14 Evaluating synergies and trade-offs, and using results

This chapter provides an overview of approaches for understanding and evaluating the results and possible trade-offs across multiple impact categories included in the assessment, and making decisions based on the results. The chapter is applicable to qualitative and quantitative assessments, either ex-ante or ex-post.

14.1 Introduction to approaches

After assessing the impacts of a policy on the various impact categories in previous chapters, the final step is to evaluate the results across all the impact categories and draw conclusions to make decisions about policy selection, design and implementation. In many cases, users will need to evaluate trade-offs, since the policy is likely to achieve positive benefits in some impact categories and have negative effects in others.

Policies can be evaluated based on the following criteria to determine which to implement or prioritize:[48]

- **Effectiveness.** Which policy option maximizes positive impacts and achieves desired outcomes across selected impact categories, and best contributes to broader goals such as SDGs?
- **Efficiency or cost-effectiveness.** Which policy option generates the greatest positive impacts for a given level of resources?
- **Coherence.** Which policy option is most likely to avoid negative impacts, limit trade-offs and achieve net benefits across the various impact categories that are relevant to policy objectives?

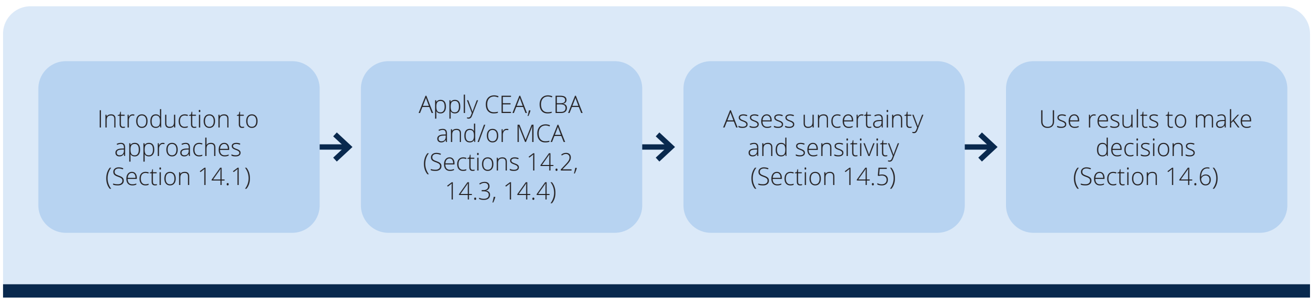
The same questions can be asked of different policy design or implementation choices within a single policy option, to optimize policy design and implementation. During or after policy implementation, the same questions can also be asked to determine how effective policies have been, to inform any adjustments to policy design or implementation and decide whether to continue current actions, enhance current actions or implement additional actions.

Multiple methods are available to address these questions. This chapter focuses on three such methods (summarized in Table 14.1):

- cost-effectiveness analysis (CEA)
- cost–benefit analysis (CBA)
- multi-criteria analysis (MCA).

FIGURE **14.1**

Overview of steps in the chapter



[48] European Commission (2009).

TABLE **14.1**

Summary of methods

Method	Description	Advantages	Disadvantages
Cost-effectiveness analysis	• Determines the ratio of costs to effectiveness for a given impact category • Can be used to compare policy options to determine which is most effective in achieving a given objective for the least cost	Simple approach; does not require that non-monetary benefits be quantified in monetary terms; fewer subjective elements	Results in multiple indicators when assessing more than one impact category; requires discount rates
Cost–benefit analysis	• Determines the net benefits to society (the difference between total social benefits and total social costs) of policy options • Can be used to compare policy options to determine which has the greatest net benefit to society, or to analyse a single policy to determine whether its total benefits to society exceed its costs	Assesses aggregated benefits (across the environmental, social and economic dimensions) of policy options with one single indicator	Complex approach that requires monetizing non-monetary costs and benefits, and requires discount rates; can underestimate non-monetary benefits
Multi-criteria analysis	• Compares the favourability of policy options based on multiple criteria • Can be used to determine the most preferred policy option	Assesses aggregated benefits (across the environmental, social and economic dimensions) of policy options with one single indicator; does not require that non-monetary benefits be quantified in monetary terms; does not require discount rate	Has significant subjective elements

Users should select one or more methods based on the objectives and circumstances. CEA and CBA are relevant to quantitative impact assessments, since they both require estimates of policy impact, whereas MCA can be applied to either qualitative or quantitative impact assessment. CBA and MCA are best suited to assessing multiple impact categories, whereas CEA works well if the policy has one primary objective and one primary measure of effectiveness (although it can be used to provide multiple results – one for each impact category). CEA and MCA are easier to conduct than CBA, which requires more complex techniques such as monetizing impacts. Other approaches beyond CEA, CBA and MCA include life cycle cost assessment and economic rate of return.

