areas while providing incentives to create new jobs and develop brownfield sites within the same areas. The planning process involved local communities and used incentives to encourage voluntary participation to achieve the plan's goals, ensuring that it was politically palatable and thus likely to be successful. While encouraging development in and near cities, Maryland also protected valuable resource-rich land from conversion through permanent conservation easements.

In the case of Ontario and British Columbia (Box 13.4), their governments passed regulatory measures to protect environmentally sensitive and working lands while encouraging transit-oriented development within the cities. From a policy perspective, environmentally sensitive and working lands are lumped together, and farming and environmental communities have joined forces on these issues – one of the reasons for so much support for conservation programmes. Conservation practices can be adopted to retain topsoil and prevent erosion

Box 13.3 Maryland's Smart Growth programme: financial incentives and planning

Maryland's Smart Growth programme targets state resources to support development in areas where infrastructure already exists and to avoid the high cost of building infrastructure far from traditional population centres. Priority funding areas are identified within existing communities and other areas where local county and town governments want state investment to support growth and development (Sartori *et al.* 2011; Lewis *et al.* 2009). This approach capitalizes on the influence of state expenditure on economic growth and development. Development is more likely to occur in these planned areas, slowing the conversion of resource-rich land.

In addition, Smart Growth helps protect valuable natural resources, purchasing land and easements in designated Rural Legacy areas that have been selected based on the extent of the development threat and the value of their agricultural, forestry and natural resources. These areas attract both Rural Legacy dollars and money from other preservation and conservation programmes (Lynch and Liu 2007), leading to more contiguous and environmentally beneficial preservation, including retention of interior forests (blocks of trees away from non-forest land or roads), wildlife habitat, groundwater recharge and wetland preservation, as well as agricultural and other productive resource use.

Three additional incentive programmes reward the redevelopment of brownfield sites (Howland 2010), businesses that create jobs in priority funding areas, and citizens who move to live near their place of work. Johns Hopkins University, for example, worked with Baltimore City and the State of Maryland to offer cash grants ranging from US$2 500 to US$17 000 to help university employees buy homes in targeted areas around its campuses (Wiewel and Knaap 2005).

on environmentally sensitive land; wetland protection can be implemented; and streams can be fenced and animals kept out. In many cases, agriculture-related programmes are relatively successful in achieving environmental protection because the opportunity costs to landowners are much lower than for land put to other uses. Programme developers have also come to understand that environmental attributes are often devalued in land markets and have developed new compensation schemes with environmentally sensitive features that benefit landowners. While the use of financial incentives and subsidies differs from regulatory measures, all of these, alone and in combination, can play important roles in addressing land-use issues. Concerns about property rights should be evaluated and addressed. For each policy, decision makers should consider the implied property rights in the existing market structure and how a particular policy will alter this. Regardless of the policy path chosen, cultivating and developing widespread public support and a willingness to plan is essential to the success of any of these policies.

Box 13.4 Canadian land-use reserves in Ontario and British Columbia: command and control

Ontario and British Columbia have protected rural and working lands surrounding major cities through regulatory measures. British Columbia established the Agricultural Land Reserve system, under which agriculture and forestry are the priority uses, and non-agricultural uses are controlled (Cavendish-Palmer 2008; Hanna 1997). The system covers approximately 4.7 million hectares. While it is criticized for not compensating farmland owners sufficiently for the alteration in rights, it has been defended on the grounds that it effectively provides food security and controls urban and peri-urban expansion.

The Ontario Greenbelt protects green space, farmland, forests, wetlands and watersheds around one of Canada's most populated and rapidly growing areas (Ali 2008; Feung and Conway 2007; Taylor *et al.* 2005). It encompasses 730 000 hectares in which limited agricultural uses are permitted, includes environmentally sensitive land and a major aquifer, and contains a UNESCO Biosphere Reserve, the Niagara Escarpment (Cavendish-Palmer 2008; Hanna 1997).

Cross-cutting issues

Implementing the selected land-use policies can provide a number of benefits to support the energy, freshwater and governance goals. Integrated land management may lead to policies that provide co-benefits, such as improving water availability and quality by reducing run-off. This form of planning may also help to identify areas that are most acceptable and best suited for the development of renewable energy, thereby decreasing uncertainty for projects and accelerating implementation. Integrated land management, if it leads to the maintenance of vegetation on a landscape, will also help attain international goals related to climate change.

Freshwater

It is critical to the appropriate use and allocation of freshwater resources that policy instruments designed to meet basic human water needs, as well as water requirements for the production of food and energy, are balanced with the need to maintain other ecosystem services. Three clusters of key policy options identified for North America are integrated watershed management, full-cost pricing and technological solutions.

