Chapter 23
Climate Policy Assessment on Global and National Scales

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Abstract The term 'climate policy' covers both policies to reduce greenhouse gas emissions (called mitigation) and policies to adapt to climate change (adaptation). Current literature on climate policy assessment essentially consists of ex ante assessments of mitigation policies, using more or less sophisticated economic models. Adaptation studies, while still very much in the minority, are becoming more frequent. The growing number of climate policies being implemented in different countries throughout the world should lead to a proliferation of ex post assessments in the coming years.

23.1 From Climate Policy to Integration of Climate Issues into 'Non-climate' Policies

The term 'climate policy' refers to all public policies designed to limit the effects of global warming. A distinction is drawn between mitigation policies, aimed at reducing greenhouse gas (GHG) emissions, and adaptation policies, which seek to limit the negative impacts of climate change on human societies (or even, in some cases, to take advantage of possible beneficial effects), whether the impacts are already present or, more often, only anticipated.

Because GHGs are generated in virtually all areas of activity, mitigation covers a wide variety of actions, ranging for instance from fossil fuel taxation, to reduction of fugitive emissions of natural gas or methane capture from landfills, to the fight against deforestation.

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Similarly, adaptation covers a broad range of actions: for instance from the abandonment of spruce—which is heat-intolerant—in lowland areas of Western Europe, to infrastructure upgrades in areas likely to be affected by major floods or the development of climate insurance mechanisms, to dyke-building to protect coastal areas threatened by rising sea levels.[1]

Whether they focus on mitigation or adaptation, climate policies typically have other consequences than just control of the greenhouse effect. For example, replacement of coal-fired electric plants with gas-fired plants or with renewable energy generation will limit GHG emissions, but will also tend to reduce fine-particle emissions, benefiting health. Similarly, a policy favouring urban public transit at the expense of cars is likely to reduce GHG emissions (if emissions from public transit are less per passenger-kilometre) while potentially helping to reduce traffic congestion. These non-climatic effects of climate policies are referred to in the literature as 'co-benefits', when they benefit human societies, and as 'adverse side-effects' when they are detrimental.[2] As will be seen, integrating co-benefits and adverse effects into climate policy assessment is a major challenge.

Climate policies, however, are only part of the toolbox available to governments to combat climate change, for they are defined as policies intended—by implication, primarily—to combat climate change. Speaking of *co*-benefits clearly emphasizes that implicit hierarchy of objectives.

However, there are many examples of public policies whose primary purpose is clearly not to combat climate change but which nevertheless have significant effects on emissions and/or on adaptive capacity. Town planning is a good example. Because they structure urban space, town planning policies play a key role in determining transport needs for households and businesses, and hence GHG emissions, and yet economic (property tax, construction financing, etc.) and social considerations (access to housing, risks of segregation, etc.) are most often their priority.

The distinction between climate policies and those whose main objective is not to combat climate change (referred to herein, for want of a better name, as non-climate policies) may appear purely rhetorical, but the distinction is an important one in the public climate change debate. Focusing the debate on climate policies alone tends to put the spotlight on very specific forms of public action, such as carbon taxes, markets for tradable emission permits, or the creation of dedicated

[1]In the recent IPCC assessment report the reader will find a detailed discussion, sector by sector and region by region, of the various options available for adaptation and mitigation (Field et al. 2014, for adaptation, Edenhofer et al. 2014 for mitigation).

[2]This terminology, taken from the last IPCC report (Edenhofer et al. 2014) is far from definitive. The terms 'ancillary benefits' or 'indirect benefits' (among others) are also used. Ürge-Vorsatz et al. (2014) contains a rundown of the various terms.

Fig. 23.1 Diversification of rural families' activities: community bread production in Kisalaya, Nicaragua (© S. Fréguin, CIRAD)

funds (for adaptation or mitigation), etc. Conversely, anything that makes for better integration of the climate issue into 'non-climate' policies is overshadowed.

Yet non-climate policies have a decisive effect on a large share of all GHG emissions and the ability to adapt to them. Hence, for ambitious anti-climate-change objectives to be attained, such policies must take account of the climate issue (Hourcade and Shukla 2013). For example, adapting a country highly dependent on agriculture to climate change may involve diversification of activities in rural areas to non-agriculture sectors (Fig. 23.1) or population migration away from the areas potentially most affected. Adaptation in that case goes well beyond climate policy at the margin (such as installing air conditioners) and necessitates a review of development strategies. The same reasoning applies to mitigation.