Valuing or monetizing impacts is not always necessary when assessing the impacts of a policy. The method outlined in Parts II, III and IV explain how to quantify the impacts of policies in physical terms, such as tonnes of air pollution reduced, number of jobs created, or number of people with increased access to energy. Expressing these impacts in monetary terms is useful to carry out a CBA, but is not always necessary to understand the benefits and costs arising from a policy, and make decisions about which policies to implement.

Users should define the impacts that are included in the CEA, CBA or MCA in a way that avoids duplication and overlap between impacts. Defining distinct impacts helps avoid double counting, which could lead to biased results.

14.2 Cost-effectiveness analysis

CEA involves comparing different policy options based on their costs in achieving a single desired objective. The output of a CEA is a ratio of costs to effectiveness for a given policy option, such as cost per job created or cost per tonne of air pollution reduced. This ratio can be compared across policy options to determine which is most cost-effective. Cost-effectiveness can also be calculated for different groups in society to assess distributional impacts.

In general, a CEA consists of three steps:

1. Estimate the cost of each policy option.

2. Estimate the impact of each policy option for relevant impact categories.

3. Calculate the cost-effectiveness of each policy option for relevant impact categories.

14.2.1 Step 1: Estimate the cost of each policy option

In CEA, cost refers to monetary costs. The cost of policy options could include direct costs to the government to implement the policy (e.g. budget expenditure and administrative costs), direct costs to members of society (e.g. taxes and other compliance costs) and indirect costs to members of society (e.g. higher fuel prices). Users should include direct government costs in all cases. Depending on the purpose of the analysis, users can include other monetary costs when conducting the CEA. There may also be negative costs that should be taken into account – that is, monetary costs that are reduced because of the policy, such as reduced energy costs or reduced subsidies for fossil fuel.

Users should compare costs of different policy options based on the present value of costs. Costs that are incurred over time can be converted to present value by applying a discount rate. Equation 14.1 provides equations for calculating the present value of costs. Box 14.1 provides more information on discount rates. Table 14.2 provides an example of calculating costs for two illustrative policies over a 10-year period.

Equation 14.1: Calculating present value of costs

$$PV_C = \Sigma_{t=0}^{n} C_t / (1 + r)^t$$

where PV_C is the present value of costs, C_t is costs in a particular year, r is the discount rate, t is the number

BOX **14.1**

Discount rates

Costs and benefits are likely to arise over multiple time periods. In economic theory, monetary impacts in the future are worth less to individuals than resources available today, since individuals can earn a return on investment on money they possess today, which they forego when receiving the same amount of money in the future. Both CEA and CBA typically convert monetary values to their present value by using a discount rate.

For sustainable development impacts, social discount rates are most appropriate, since they reflect a society's relative valuation of today's well-being versus well-being in the future. Social discount rates can vary widely – for example, from 0% to more than 10% – depending on how they address equity concerns with respect to future generations, among other considerations not accounted for in national interest rates or typical discount rates. The World Bank has recommended using social discount rates of 6% for low- and middle-income countries, and 4% for high-income countries.[48] The European Commission Impact Assessment Guidelines recommends a discount rate of 4%.[49]

The following discussion offers further perspectives on the choice of a discount rate: "A high discount rate suggests those alive today are worth more than future generations. A third approach to discounting, based on ethics, says this is wrong, and argues for a very low or even zero rate. This is why the Stern Review on the economics of climate change published in 2006 adopted a rate of 1.4%. US government guidance is to use discount rates of both 3% and 7% for valuing costs and benefits within a single generation of, say, 30 years. It suggests using a lower rate, for time horizons that cross generations. UK government guidance from HM Treasury is to use a 3.5% rate. However, it says: 'The received view is that a lower discount rate for the longer term (beyond 30 years) should be used.' It sets out a sliding scale falling to 1% for time periods greater than 300 years. In a major survey of 197 economists, the average long-term discount rate was 2.25%. The survey found almost all were happy with a rate of between 1 and 3%, whereas only a few favoured higher figures."[50] Users should consider a range of discount rates and conduct sensitivity analysis to see how the choice affects the overall results.

[49] World Bank and IHME (2016).

[50] European Commission (2009).

[51] Carbon Brief (2017).

of years from the present and *n* is the number of years.

14.2.2 Step 2: Estimate the impact of each policy option for relevant impact categories

Users should use the quantitative assessment results from previous chapters for all relevant impact categories as the measure of impact for each policy option – that is, the change in indicator value attributed to the policy. Table 14.3 provides an illustrative example of the effectiveness of each policy option.

14.2.3 Step 3: Calculate the cost-effectiveness of each policy option for relevant impact categories

Equation 14.2 provides the equation for calculating cost-effectiveness. Cost-effectiveness can only be calculated for one impact category at a time. Users can apply the method individually to each impact category of interest to calculate different cost-effectiveness ratios for each impact category, such as cost per job created or cost per tonne of air pollution reduced.