Integrated watershed management

Integrated watershed planning and management can be applied in combination with other water management measures and has become an indispensible instrument for improving water resources. It is an holistic approach to managing water within drainage areas. This approach is consistent with the broader concept of integrated water resources management discussed in Chapter 4 and aims to achieve optimal and sustainable water availability that will improve human quality of life while maintaining environmental integrity for all species. Integrated watershed planning and management has proved effective in addressing some complex challenges over the last few decades (Heathcote 2009). The method recognizes that water issues cannot be addressed independently but require the balanced consideration of all environmental, social, economic and technical aspects. It may include goals such as flood prevention, enhancement of aquatic habitat and biodiversity, reduction in the loss and degradation of wetlands, pollution control and economic growth. The success of programmes can be assessed through water quality indicators including contaminant concentration, dissolved oxygen and biodiversity, water flow and flood prevention.

Developing and implementing an integrated watershed planning and management policy requires active participation, interaction and collaboration between stakeholders. Currently, this is not administered nationally in the United States and Canada, but through initiatives at the regional or state/provincial level. For example, the Total Maximum Daily Loads programme for pollutant control in the United States is being implemented at the state level as required by the Clean Water Act. States are required to identify impaired waters and calculate the maximum amount of a pollutant a water body can receive and still meet water quality standards, and then develop plans, with public input, to address point and non-point sources of pollutants in an effort to restore and maintain the water quality. Although the programme has shown a varying degree of success across the country – due in part to the differences of each watershed – factors that have been recognized to enhance implementation include a focused watershed plan, active stakeholder involvement, coordination between local and state governments, a diversity of approaches to addressing sources of pollution, and adequate resources for watershed characterization and monitoring (Benham *et al.* 2008). An attractive aspect of integrated watershed planning and management is that it need not require expensive infrastructure such as water treatment and control structures. Therefore, costs do not necessarily restrict implementation, so it can move forward in situations and regions where financial resources are limited. This makes integrated watershed planning and management highly transferable, provided effective coordination and implementation mechanisms can be established. It can also be applied at a diversity of scales ranging from small urban stream restoration projects to large watershed programmes, such as the Great Lakes (Box 13.5), Chesapeake Bay (Hassett *et al.* 2005), the Everglades (Davis and Ogden 1994) and San Francisco Bay (IRWMP 2006). Of its many benefits, perhaps the most notable is that stakeholders are actively involved in selecting the management strategies to solve water resource problems. Active stakeholder involvement, with explicit discussion of issues, improves decision making and acceptance, thus offering advantages over top-down planning, which often lacks public support and understanding.

Integrated watershed planning and management is not without problems, however, and it is often difficult to determine how well it works. In the Chesapeake Bay watershed, it was initiated decades ago in an effort to clean up the estuary and restore coastal fisheries. Projects to improve water quality have largely focused on tributaries, and include re-vegetating riparian areas, improving stream channels and restoring wetlands. Millions of dollars have been spent on thousands of restoration projects within the watershed, yet the success is difficult to gauge, due in part to a lack of comprehensive monitoring of individual projects (Hassett *et al.* 2005). While clear indications of widespread water quality improvements in the Chesapeake Bay have not yet been observed, outcomes in some areas look promising (Ruhl and Rybicki 2010).

In general, integrated watershed planning and management faces serious challenges due largely to the magnitude and complexity of problems as well as socio-political rather than technological or hydrological barriers. The mismatch between watershed boundaries and political boundaries poses a challenge because of the often conflicting needs of the multiple landowners and political entities with jurisdictions in watersheds (Blomquist and Schlager 2005). To overcome this, a watershed authority is typically established to coordinate and implement the plan, and faces the formidable task of bringing together the stakeholders and facilitating agreements to balance the needs of competing interests. Thus, collaboration and public participation are essential. The challenges of creating watershed authorities are magnified when watersheds cross international boundaries. However, these challenges can be met through such efforts as the International Watersheds Initiative, which was conceived by

Smart meters measure residential water consumption. *© Kenneth Cheung*

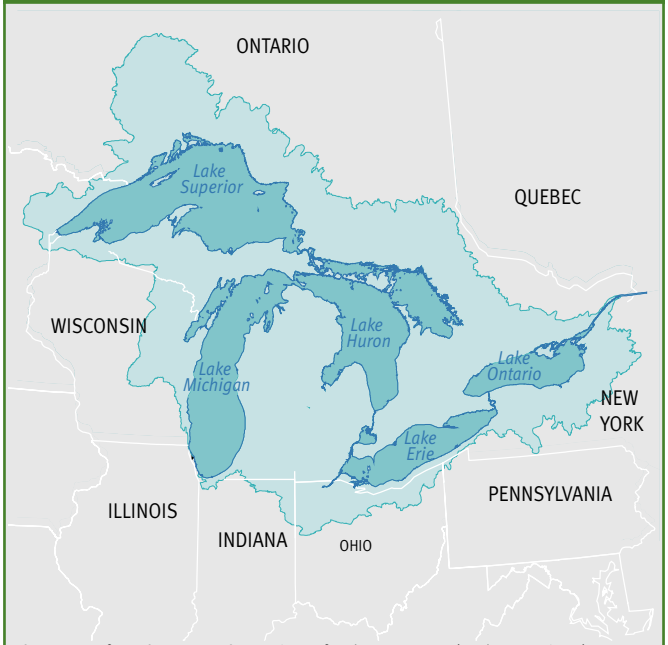
Box 13.5 Protection and management of the Great Lakes Basin