In what follows, we shall begin by discussing climate policy assessment, then focus on the specific problems posed by the integration of climate issues into policies whose primary objectives lie elsewhere.

23.2 Assessing the Value of Climate Policies: The 'Cost-Benefit' Approach

In evaluating climate policies, the first question is, "are they worth the effort?" In other words, are the constraints the policies impose (e.g. rising energy prices, in the case of a carbon tax) offset by the benefits they confer: less climate change, so less impact to be mitigated and fewer negative consequences for human societies to adapt to?[3]

That is a very tough question, as the constraints imposed and benefits conferred by climate policies must be simultaneously and consistently evaluated, but responsibility for the evaluation of each lies with different disciplines and bodies of knowledge (roughly, IPCC groups III and II, respectively; Edenhofer et al. 2014; Field et al. 2014), which are not easily reconciled. The benefit aspect, in particular, is still particularly hard to grasp.[4] Of course, information on the impacts—and therefore on those that may be avoided under a given climate policy—can always be supplied, but incorporating that information into a cost-benefit assessment on climate policy will require significant investment.

The first cost-benefit analyses to emerge circumvented the difficulty by using very compact models (see the seminal paper by Nordhaus 1992) that represented the impacts in simple functional forms with few parameters. A wide range of possible visions of impacts can be easily explored using such models. A second series of studies, such as Stern's (Stern 2007), depend instead on detailed models of the Earth system, in which the impacts are better represented than in aggregated models (i.e. more processes are captured), but not well enough as to dispel all uncertainty.

The cost-benefit studies available to date lead to very different recommendations. Some take a 'wait-and-see' approach, advocating that GHG emission limits be phased in, while others call for an immediate, all-out attack. The differences are of course due to different visions of climate change impacts,[5] but also varying degrees of optimism regarding technological progress or societies' capacity to change their lifestyles and consumption patterns.[6]

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[3]When the difference between benefits and costs can be measured, a subsidiary issue is the search for the 'best' climate policy options, that is, those that maximize that difference.

[4]The way in which the climate will change in a given emissions scenario remains uncertain—the more so the lower we go in the geographic scale. Also, the way the major biogeophysical cycles (the water cycle, for example) and ecosystems respond to climate change is still poorly known. And lastly, the impact the changes will have on societies will depend on their lifestyles, their wealth, their knowledge, etc. All of these parameters are difficult to predict in the long term.

[5]In particular the presence or absence of non-linearities (Ambrosi et al. 2003).

[6]Part of the debate centres on the relative weight to be assigned, in economic calculations, to future cash flows relative to present cash flows, a parameter called the 'discount rate' (see e.g. Heal 2009).

As all of the parameters are so uncertain, it is an illusion to suppose that cost-benefit analyses can help to identify 'the' right policy. Crucially, however, they already inform the debate by elucidating the conditions under which a given climate policy can actually be 'worth it' (Perrissin-Fabert et al. 2012).

23.3 Assessing Climate Policy Effectiveness: The 'Cost-Effectiveness' Approach

The difficulty of simultaneously evaluating the constraints and benefits associated with a given policy is so great that much of the literature on climate policy assessment focuses on a simpler question. Given a certain mitigation or adaptation objective, expressed in physical units—for example, to reduce GHG emissions by a million tonnes, or to guarantee a coastal town's inhabitants a constant risk of flooding despite the foreseeable rise in sea level—what is the least constraining policy to achieve it?

The cost-effectiveness approach is less demanding than the cost-benefit approach, since benefits (in other words, the climate change impacts obviated by the policy) need no longer be evaluated. Conversely, it tells us nothing whatsoever about the policy's social value. For instance, a cost-effectiveness analysis can reveal the least expensive way to reduce a country's emissions by 50 % by 2050, but it cannot tell us whether 50 % is too ambitious or too timid.

That is not to say a cost-effectiveness evaluation is easy; quite the reverse. The consequences of climate policies for the economy and society are inherently difficult to assess. A carbon tax, for example, will tend to drive up the price of energy and energy-intensive goods. Companies will respond by adapting their production processes to give more weight to other factors (e.g. labour), and households will shift, at least in part, to goods and services with lower carbon content. Imports and exports will be affected, more so if the tax is not simultaneously levied by the country's trading partners. Domestic firms may become less competitive as a result. And so on. Anticipating the final result of these interactions requires sophisticated tools that are still far from being scientifically stabilized (Box 23.1).