Equation 14.2: Calculating cost-effectiveness for a policy

$$\text{Cost-effectiveness} = \frac{PV_C}{impact}$$

TABLE **14.2**

Example of calculating costs (present value) of two policies over a 10-year period (illustrative results only)

Policy options	Discount rate	Costs in each year (million $)					Discounted costs (million $)					Present value (million $)
		Year 1	Year 2	…	Year 9	Year 10	Year 1	Year 2	…	Year 9	Year 10	
Solar PV incentive policy	3%	1	1	…	1	1	0.97	0.94	…	0.77	0.74	8.53
Energy efficiency policy		0.4	0.4	…	0.4	0.4	0.39	0.38	…	0.31	0.30	3.41

TABLE **14.3**

Impact of two policies across three impact categories (illustrative results only)

Policy options	GHG reduction	Air pollution reduction	Job creation
Solar PV incentive policy	50,000 tCO_2e per year for 10 years	1,000 t $PM_{2.5}$ per year for 10 years	200 jobs created in the first year, which last for 10 years
Energy efficiency policy	30,000 tCO_2e per year for 10 years	600 t $PM_{2.5}$ per year for 10 years	50 jobs created in the first year, which last for 10 years

TABLE **14.4**

Calculating cost-effectiveness for a solar PV incentive policy (illustrative results only)

Policy options	GHG reduction	Air pollution reduction	Job creation
Solar PV incentive policy	\$17 per tCO_2e reduced	\$853 per t $PM_{2.5}$ reduced	\$42,651 per job created
Energy efficiency policy	\$11 per tCO_2e reduced	\$568 per t $PM_{2.5}$ reduced	\$68,241 per job created

Note: Results are over the 10-year assessment period.

where PV_C is the present value of costs, and *impact* is the quantified change for a specific impact category.

Table 14.4 shows the cost-effectiveness results for both policy options for each of three impact categories: GHG reduction, air pollution reduction and job creation. In this illustrative example, the energy efficiency policy is more cost-effective in reducing GHG emissions and air pollution, but less cost-effective in creating jobs.

From the point of view of cost-effectiveness, users should balance the trade-offs and choose which policy option to implement based on which impact categories are most important and the relative cost-effectiveness of the results. CBA and MCA offer further approaches to help decide which policy option to implement.

14.3 Cost–benefit analysis

Unlike CEA, CBA takes into account a wide variety of costs and benefits of a policy in an aggregated manner. CBA involves quantifying the benefits and costs of a policy, and expressing them in monetary terms, using valuation methods. These amounts are used as a proxy to represent social and environmental impacts that may not have an explicit economic or monetary value.

The result of CBA can be used to determine whether the net benefits of a single policy exceed its net costs and therefore whether the policy should be implemented (in the case of ex-ante assessment) or continued (in the case of ex-post assessment). CBA can also be used to compare multiple policy options to determine which has the greatest net benefits to society and should be implemented.

There are three steps to conducting a CBA:

1. Quantify all relevant costs and benefits of the policy.
2. Express non-monetary costs and benefits in monetary terms.
3. Calculate the present value of all cost and benefits, and calculate the net present value for each policy option.

14.3.1 Step 1: Quantify all relevant costs and benefits of the policy

In CBA, benefits refer to positive impacts and costs refer to negative impacts. Benefits also include avoided negative impacts. Unlike CEA, where only monetary costs are accounted for, CBA includes all relevant social, economic and environmental costs and benefits: both monetary and non-monetary. Costs should be calculated as described for CEA, while the broader impacts should be quantified in physical terms (rather than monetary terms), as described in Parts II, III and IV. Table 14.5 provides an example of costs and benefits for two policy options.

TABLE **14.5**

Costs and benefits of two policy options (illustrative results only)

Policy options	Costs	Benefits		
		GHG reduction	Air pollution reduction	Job creation
Solar PV incentive policy	$1,000,000 each year for 10 years	50,000 tCO_2e per year for 10 years	1,000 t $PM_{2.5}$ per year for 10 years	200 jobs created in the first year, which last for 10 years
Energy efficiency policy	$400,000 each year for 10 years	30,000 tCO_2e per year for 10 years	600 t $PM_{2.5}$ per year for 10 years	50 jobs created in the first year, which last for 10 years

14.3.2 Step 2: Express non-monetary costs and benefits in monetary terms

CBA involves expressing non-economic impacts in monetary terms using valuation methods. Economists estimate monetary values of non-monetary costs and benefits by linking them to market prices or quantifying their impact on utility, such as the satisfaction a person derives from consuming a particular good or their change in well-being.[52]

A downside of CBA is that many environmental and social benefits are intangible, uncertain, subjective or controversial to monetize. If all costs and benefits cannot be properly quantified in monetary terms, a partial CBA can be carried out that includes the subset of costs and benefits that are quantified and monetized. Alternatively, users can apply MCA, which does not monetize benefits.