Canada and the United States share the benefits and responsibility of co-managing the Great Lakes watershed ecosystem, the Earth's largest surface freshwater system (GLIN 2011a) (Figure 13.1). In addition to providing drinking water to nearly 33 million people, this abundant supply of water is at the core of the region's economy. The Great Lakes–St Lawrence River Basin Sustainable Water Resources Agreement of 2005, signed by eight American states and two Canadian provinces, provides a framework for each state and province to manage and protect the basin as a whole. The agreement's principles stem from an ecosystem-based water management approach and include bans on new diversions of water from the basin, with a few exceptions; imposes a consistent standard to review proposed uses of basin water; requires that each state and province develop and implement a water conservation and efficiency programme; strengthens the collection and sharing of technical data among parties; and ensures a strong commitment to continued public involvement in implementing the agreement.

The Great Lakes and St Lawrence Cities Initiative is an example of a successful cross-jurisdictional initiative that has been effective in increasing water efficiency and reducing demand across the region. The initiative includes the objective that, by 2015, all participating cities of the basin reduce water use by 15 per cent relative to levels of use in 2000. By 2010, almost half of the 33 participating cities had collectively achieved a 13 per cent reduction, conserving around 330 million m^3 of water. Policy instruments that helped achieve this reduction include:

- technological instruments such as infrastructure upkeep and water metering;
- economic incentives such as subsidies that promote water efficiency, and reduced water rates for industrial users based on their commitment to implement sustainable water-saving projects; and
- educational outreach (GLSL Cities 2011).

Figure 13.1 The Great Lakes Basin



Source: Base from ESRI, 2001; U.S. Army Corps of Engineers,1998; and Environment Canada,1995.

the governments of Canada and the United States to promote the establishment of watershed authorities and facilitate integrated transboundary management (Blaney 2009).

Full-cost pricing

Full-cost pricing of water delivery has been defined by the US EPA as "a pricing structure which fully recovers the cost of providing that service in an economically efficient, environmentally sound, and socially acceptable manner, and which promotes efficient water use by customers" (USEPA 2006). Based on the user-pays and polluter-pays principles, high-volume users pay proportionately more than low-volume users. The aim is to make it possible for all consumers to afford the volume of water necessary for basic human needs while charging increasing prices for consumption beyond that level. Full costs include all public and private costs, both market and non-market values, and account for costs that will be incurred in the future, such as those arising from infrastructure rehabilitation and replacement. In public water provision, once the water delivery infrastructure is in place – such as dams, canals, pumps, pipelines or treatment plants – the marginal cost to the utility company of delivering water to its customers is equal to its variable costs. These costs amount primarily to administrative and maintenance costs, which are near zero compared to the cost of establishing the overall infrastructure. The resulting artificially low market price to customers generally leads to water consumption decisions being based on incomplete information, resulting in overconsumption. In a full-cost pricing model, all infrastructural, environmental and intergenerational costs are included in the delivery price. In practice it is difficult to account for all of these costs accurately; nonetheless, various pricing systems attempt to convey more complete cost information so as to require consumers to pay more of the costs associated with their respective levels of water consumption. One example of how full-cost pricing can be implemented is through increasing block rates, thought to be the most effective in encouraging conservation. In this pricing structure, the amount charged per unit of water consumed increases with the total volume consumed.

Numerous examples of successful implementation of full-cost pricing exist, and are typically evaluated in terms of reductions in water consumption (USEPA 2005). An example is offered by

the Marin Municipal Water District (MMWD), a public agency that provides water for 195 000 residents in south and central Marin County, California (MMWD 2011). The MMWD's water rate structure includes a base fee that covers such services as meter reading, billing, meter replacement and repair, customer service, water conservation and administration, and four levels of charge that cover the cost of water transmission, treatment, distribution, watershed maintenance, and importing and recycling water. The MMWD imports a quarter of its water from the Russian River in Sonoma County through an agreement with the Sonoma County Water Agency. The environmental costs of using water from the Russian River stem from the Federal Endangered Species Act, and include expenses related to improving conditions for several fish species that are classified as threatened or endangered, for example by constructing fish ladders, as well as channel maintenance and monitoring. The MMWD is unusual in that customers pay the full cost of water without state and federal subsidies or cost sharing with other water agencies. Rates are comparable to other northern California water agencies, and overall water use has remained relatively stable over the last several decades despite an increasing population (Fryer 2009). These water-saving measures are a result of a better understanding of the true value of water, and have minimized the financial and environmental costs of water supply expansion.