Cost-effectiveness evaluations for mitigation policies may, as a first approximation, be sorted into two broad categories. The first chiefly seeks to cost out mitigation objectives at the global level, and in particular—in recent times—to determine how to keep the average temperature at the Earth's surface from increasing by more than 2 °C relative to preindustrial times, at the lowest possible cost. Mitigation policies are represented in a fairly crude way, such as a carbon tax differentiated by major region of the world, possibly combined with different measures of support for clean technologies. That kind of study, summarized in Chap. 6 of Edenhofer et al. (2014), concludes in particular that the +2 °C goal is still achievable, and relatively affordable, always provided there are very large tracts of land available to sequester carbon in biomass or to generate carbon-negative

Fig. 23.2 Okoume logging in a natural rainforest in Gabon. What climate policies can move forestry toward mitigation? (© D. Louppe/CIRAD)

bioenergy,[7] and subject to far-reaching assumptions on the functioning of the economic system.

A second strand of the literature evaluates the cost of emission reduction sector by sector, based mainly on sectoral techno-economic models. That work can of course not be reviewed here, but summaries can be found in Chaps. 7–12 of Edenhofer et al. (2014). As regards only agriculture, forestry and other types of land use, IPCC summarizes the literature by pointing out that the least costly mitigation options, on average, at the global level, are: in forestry, reduced deforestation and forest management (Fig. 23.2); and in agriculture, crop and grazing management and soil restoration (with higher avoided emissions costs). The report also notes that changes in diet and lower losses in the food production chain may have great potential, but little investigation has been done in that area.

[7]I.e., first- or second-generation fuels coupled with sequestration of CO_2 emissions from combustion.

Box 23.1. On the cost of emission reduction, mitigation policies' main indicator for cost-effectiveness evaluations.

Cost-effectiveness evaluations of mitigation policies generally result in a mitigation cost, expressed as so many monetary units per tonne of avoided carbon dioxide (CO_2) emissions (e.g. €/t CO_2). That unit cost is calculated as the ratio between the total cost produced by the policy—with respect to a so-called 'baseline' situation wherein the policy would not have been adopted, all else being equal—and the volume of emissions not emitted because of the policy.[8]

It is therefore an average. In one sense, it is averaged over time, since the calculation shows the costs (numerator) and the emission reductions (denominator) throughout the public policy's validity period. In other words, two policies with the same emission reduction cost can actually have very different temporal profiles. In another sense, it is a spatial average. For instance, a grant for the installation of small run-of-river turbines may be expected to spawn many projects, whose costs (relative to avoided emissions) are by no means necessarily equal (the watercourses being more or less suitable, the flow more or less regular, etc.). Such differences are glossed over by the average cost. In particular, it is often useful to know the marginal cost as well, that is, the cost of the most expensive installed turbine.

The exact meaning of the numerator in the ratio also needs to be clarified. In some analyses, it is the engineering cost associated with the policy, in others a sectoral cost, and in still others a so-called 'macroeconomic' cost—all of which differ in scope and in the way they are calculated.

Engineering costs are direct costs associated with the emission reduction operations triggered by the policy. Take, for example, a policy that promotes renewable energy and entails the construction of new wind farms in a country that generates its electricity from coal. The associated 'engineering cost' is the difference between a wind farm's total cost (investment, operation and maintenance) and the total cost of a coal-fired plant with equivalent characteristics (capacity, service life, etc.).

Sectoral costs comprise, in addition to the direct costs, the costs (or profits) for the various stakeholders in the economic sector concerned. Thus, paying forest owners for the carbon sequestered by their trees is likely to result in longer rotations, with a direct cost to the owners that can be estimated. But, by reducing the timber supply, this policy will impact prices, and hence the different stakeholders in the supply chain (traders, primary and secondary processing) and the end consumer. The sum of the costs for each stakeholder constitutes the sectoral cost.

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[8]If the policy reduces emissions of gases other than CO_2, a conventional 'exchange rate' is used (the global warming potential of the gas over 100 years according to the United Nations Framework Convention on Climate Change) to express the reduction as tonnes CO_2 equivalent (denoted t CO_2-eq). For example, emission of 1 t of methane 'equals' 23 t of CO_2.

The macroeconomic cost, meanwhile, covers the impact of the policy at the macroeconomic level (change in GDP, unemployment rate, etc.). It is estimated using dedicated models, which present the savings in a highly aggregated manner. The value of that level of analysis is that it seeks to capture economic feedback that may be very important to the evaluation—for example, the effect of a carbon tax on income or on the balance of trade—but which a sectoral analysis (and a fortiori an engineering analysis) will miss.