Users should avoid double counting monetary values across multiple impacts. For example, some policies to reduce GHG emissions also generate jobs, bringing economic benefits, which may be reflected in the monetary value of GHG reduction. If the benefit from job creation is quantified separately from the benefit from GHG reduction, the same benefit should not be included in both monetary values.

The appropriate monetary value for each impact should be based on the specific circumstances of the assessment. As an illustrative example, in the case of the solar PV incentive policy, the monetary values for GHG reduction, air pollution reduction and job creation are assumed to be $41/$tCO_2e$, $140,000/t $PM_{2.5}$, and $293,330/job, respectively, based on relevant literature.[53] These values are illustrative and represent one of multiple ways of assigning monetary values to benefits (e.g. estimating economic impacts of job creation).

14.3.3 Step 3: Calculate the present value of all cost and benefits, and calculate the net present value for each policy option

The output of a CBA is a calculated value representing the present value of net benefits of the policy to society. Users should discount the future costs and benefits to calculate the present value of costs and benefits, and calculate the net present value for each policy option. This step is similar to step 1 for CEA. Users should use equation 14.3 to calculate the result, which is an aggregated value representing the net present value of the net benefits of the policy to society.

The results can be used, for example, to determine whether a policy has a positive net benefit to society and therefore should be implemented, or to compare two policy options and implement the policy option with the greatest net benefits.

[52] European Commission (no date).

[53] Adapted from Interagency Working Group on Social Cost of Greenhouse Gases (2016), U.S. EPA (no date, b) and Kentucky Cabinet for Economic Development (2018).

CBA typically considers net benefits in aggregate rather than addressing distributional impacts among different groups in society. However, the various costs and benefits in a CBA can be disaggregated among different stakeholder groups to assess distributional impacts. Alternatively, if distributional impacts are significant, MCA may be preferable.

Equation 14.3: Calculating the net benefit of a policy

$$\mathrm{NPV} = \mathrm{PV}_B - \mathrm{PV}_C$$

where NPV is the net present value, representing the net benefits of the policy.

$$\mathrm{PV}_B = \Sigma_{t=0}^{n} \mathrm{B}_t \,/\, (1 + r)^t$$

where PV_B is the present value of benefits, B_t is the benefits in a particular year, r is the discount rate, t is the number of years from the present and n is the number of years.

$$\mathrm{PV}_C = \Sigma_{t=0}^{n} \mathrm{C}_t \,/\, (1 + r)^t$$

where PV_C is the present value of costs, C_t is costs in a particular year, r is the discount rate, t is the number of years from the present and n is the number of years.

Table 14.6 shows the calculation of net benefits of policy options for the illustrative solar PV incentive policy, focusing on the monetized value of GHG reduction, air pollution reduction and job creation. In the example, the solar PV incentive policy has greater net benefits than the energy efficiency policy, so is the preferred policy option.

TABLE **14.6**

Calculation of net benefits (NPV) for two policy options (illustrative results only)

Policy options		Annual costs/benefits	Discount rate	Duration	Present value of costs/benefits
Solar PV incentive policy	Costs	$1,000,000	3%	10 years	$\sum_{t=1}^{10}$ $1,000,000 / (1+0.03)^t = $8,530,203
	Benefits	(50,000 × $41) + (1,000 × $140,000) + (200 × $293,330) = $200,716,000			$\sum_{t=1}^{10}$ $200,716,000/(1+0.03)^t = $1,712,148,193
	Net benefits	**$199,716,000**			$1,712,148,193 – $8,530,203 = **$1,703,617,990**
Energy efficiency policy	Costs	$400,000	3%	10 years	$\sum_{t=1}^{10}$ $400,000 / (1+0.03)^t = $3,412,081
	Benefits	(30,000 × $41) + (600 × $140,000) + (50 × $293,330) = $99,896,500			$\sum_{t=1}^{10}$ $99,896,500/ (1+0.03)^t = $852,137,408
	Net benefits	**$99,496,500**			$852,137,408 – $3,412,081 = **$848,725,327**

14.4 Multi-criteria analysis

MCA or multi-criteria decision analysis (MCDA) allows stakeholders to determine an overall preference among alternative options, where the options accomplish multiple goals. It uses normalization and weighting to aggregate results into one metric.[54,55] Indicators used to measure each criterion can be qualitative or quantitative.[56] There are multiple ways to construct and apply an MCA. For example, different scales can be used to assign a performance score and to determine criteria weight factors.

This section provides simplified guidance based on the MCDA approach described in the United Kingdom Government's *Multi-criteria Analysis: a Manual*.[57] Additional references are listed at the end of the chapter for further guidance on this and other MCA approaches.

MCA can be summarized into three general steps:

1. Identify the decision context, policy options, assessment objectives and criteria.
2. Score the performance of each policy option for each criterion.
3. Assign a weight to each criterion, and calculate an overall score and/or cost–benefit ratio for each option.