A residential condensing hybrid tankless water heater. This technology produces hot water on demand and is much more energy efficient than a conventional hot water holding tank. *© BanksPhotos/iStock*

Despite successes, there are also some limitations to full-cost pricing, including its complexity compared to the simplicity of traditional marginal-cost pricing structures, making it difficult for consumers to respond to the price information by adjusting their water use. Public outreach campaigns and in-bill information leaflets that describe cost structures are addressing this barrier to some extent. Another limitation is the difficultly in setting prices properly, in particular in identifying and allocating non-market costs such as environmental losses associated with water delivery – for example the environmental effects of constructing new diversion and containment structures. Various formal methods have been developed, however, for assigning market values to non-market costs over time, identifying present and amortized values for those costs, and then adding them to the marginal cost to customers on the basis of water consumed (Renzetti and Kushner 2004; Rogers *et al.* 2002). Implementing full-cost pricing requires adequate institutional support and agreement, as well as the personnel and data necessary for estimating cost components.

Technological solutions and conservation measures

Technological advances and conservation measures can effectively decrease water use in the residential, industrial and agricultural sectors. This has been accomplished in large part through regulation, financial incentives and voluntary measures. Many options are available for reducing water consumption and increasing efficiency depending on the sector, including low-tech solutions, water-saving appliances, water reuse systems and metering. For example, the decline in average residential water use in North America over the last 25 years is largely attributed to increased efficiency standards for household appliances (Rockaway *et al.* 2011). In the agricultural sector, flood irrigation systems are being replaced by more efficient technologies designed to increase crop yield per unit of water use. Simpler conservation measures such as responsible water-use habits go hand-in-hand with efficiency, and can be promoted through water education programmes. Examples of cities that have implemented such programmes include El Paso, Texas (EPWU 2007), San Diego, California (City of San Diego 2011) and Prince George, British Columbia (City of Prince George 2011).

Conserving water through improved long-term sustainable efficiency can lead to a range of economic and environmental benefits. Some of the advantages of this approach include adaptability to site-specific needs, avoidance of more expensive potable water supplies, and the reduced costs of operating and maintaining water distribution and treatment infrastructure, with associated energy savings. For commercial and industrial facilities, savings in water and energy costs realized by implementing efficiency measures can quickly offset the investments made. For instance, in the State of California the average estimated payback period for investing in water-efficient technologies in the commercial, industrial and institutional sector is typically less than two and a half years (Vickers 2001). Obstacles to implementing

water efficiency measures include situations in which the capital investment does not justify the water cost savings in the short term, or when a general consensus cannot be reached among stakeholders that the benefits accrued to the water rate payers are worth the investment in the long run. Decisions often depend on the costs associated with water use and water discharge, environmental compliance and production. Other economic incentives may be required in some areas with low water costs, including subsidies, tax credits and grants. In many cases, it will be a combination of sector-specific instruments and incentives appropriate to a region's issues and needs that will allow a variety of innovative and effective water-use efficiency measures to be implemented.

Cross-cutting issues

Policies that promote the integrity of the water cycle and the essential life-supporting services it provides can indirectly help achieve the internationally agreed goals for land use and renewable energy. Successful implementation of integrated watershed planning and management is likely to promote sustainable land use by restoring ecosystem function and enhancing resilience. When the true cost of water supply is assessed, added revenue may be used to fund restoration programmes carried out over the landscape. Water conservation that stems from financial incentives and technological advances will further reduce land degradation and minimize energy requirements for the use and distribution of water. Greater reliance on renewable energy sources will reduce greenhouse gas emissions that cause climate change, which may mitigate projected impacts on the water cycle.

Energy

Canada and the United States are endowed with diverse and abundant renewable energy resources. Transforming that vast potential into a sustainable energy system requires mobilizing political will, behavioural change and smart, comprehensive policies that support renewable energy. There are several environmental issues associated with the current energy system, including climate change, elevated water consumption and air pollution.

Since fossil fuel consumption is the major contributor to increasing atmospheric concentrations of carbon dioxide (CO_2), experts contend that policy interventions should be strengthened, not just to increase renewable energy production, but to substitute renewable energy for the current carbon-emitting energy systems (Delucchi and Jacobson 2011; IPCC 2011; Jacobson and Delucchi 2011; Schneider *et al.* 2000). Renewable electricity technologies offer an effective means of reducing greenhouse gas emissions, thus providing a tool for climate change mitigation (Awerbuch 2006). This section highlights practical lessons learned as well as comprehensive and emerging novel approaches from North America's electricity sector. It has become clear that even partial mitigation of the rate of climate change requires more carbon-free sources of electricity (Schiermeier *et al.* 2008). In addition, policy innovation and technical improvements are rapidly advancing in this sector, thus providing the clearest examples for emulation.