The three levels are not equivalent, even when expressed in the same currency. Great care is needed, then, in comparing emission reduction costs one to one. Neither is there any clear hierarchy between studies at each level. Macroeconomic assessments may appear more complete at first glance, since they summarize the impact of public policy on the overall economy (not just one sector). However, they reflect a very coarse view of the technology and the associated constraints—an area where techno-economic and sectoral models are much more useful. Further, the available macroeconomic models often assume that the economic system runs very smoothly (agents make correct predictions, markets work properly, prices adjust quickly, etc.), so comparisons between these tools are misleading to say the least.[9]

23.4 Evaluation of Co-benefits and Adverse Side-Effects

One of the major innovations in the literature over the last 10 years has been a much more detailed examination of climate policies' co-benefits and adverse side-effects. A detailed summary will be found in each sectoral chapter of Edenhofer et al. (2014).

However, integrating co-benefits into climate policy assessment raises difficult problems, the most serious one, in practice, being the lack of measurements. In most studies, climate policies' consequences in dimensions other than the purely climatic are ignored. To gauge those consequences would require specific studies, costly to undertake and therefore generally omitted. For example, few evaluations of biomass energy deployment policies seriously assess their implications for biodiversity.

In the recent literature, however, climate policies are more and more frequently assessed in several dimensions, either through a combination of separate studies, or

[9]Techno-economic models have often been termed more 'optimistic' in that they produce emission reduction costs that are lower than in macroeconomic models. Ongoing research is trying to reduce the disparity between the two families of models, in particular by producing so-called 'hybrid' models that contain a general representation of the economy, but retain a somewhat detailed representation of the technical system and less-than-totally-smooth functioning of the economy (Hourcade et al. 2006).

because some of the assessment models mentioned above integrate modules on, for example, local pollution or inequalities. The implications of policy choices for climate and any co-benefits or adverse side-effects are typically evaluated separately, in physical terms. For example, an epidemiological model is used to estimate the number of days of sick leave that are likely to be gained if coal-fired power plants are replaced with renewable-energy power plants. Thus, the evaluation uses a number of criteria.

The next step is to determine the total net cost of the policy by integrating direct costs, co-benefits and adverse side-effects into a common metric. For example, can a local pollution reduction achieved by a breakthrough in renewable energy at the expense of coal offset the policy's economic cost, perhaps in terms of higher energy prices, producing an economic downturn?

That stage is conceptually more difficult. On the one hand, a physical reduction, e.g. of local pollution, does not necessarily correspond to an economic benefit. If pollution is already very low, the cost of additional pollution reduction for companies and households may be incommensurate with the public health benefits. On the other hand, the fact that a given climate policy produces a co-benefit does not mean that a different climate policy, with a specific policy on that co-benefit, would not be more effective.

23.5 Outlook

In general, when we speak of assessment of public policies, we mean ex post assessment. In the case of climate change, as we saw above, the assessment exercises have mostly been conducted ex ante, for the simple reason that few climate policies have so far been implemented in the world, or in any case not long enough for an ex post assessment to be relevant. That situation should gradually change as public policies to limit the impacts of climate change become more common.

Then, too, most studies focus on evaluating mitigation policies; those that deal with adaptation are very much in the minority. That imbalance is due to a much better developed base of tools and models for mitigation than for adaptation (climate policy assessment in particular being based on all the tools developed to assess energy policies since the first oil shock), but also to the greater attention paid to mitigation by the international community during the 1990s and much of the early 2000s. In that area too the balance is being redressed—because tools to evaluate impacts and adaptation are rapidly being developed, but also because of a realization that even if mitigation policies are a success, the scale of climate change will be so great that significant adaptation action will be required.[10]

[10]Moreover, mitigation and adaptation are often linked, for example in the field of agriculture and forestry.

Climate policies are only one aspect of the tools available to governments to combat climate change. The challenge is also (or mainly?) to take the climate issue into account in integrated policies whose goals are (primarily) of a different order. In that case, assessment becomes more delicate, since what it really amounts to is comparing a number of development trajectories of a whole system (a city, a national economy, etc.) using a multicriterion analysis—one of the criteria being GHG emissions or climate change vulnerability. Comparing widely varying future states presents economic analysis with methodological problems that have as yet no solution. There are, however, attempts at integrated analyses, for instance at the city level (see in particular Chap. 12 of Edenhofer et al. 2014).

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