14.4.1 Step 1: Identify decision context, policy options, assessment objectives and criteria

In the first step, the user should answer the following questions:[58]

- What are the overall reasons or objectives for the analysis and who are the stakeholders for the decision?
- What are the options to be assessed?
- What is the decision that needs to be made?
- What are the economic, social and political factors that should be considered for the decision?

Most questions in step 1 should be largely defined in the assessment steps detailed in Chapters 2, 4 and 5. Users should review these and determine whether they are appropriate for the MCA. Users should also review whether the policy being assessed creates appropriate options for the MCA, since an MCA requires multiple policy options. If only a single policy's sustainable development impacts are being assessed, users should decide whether to conduct additional impact assessments for additional policy options and/or use "no action" as an option.

For example, in the case of a solar PV incentive policy, the reason for the assessment is to support the government's efforts to pursue multiple policy objectives, such as addressing climate change, improving health from improved air quality, creating jobs, improving energy independence and reducing budget deficits. Within that context, three policy options are identified: enact a solar PV incentive policy, enact an energy efficiency policy, or take no action. These policy objectives translate into five criteria for the MCA: GHG reduction, air pollution reduction, job creation, energy independence and direct costs.

14.4.2 Step 2: Score the performance of each policy option for each criterion

This step involves characterizing, either quantitatively or qualitatively, the performance of each option against each criterion, then normalizing the performance to scores.[59]

A performance matrix can be used to summarize and present the performance of options. For criteria that are assessed quantitatively, the value should be used directly. For criteria that are assessed qualitatively, the user should provide a succinct description of the result.

In the example of the solar PV incentive policy, four criteria were quantified, and one criterion (energy independence) was assessed qualitatively. The results are shown in Table 14.7.

The performance of each option should be assessed relative to a baseline scenario (as described in Chapter 8). In this example, the baseline scenario is

[54] DCLG (2009).

[55] JISEA (2014).

[56] WRI (2014).

[57] DCLG (2009).

[58] USAID (2014).

[59] DCLG (2009).

"no action", where no policy is implemented. When scoring the "no action" option, users should be aware that taking no action often also has costs. For example, not acting on climate change has significant monetary, social, economic and environmental costs.

After producing the performance matrix, users should rank the performance for each criterion. For criteria that are quantitatively assessed, the user should assign 100 to the best option and 0 to the worst option. All others should be scaled between these limits in proportion to their quantitative impacts.

For criteria that are assessed qualitatively, users can directly assign scores to each option's performance for each criterion, giving the best performance a score of 100 and the worst performance a score of 0, and score everything else in between. This may require making difficult judgments about the degree of difference between each option's qualitative performance. However, such judgments are required to conduct an MCA for qualitatively assessed criteria.[60]

Table 14.8 illustrates the performance scores for the solar PV incentive policy.

14.4.3 Step 3: Assign a weight to each criterion, and calculate an overall score and/or cost–benefit ratio for each option

In this step, users should determine how important each criterion, or impact category, is to the decision. The process of deriving weights is fundamental to the effectiveness of MCA and has a very significant effect on the overall results.[61] The weights should appropriately reflect value assumptions and policy priorities. Since it is subjective, weighting should be developed in consultation with stakeholders, such as policymakers, businesses, civil society, and other

TABLE **14.7**

Performance matrix for an illustrative multi-criteria analysis (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation	Energy independence	Monetary costs ($)
Solar PV incentive policy	50,000 tCO_2e	10,000 t $PM_{2.5}$	200	Major positive impact	8,530,203
Energy efficiency policy	30,000 tCO_2e	6,000 t $PM_{2.5}$	50	Moderate positive impact	3,412,081
No action	0	0	0	No impact	0

TABLE **14.8**

Performance scores for an illustrative multi-criteria analysis (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation	Energy independence	Direct Monetary costs ($)
Solar PV incentive policy	100	100	100	100	0
Energy efficiency policy	60	60	25	50	60
No action	0	0	0	0	100

[60] DCLG (2009).

[61] DCLG (2009).

experts and affected stakeholders. Weighting should be guided by the objectives of the assessment, and the local policy objectives and context. It should be transparently documented and justified.

One approach is to allocate a total of 100 points among all criteria, with more points meaning that the criterion is more important. When allocating the points, users should take into account the importance of each criterion, and also the size of the difference between the least and most preferred options. For example, the user may decide that job creation is important, but, in the illustrative case of the solar PV incentive and energy efficiency policies, the difference between the best- and worst-performing options is only 100 jobs, which is insignificant in the broader context of total jobs in a country. That criterion should receive a low weight because the difference between the highest and lowest options is small.[62]

Once the weights are determined, the user should determine an overall score for each option by calculating the weighted average of its scores on all the criteria.[63] Equation 14.4 shows how to calculate the result.