Tehachapi Pass Wind Farm, California, generating clean, renewable energy. *© Patrick Poendl/iStock*

North America's current dependence on fossil fuel resources largely stems from a cycle of pricing effects, partially due to subsidies that favour conventional fossil fuel energy production and that externalize pollution costs. For example, an analysis of all energy subsidies provided in the United States in 2004 shows that 86 per cent went to fossil fuels, 8 per cent to nuclear energy and just 6 per cent to renewables and energy efficiency (Sovacool and Watts 2009). Recently, Energy Secretary Steven Chu announced that the Obama administration intends to repeal US$46.2 billion in subsidies to oil, natural gas and coal companies in the next ten years in order to fund renewable energy spending (Bloomberg 2011). Economists argue that to address these uneven subsidies and other market failures associated with fossil fuels and to accelerate renewable energy deployment, the multiple social and environmental costs of emissions have to be included in the price of conventional energy production (Sovacool 2009a). Smart, novel and comprehensive policies are therefore necessary to provide the incentives, transmission networks, transparency and market space essential to support rapid and sustained renewable energy development and the substitution of fossil fuels.

During the selection process, three policy clusters were identified affecting renewable energy adoption: providing financial support to alter incentives or encourage behavioural change; improving networks and grid flexibility; and decreasing institutional barriers. This section highlights key policies that support current instruments affecting the adoption of renewable energy and discusses the benefits, drawbacks and potential for transfer and scale-up. However, as experts contend and the case studies in this section illustrate, a comprehensive policy approach is important when considering renewable energy support (Sovacool 2009b). Such an approach could accelerate renewable energy development by simultaneously confronting the multiple

challenges and barriers that are delaying the transition to a sustainable energy system.

Support to alter incentives or encourage behavioural change

The policy measures described in this section provide market incentives that partially address fossil fuel subsidies and the externalization of the costs of pollution (Sovacool and Watts 2009). Examples already in use in North America include production tax credits, feed-in tariffs and renewable portfolio standards; in addition, governments supply funding for research and development. Production tax credits represent kilowatt-hour tax credits for qualified renewable energy sources while feed-in tariffs typically guarantee grid access and provide long-term contracts for electricity generation at stable prices (DSIRE 2011; Mendonca 2007). Where they are well designed, feed-in tariffs also provide renewable energy premiums using the rate-payer base rather than government funds. Renewable portfolio standard policies also avoid the use of government funds, with the exception of monitoring compliance with the standard, and typically require utilities to procure renewable energy resources as a prescribed percentage of total electricity (Fischer 2010). Investments in research and development help to improve technologies that drive prices down, providing market advantages aimed at increasing the renewable energy market. The close coupling of research and development with investment subsidies has shown to improve policy effectiveness (Soderholm and Klaassen 2007; Klaassen *et al.* 2005).

Improving networks and grid flexibility

Renewable energy sources and current fossil fuel generation facilities are often located in different places, thus requiring networks to transport energy from new source areas to load centres. In addition, fossil fuel generation, which is characterized by long-term capital stock, currently dominates the market, limiting opportunities for new technologies to enter. Several policy measures have been devised that improve the management and characteristics of transmission networks and increase market access and space. These include designating transmission cost recovery and allocation; managing the grid through independent system operators; developing smart grids; and phasing out coal plants. These policies are intended to make it easier to develop infrastructure, open market space and transmit renewable energy from areas of generation to load centres.

Cost recovery and allocation policies provide clear frameworks for developers to recover installation costs from transmission projects, which is necessary to provide an energy transportation network to increase renewable energy use. Currently, it is difficult to finance the development of transmission structures that cross multiple state and provincial jurisdictions, with, in many cases, associated problems in assigning costs and benefit levels. To overcome this, experts have proposed that federal authorities should determine cost allocation (Willrich 2009).

Energy developers also encounter problems with the lack of transparency and access to the grid (Sovacool 2009b) as, traditionally, vertically integrated companies generate, transmit and distribute electricity. In many areas, utility companies still own and operate the transmission assets, leading to a lack of transparency in the availability of transmission. Independent system operators are third-party public institutions responsible for granting access to transmission grids, which could provide desirable conditions for accelerating renewable energy deployment by ensuring transparency and fair access to markets (Joskow 2005). In Texas, where cost allocations are assigned to all supply entities, representing a novel approach for North America (Schumacher *et al.* 2010), the construction of high-voltage electricity transmission is proceeding rapidly (Box 13.6).

Phasing out coal plants is a relatively new policy instrument that decreases greenhouse gas emissions while simultaneously increasing grid flexibility and providing market space for renewable energy. Since coal-fired technology has a limited ability to respond to load fluctuations, these policies typically substitute coal-fired generation with natural gas, which has more responsive technologies that emit lower levels of pollutants and greenhouse gases than coal-fired generation (Dewees 2008). Coal phase-out policies provide public health benefits and accelerate the transition to a sustainable energy system by decreasing emissions that lead to climate change (Winfield *et al.* 2010). This particular policy rapidly internalizes the costs associated with the market failure of fossil fuel energy by targeting concentrated sources of emissions.

Policies for overcoming institutional barriers

The final cluster consists of policies that increase the pace of renewable energy deployment by removing institutional barriers and facilitating long-term planning. One method of removing barriers is by consolidating siting authorities, either by aggregating multiple jurisdictions into one decision-making body or by placing the siting authority in an existing entity; examples are the Province of Ontario (Box 13.2) and the State of Texas (Box 13.6) (Gallant and Fox 2011; Bohn and Lant 2009; Wilson and Stephens 2009).

Agencies may also conduct integrated resource planning, which typically requires involving the public, identifying energy efficiency and resource options, developing action plans, and describing efforts to minimize the environmental effects of resource acquisitions. Experts contend that plans for designing and optimizing systems should now include explicit consideration of grid-connected renewables. They also maintain that including the evaluation of renewable energy sources in integrated resource planning helps develop a cost-effective sustainable energy system (Yilmaz *et al.* 2008).

Benefits of the selected policy measures

Empirical evidence shows that widespread renewable energy results in decreased environmental impacts and increased social benefits (IPCC 2011). Thus, increasing renewable energy production and displacing fossil fuels in the energy system by addressing perverse subsidies, providing paths to markets and market space, and removing institutional barriers could deliver multiple benefits. Environmental benefits include reduced

greenhouse gas emissions and air pollutants, lower water use in the case of wind and solar photovoltaics, and decreased water pollution (Sovacool and Watts 2009; Roth and Ambs 2004). Social benefits include enhanced energy security and reliability by diversifying the supply and using indigenous resources, and reduced energy price volatility and disruptions (Awerbuch 2006; Roth and Ambs 2004). In addition, experts maintain that renewable energy developments are associated with enhanced economic development and more jobs (IPCC 2011; Wei *et al.* 2010). Finally, the use of renewable resources also benefits public health through decreased emissions and fewer occupational injuries (Sumner and Layde 2009; Rabl and Spadaro 2000).

Research clearly demonstrates that renewable energy sources generate significantly lower greenhouse gas emissions than fossil fuel options (IPCC 2011; Awerbuch 2006). Scenario analyses indicate that increasing renewable energy deployment from 27 to 77 per cent of the primary energy supply by 2050 may be expected and may achieve savings of up to 85 per cent of global CO_2 emissions for the scenarios with the highest renewable energy shares (IPCC 2011). The majority of the technologies deployed in these scenarios are wind, direct solar and modern biomass, with an annual average cost of less than 1 per cent of global gross domestic product (GDP) per year (Edenhofer *et al.* 2011). Furthermore, experts forecast that by 2030 the production costs, including social costs, of renewable energy would be lower than energy production by fossil fuels (Delucchi and Jacobson 2011; Jacobson and and Delucchi 2011). However, to achieve this transition, existing policies must be significantly strengthened and implemented comprehensively and therefore require additional political will (Jacobson and Delucchi 2011; Sovacool and Watts 2009).

The benefits of improving networks and reducing institutional barriers include lower costs and faster deployment of renewable energy. In the case of transmission, improved networks generally enhance reliability, lower the delivered costs of electricity and restrict the ability of generators to exercise market power (Hirst 2004). Experts commonly call for reducing institutional barriers to expedite the transition to a sustainable energy system (Mitchell *et al.* 2011). Quantitative analysis also shows that reducing siting barriers correlates with increased wind power development (Bohn and Lant 2009).

Potential drawbacks of selected policy measures

The successful implementation of production tax credits or feed-in tariffs requires an in-depth understanding of the various energy prices for all renewable energy sources as well as the costs of externalities. These policies therefore have potential drawbacks. Specifically, production tax credits or feed-in tariffs can be extremely inefficient. Since incentive levels are fixed over time, this may lead to limited innovation and downward price pressures. Likewise, implementing renewable portfolio standards also requires an in-depth knowledge of markets to establish appropriate targets, enforcement mechanisms and sector-specific set-asides. While context dependent, these are usually

A large-scale oil refinery complex in the Alberta oil sands, Canada, near Fort McMurray. *© Dan Barnes/iStock*

subsidies aimed at a particular industry (Berry and Jaccard 2001). Inadequately designed renewable portfolio standards may encourage particular technologies and therefore lead to technological lock-ins (Unger and Ahlgren 2005).

In addition, critics argue that implementing renewable energy policies may increase the cost of energy and/or increase tax burdens (Gallant and Fox 2011). These expenses are especially burdensome to lower-income households; however, widespread renewable energy adoption combined with progressive tax design and incentives offers some protection from energy price increases. For example, subsidy programmes already exist to assist low-income households with energy costs in the United States, so expanding existing programmes could provide assistance for vulnerable groups should energy prices rise.