Equation 14.4: Calculating an overall score for each option

$$S_i = \frac{\sum_{j=1}^{n} W_j S_{ij}}{100}$$

where S_i is the overall score for option *i*, W_j is the weight for criterion *j*, and S_{ij} is the performance score of option *i* for criterion *j.*

Table 14.9 shows the overall scores for each option in an illustrative MCA. In this example, the solar PV incentive policy has the highest score, so is the most preferred policy option.

Another useful approach is to calculate the benefits score without including monetary costs. To do so, users should classify all criteria into two categories – costs and benefits – assign weights to criteria in the benefits category only, and then calculate the weighted-average performance scores for each option. By separating performance scores and costs, users can calculate the cost–benefit ratios for each option.

Table 14.10 demonstrates how to calculate performance scores and cost–benefit ratios. In this example, the criteria weights from Table 14.9 have been scaled proportionately because direct

TABLE **14.9**

Calculating overall scores for an illustrative multi-criteria analysis (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation	Energy independence	Direct Monetary costs ($)	Overall score
Criteria weights	**30**	**30**	**5**	**5**	**30**	**-**
Solar PV incentive policy	100	100	100	100	0	70
Energy efficiency policy	60	60	25	50	60	57.75
No action	0	0	0	0	100	30

Abbreviation: -, not applicable

[62] DCLG (2009).

[63] DCLG (2009).

TABLE **14.10**

Calculating performance scores for an illustrative multi-criteria analysis (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation	Energy independ-ence	Overall perform-ance score	Direct monetary costs (million $)	Cost–benefit ratio ($ per unit of perform-ance score)
Criteria weights	**42**	**42**	**8**	**8**	**-**	**-**	**-**
Solar PV incentive policy	100	100	100	100	100	8,530,203	85,302
Energy efficiency policy	60	60	25	50	56.4	3,412,081	60,498
No action	0	0	0	0	0	0	-

Abbreviation: -, not applicable

monetary costs are now excluded. The solar PV incentive policy has a higher cost–benefit ratio than the energy efficiency policy. If policymakers are concerned with maximizing benefits or effectiveness, the solar PV incentive policy is preferred, as shown in Table 14.9. If policymakers are concerned with maximizing benefits per unit of cost, the energy efficiency policy is preferred. These results are very sensitive to assumptions about performance scores and criteria weights, so conclusions should be made carefully.

14.5 Assess uncertainty and sensitivity

All approaches to evaluating trade-offs (CEA, CBA and MCA) involve a certain level of complexity and subjectivity. Therefore, it can be useful to conduct uncertainty and sensitivity analyses to examine the extent to which key assumptions or different views among stakeholders affect the results. Users should follow the guidance in Chapter 11 to assess the uncertainty and sensitivity of the results.

Table 14.11 provides examples of key parameters for sensitivity analysis for CEA, CBA and MCA. The list is not exhaustive, and users should consider whether differences in assumptions and values advocated by different stakeholders yield significantly different results. If so, the assumptions and values should be investigated and discussed further. If not, the results can be considered more robust for purposes of choosing between policy options.

Table 14.12 shows how the values of key parameters can be varied as part of a sensitivity analysis. Table 14.13 shows how a sensitivity analysis can be calculated for one key parameter as part of a CEA.

TABLE **14.11**

Examples of key parameters for sensitivity analysis

Type of analysis	Key parameters for sensitivity analysis
Cost-effectiveness analysis	Discount rate
Cost–benefit analysis	Discount rate; monetary value of non-monetary costs and benefits
Multi-criteria analysis	Criteria weights; performance scores for qualitatively assessed criteria

TABLE **14.12**

Parameters considered for sensitivity analysis (illustrative results only)

Sensitivity scenario	Cost-effectiveness analysis	Cost–benefit analysis		Multi-criteria analysis	
	Discount rate (%)	Discount rate (%)	Monetary value of CO_2 emissions reduction ($)	Criteria weights (GHG reduction : air pollution reduction : job creation : energy independence : monetary costs)	Performance scores for energy independence (solar PV policy : energy efficiency policy)
Primary scenario	3	3	41	30:30:5:5:30	100:50
Alternative scenario 1	1.4	1.4	13	10:40:5:5:40	100:20
Alternative scenario 2	6	6	120	20:20:15:15:30	100:80

TABLE **14.13**

Sensitivity analysis of discount rates in a cost-effectiveness analysis (illustrative results only)

Sensitivity scenario	Policy option	GHG reduction ($ per tCO_2e)	Air pollution reduction ($ per t $PM_{2.5}$)	Job creation ($ per job)
Primary scenario: discount rate 3%	Solar PV incentive policy	17	853	42,651
	Energy efficiency policy	11	568	68,241
Alternative scenario 1: discount rate 1.4%	Solar PV incentive policy	19	927	46,356
	Energy efficiency policy	12	618	74,170
Alternative scenario 2: discount rate 6%	Solar PV incentive policy	15	736	36,800
	Energy efficiency policy	10	491	58,881

14.6 Using results to make decisions

Depending on the assessment objectives, different decisions need to be made. For ex-ante assessments, decisions may include whether to implement a specific policy, whether to implement multiple policies, or how to improve a policy before implementation. For ex-post assessments, decisions may include whether to continue or discontinue a policy that is in effect, whether to revive a policy that is no longer in effect, or how to improve a policy during implementation.

14.6.1 Choosing a policy option

CEA, CBA and MCA provide useful insights on the effectiveness, efficiency and coherence of policy options. However, before decisions are made based on the results, it is important to gather further inputs and perspectives on the best course of action, since each analytical approach has limitations and involves subjective judgments.

In general, policy options that do not have positive net benefits should be eliminated. The same is true for policy options that are inferior to others under every criterion. To assist with decision-making, users can develop a performance matrix of policy options (including no action), using effectiveness, efficiency and coherence as criteria, as illustrated in Table 14.14. The example shows that any of these policy options would be preferred based on certain criteria, but not on others. Users should prioritize or weight criteria to decide which policy option is preferred overall.

In some circumstances, rather than taking a neutral approach to maximizing net benefits across all impact categories, users may want to focus on minimizing negative impacts in certain key impact categories or ensuring zero negative impacts across all impact categories. Users should consider the following factors when making decisions regarding trade-offs:

- **Minimum requirements.** There may be minimum thresholds for a given impact category below which a policy should not be implemented – for example, relating to human rights violations. Minimum requirements are not negotiable, meaning that the negative impact cannot be offset by positive impacts in other impact categories. Minimum thresholds could be set by statutes, science or sociopolitical expectations. In such

TABLE **14.14**

Illustrative performance matrix for policy options (illustrative results only)

Policy option	Effectiveness	Efficiency	Coherence
Solar PV incentive policy	Reduces 50,000 tCO_2e and 10,000 t $PM_{2.5}$; creates 200 jobs; major positive impact on energy independence (Table 14.7) Overall performance score of 100 (Table 14.10)	\$17 per tCO_2e reduced; \$853 per t $PM_{2.5}$ reduced; \$42,651 per job created (Table 14.4) Cost of \$85,302 per unit of performance score (Table 14.10)	Good balance of climate, air, energy independence and job impacts Trade-off exists with monetary costs, but net benefits of \$1,704 million (Table 14.6)
Energy efficiency policy	Reduces 30,000 tCO_2e and 6,000 t $PM_{2.5}$; creates 50 jobs; moderate positive impact on energy independence (Table 14.7) Overall performance score of 56.4 (Table 14.10)	\$11 per t tCO_2e reduced; \$568 per t $PM_{2.5}$ reduced; \$68,241 per job created (Table 14.4) Cost of \$60,498 per unit of performance score (Table 14.10)	Good balance of climate, air, energy independence and job impacts Trade-off exists with monetary costs, but net benefits of \$849 million (Table 14.6)
No action	No positive impacts	No costs (or benefits)	No trade-off (because there are no benefits)

Source: Adapted from European Commission (2009).

cases, users should either improve the policy design to mitigate the negative impacts or discontinue the policy option.

- **Irreversibility.** Policies may have negative impacts, such as loss of species, that are irreversible, are deemed unacceptable and cannot be offset with positive impacts in other impact categories. In such cases, users should improve the policy design to avoid irreversible negative impacts or discontinue the policy option.

- **Precaution.** Policies may present major risks that are highly uncertain but could be catastrophic. Users should adopt the precautionary principle by taking precautionary protection against potentially hazardous impacts, and in such cases give more weight to avoiding negative impacts than achieving positive impacts.[64]

If multiple policy options are being considered for implementation, users should also be aware that, if policy A is better than policy B, it is not necessarily the case that policy A + C is better than policy B + C, because of the potential for interactions between the policies (described in Chapter 4). In such a case, users should consider evaluating the impact of each combination of policies separately to determine which combination is best.

14.6.2 Improving policy design

Users should consider improving policy design based on the assessment results. In some cases, the assessment findings may warrant complete redevelopment of a policy option. To improve policy design, users can explore how different policy implementation specifications can mitigate any negative impacts. For example, if a solar PV incentive policy is found to have negative impacts on the national budget, policymakers can optimize the policy by choosing a financing model that would lead to lower costs.