Policies to increase transmission networks and reduce siting barriers also have potential drawbacks. When reallocating the costs of transmission, these policies could result in disproportionate financial burdens on parties who do not benefit. Reducing siting barriers may also decrease public participation.

Replication and transferability of selected policies

The potential for replication and transferability of these policies is not straightforward and is arguably dependent on context and specific instrument design. For example, the North American grid exists in an institutional framework that is highly fragmented, while other countries may have nationally owned networks, in which case fragmentation may not be an issue (Willrich 2009; Joskow 2005). Germany, France, Italy, Japan and Denmark have experience in replicating and transfering feed-in tariffs at the national level, while the United States and Australia have experience with production tax credits and renewable portfolio standards (IEA 2011). Policies on feed-in

tariffs and renewable portfolio standards are in force in diverse jurisdictions including Canada, China, Kenya, Portugal and Uganda (IEA 2011). Statistically, correlations demonstrate that the policies are effective, particularly in the case of feed-in tariffs (Haas *et al.* 2011). Direct causal evidence of effectiveness for other policies, however, is limited, as is evidence of the potential for replication and transferability to other jurisdictions (Carley 2009; Doris *et al.* 2009).

Proactive measures to accelerate the use of renewable energy

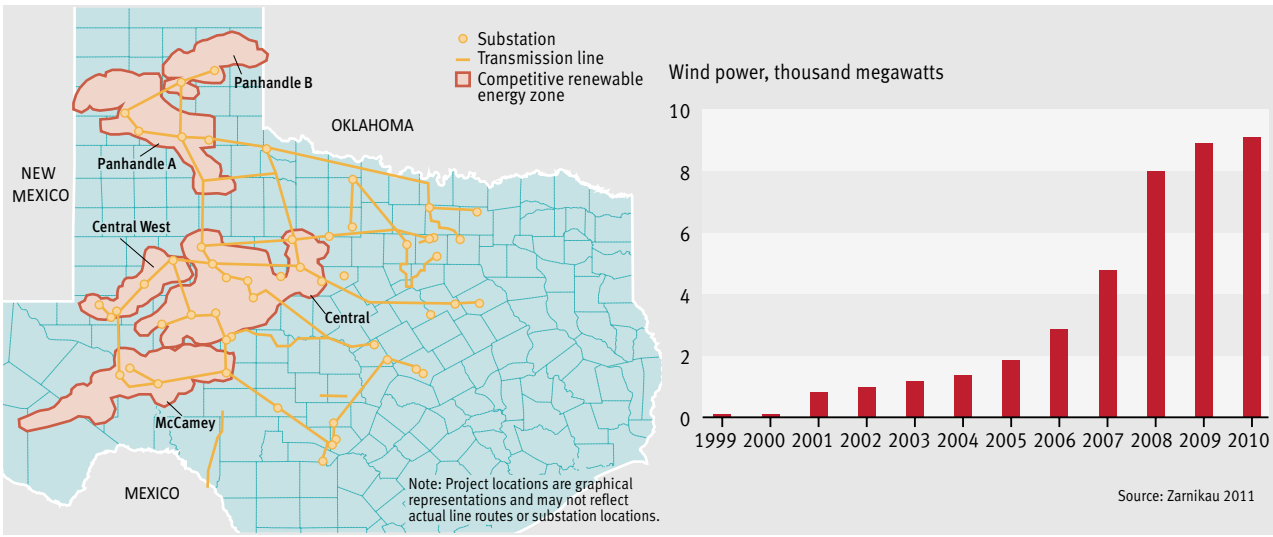
Achieving the international goal of urgently expanding the share of renewable energy supply in North America's energy mix

Box 13.6 Texas: a rapid expansion of wind energy

Texas has emerged as the leader in the growth of wind energy in the United States, with policies that direct market mechanisms towards achieving the state's energy capacity goals. Policies include customer choice, wholesale electricity markets, and a transmission cost allocation method along with tradable renewable energy credits and federal tax credits (Zarnikau 2011). In addition to these policies, the authority for siting wind farms in Texas is centralized, making it relatively easy to obtain licenses compared to other areas of the country (Bohn and Lant 2009; Wilson and Stephens 2009).

Expanding electricity transmission facilities has been a key component of Texas's package of policy instruments. The state is an unusual jurisdiction in North America because it has a single grid authority, the Electric Reliability Council of Texas (ERCOT). As part of its transmission policies, Texas dispensed with the demonstration of a need and designated Competitive Renewable Energy Zones, thus allowing capacity to be built ahead of need. Texas also allocates costs for these facilities across all companies that provide electric power to consumers within the ERCOT area (Schumacher *et al.* 2010), allowing transmission developers to recover the costs from the installation of new power lines. In addition, the charging of all consumers and not just the beneficiaries provides a consistent framework across the entire grid, eliminating the political dispute over who pays and who benefits from new transmission. These policies, which actively plan for expanding transmission, have been vital in promoting the state's rapid growth in renewable energy production (Figure 13.2).

Figure 13.2 Proposed renewable energy zones, potential transmission expansion and the growth of wind power in Texas



Texas's comprehensive policy package – which mandates renewable energy production, consolidates the siting authority and spreads transmission costs across all consumers – is a novel approach that has provided impressive results. Wind power deployment has grown from a capacity of 50 megawatts in 1999 to more than 9 272 megawatts in early 2010, accounting for 8.4 per cent of the state's total electrical generation in the first quarter of 2010. While there have been challenges in grid integration and additional transmission expansion is currently under way, projections based on the current policies indicate that Texas's wind energy will continue to expand and that solar energy deployment is expected to boom. The achievements and forecasts indicate that if the policy regime is properly designed, market-based initiatives can realize significant and rapid renewable energy development (Zarnikau 2011).

requires mobilizing political will and increasing public support to implement comprehensive renewable energy policies focused on addressing market failures, providing clear market signals, modernizing transmission systems, proving new technologies including energy storage, and streamlining institutional structures. A modernized, clean, reliable and efficient 21st century energy system will provide greater energy security, enhanced price stability and increased economic performance, and may save up to 85 per cent of global greenhouse gas emissions by 2050 (IPCC 2011; Awerbuch 2006).

Current research argues that in accounting for fossil fuel externalities and subsidies, the question appears not to be one of cost, but rather of social and political barriers (Delucchi and Jacobson 2011). Cultivating and developing widespread public participation and support is essential for generating the political will to implement the policies necessary to achieve the internationally agreed goal. The case studies illustrate that comprehensive policy packages that include incentives to offset externality and subsidy advantages afforded to fossil fuels, provide for energy transmission and reduce institutional barriers, can also significantly accelerate the transition to a sustainable energy future.

Cross-cutting issues

Increasing the deployment of renewable energy can provide a number of benefits to support the other internationally agreed goals. Wind and solar photovoltaic renewable energy can decrease water stress since it uses less water than conventional thermo-electric forms of generation (Roth and Ambs 2004). Benefits for land use include relative reductions in greenhouse gas emissions, thereby decreasing potential climate change impacts (Turney and Fthenakis 2011). However, land use for expanding renewable energy systems may require the disturbance of additional areas, depending on the particular technology being deployed (Fthenakis and Kim 2009). At the same time, an integrated approach to siting renewable energy, increased transparency and collaboration between agencies may lead to improvements in environmental governance.

CONCLUSIONS

This chapter has suggested that there are many policies and market instruments that have contributed, however uncertain the causality, towards achieving the internationally agreed goals. It is unlikely the policies were instituted with the global goals in mind, however; rather, the impetus probably came from bi-national, national and sub-regional institutions and governing bodies. It is important for all levels of governance and decision making to set clear short-, medium- and long-term environmental goals and specific targets as a crucial means of inducing a change in behaviour among public and private actors. Performance indicators are necessary to evaluate policy progress and clearly identify successes and shortcomings, and it is also essential to work towards synergy between the goals adopted under climate change and other environmental themes, while keeping in mind the potential contradictions between different environmental goals – at least in the short term, for example in the case of clean air and climate change – as well as between environmental protection and sustainable development, where conservation issues can arise.

Yosemite, one of the largest and least fragmented habitat blocks in the Sierra Nevada, was central to the development of the national park concept in the United States. *© Pgiam/iStock*

Some of the policy examples show how cultivating public will and political support while reducing negative public perceptions has moved the region closer to achieving environmental goals. Public-private partnerships have become increasingly important as government funds and staff have shown to be unable to assess resources, coordinate sustainable management and accommodate the increasing demands of multiple users.

The selected policy options suggest a number of opportunities for future environmental governance in North America. The most efficient and least controversial financial mechanism for ecosystem services focuses on users of an ecosystem service – such as water quality – who are willing to pay for the service and compensate the owners or managers of that resource for implementing best management practices.

Finally, and importantly, the examples reveal that applying successful policy options is complex, often requiring hybrid techniques combining two or more regulatory mechanisms to adjust existing market rules, financial incentives to shift pricing in existing markets, and participatory techniques. Transferring and up-scaling the processes that appear to have contributed to the success of a policy or market instrument will further speed up the achievement of internationally agreed environmental goals. In general, transferring processes is more feasible than replicating policy contents, since more is known about factors that influence the likelihood of transfers. The success of policies and instruments is very context dependent, while processes foster legitimacy and learning. Failing to protect ecosystem services for the generations to come will undoubtedly be more costly – socially, economically and environmentally – than the burden of expanding processes and policies that seem already to have proven successful.

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