Users should also consider establishing safeguards as part of the policy design (e.g. environmental standards for solar manufacturing) to minimize the likelihood of negative impacts, or developing measures to offset any negative impacts (e.g. job retraining programmes for job losses in the coal-mining sector). The effectiveness of safeguards and offset measures should be evaluated and closely monitored during the policy implementation period to ensure that they are working as planned.[65]

TABLE **14.15**

Further references on CEA, CBA and MCA

Reference	Topics
Asian Development Bank (2007). *Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: a Survey*. Economics and Research Department Working Paper, Series No. 94.	Discount rates
Bakhtiari, F. (2016). *Valuation of Climate Change Mitigation Co-Benefits*. Copenhagen: UNEP DTU Partnership.	Valuation methods
Boardman, A., and others (2006). *Cost–Benefit Analysis: Concepts and Practice*. Upper Saddle River, New Jersey: Prentice Hall.	CBA
Centre for European Policy Studies and Economisti Associati (2013). *Assessing the Costs and Benefits of Regulation*. Study for the European Commission, Secretariat General.	CBA, discount rates, valuation methods
Council of Economic Advisers (2017). *Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate.*	Discount rates
Eureval-C3E (2006). *Study on the Use of Cost-effectiveness Analysis in EC's Evaluations.*	CEA

64 Federal Office for Spatial Development, Switzerland (2004).

65 Federal Office for Spatial Development, Switzerland (2004).

TABLE **14.15,** continued

Further references on CEA, CBA and MCA

Reference	Topics
European Commission (2009). *Impact Assessment Guidelines.*	CEA, CBA, MCA, discount rates
European Commission (2009). *Impact Assessment Guidelines: Technical Annex.*	CEA, CBA, MCA, discount rates
European Commission (2014). *Guide to Cost–Benefit Analysis of Investment Projects.*	CBA
European Commission (no date). *Better Regulation Toolbox*. Chapter 8: Methods, models, costs, and benefits.	CEA, CBA, MCA, discount rates
HM Treasury, United Kingdom (2011). *Green Book: Appraisal and Evaluation in Central Government.*	CEA, CBA, MCA
Interagency Working Group on Social Cost of Greenhouse Gases, United States Government (2016). *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis: Under Executive Order 12866.*	Social cost of carbon
Jeuland, Marc, and Jie-Sheng Tan Soo (2016). *Analyzing the Costs and Benefits of Clean and Improved Cooking Solutions.* Washington, D.C.: Clean Cooking Alliance.	CBA
Lawrence, Robert S., Lisa A. Robinson and Wilhelmine Miller, eds. (2006). *Valuing Health for Regulatory Cost-Effectiveness Analysis*. Chapter 5: Recommendations for regulatory cost-effectiveness analysis. Washington, D.C.: National Academies Press.	CEA
Organisation for Economic Co-operation and Development (2006). *Cost–Benefit Analysis and the Environment: Recent Developments.*	CBA
Organisation for Economic Co-operation and Development (2014). *OECD Regulatory Compliance Cost Assessment Guidance.*	CEA
Organisation for Economic Co-operation and Development (2016). *The Economic Consequences of Outdoor Air Pollution.*	CBA
Puig, D., and S. Aparcana (2016). *Decision-Support Tools for Climate Change Mitigation Planning*. Copenhagen: UNEP DTU Partnership.	CEA, CBA, MCA
Scrieciu, S. Ş., and others (2014). Advancing methodological thinking and practice for development-compatible climate policy planning. *Mitigation and Adaptation Strategies for Global Change*, vol. 19, No. 3, pp. 261–288.	MCA
United Kingdom Department for Communities and Local Government (2009). *Multi-Criteria Analysis: a Manual.*	MCA
United Kingdom Department for Environment, Food and Rural Affairs (2003). *Use of Multi-criteria Analysis in Air Quality Policy: a Report.*	MCA
United Nations Economic Commission for Europe (2017). *Sustainable Development Briefs No.2: the Co-Benefits of Climate Change Mitigation.*	CBA
United States Agency for International Development (2014). *Application of Multi-Criteria Assessment (MCA) Methods: a Seven Step Process.*	MCA
United States Environmental Protection Agency (2010). *Guidelines for Preparing Economic Analyses.*	CBA, valuation methods, discount rates

TABLE **14.15,** continued

Further references on CEA, CBA and MCA

Reference	Topics
United States National Academies of Sciences, Engineering, and Medicine (2017). *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.*	Social cost of carbon
World Bank, Independent Evaluation Group (2007). *Sourcebook for Evaluating Global and Regional Partnership Programs: Indicative Principles and Standards.*	CEA, CBA, MCA
World Bank (2008). *Social Discount Rates for Nine Latin American Countries*. Washington, D.C.	Discount rates
World Bank and ClimateWorks Foundation (2014). *Climate Smart Development: Adding up the Benefits of Actions that Help Build Prosperity, End Poverty and Combat Climate Change.*	CBA, valuation methods, discount rates
World Bank and Institute for Health Metrics and Evaluation, University of Washington (2016). *The Cost of Air Pollution: Strengthening the Economic Case for Action.*	CBA
World Health Organization (2003). *WHO Guide to Cost-Effectiveness Analysis.*	CEA

APPENDICES