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Chapter 4

Prioritization of green growth options and pathways

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Policy makers developing green growth plans have to take decisions on many levels: the degree of ambition, the choice of different options for achieving those ambitions, and the pathways to be taken for implementing and combining these options towards desired outcomes. This chapter reviews good practices in various countries to describe how analytical and consultative tools and approaches have been used to aid decision makers in their assessment and communication of these options and pathways.

Key lessons from effective approaches are:

- The choice of tools and approaches should be deliberate and cover economic, environmental, and social aspects. The tools should follow, not drive the questions to be asked by the analysis.
- The policy questions should drive the analytical approach.

In practice, however, factors such as funding availability, donor and political priorities, and political timeframes can lead to a limited selection of analytical tools and approaches being considered.
• The scope of the tool should not restrict the scope of the green growth plan. The choice of analytical tools should be driven by the strategic priorities, not vice versa. For example, analytical tools that focus on narrowly defined metrics (such as cost-effectiveness of GHG abatement) may not be appropriate as they do not assess options in relation to other important development goals.

• The choice of analytical approach will depend on the complexity of the issue being assessed. More complex tools may be required when assessing an action with multiple impacts, or a package of actions where there are likely to be trade-offs and interactions.

• The analytical approach is often driven by pragmatic considerations such as the availability of data, resources, and capacity. Tools and methods that can be replicated and used by local experts will have more chance of being maintained. For example, spreadsheet analysis of key economic and social impacts offer a simple approach to prioritization, which can be a good place to start especially in least developed countries where data and resources may be scarce.

Combine top-down approaches driven by the vision and strategy, with bottom-up analysis of concrete actions and options. Combining tools and approaches can improve the consistency and robustness of results and address limitations of individual tools.

• Bottom-up models capturing technological detail can be combined with top-down models to address macro-economic impacts and feedbacks. In subsequent iterations of the analytical cycle, or in countries where data and resources are more advanced, more complex approaches are appropriate. For example, specialized sector-specific models might be used that relate to complex and interrelated systems such as management of water catchment areas (see Waal River case, Case 1), electricity systems, and macro-economic impacts of infrastructure development, such as in the case of the UK (Case 7).

• A relatively easy approach to prioritizing options is to rank them based on their cost-effectiveness (preferably not limited to financial costs and benefits, but viewed in a broader development context). However, a narrow analysis of short-term cost-effectiveness does not take into account longer-term trends and public preferences. In such instances additional tools may be required to strengthen the analysis.

• The choice of analytical approach should allow for a reasonable representation of social economic realities and observed behavior. Whilst many country governments may lack the expertise or data, it is essential that they do not resort to off-the-shelf models without critically scrutinizing and questioning the assumptions and theoretical underpinnings. For instance, a comparative static Computable General Equilibrium (CGE) model will be of limited value when applied to an economy that is far away from equilibrium, facing major institutional barriers and structural problems.

Choosing priorities and pathways requires clear assumptions, reasonable data, and active stakeholder engagement.

• Options for action should be assessed against key selection criteria related to green growth dynamics. These criteria should be linked to the government’s vision and strategy and in developing countries are often strongly influenced by national development plans.

• Workshops involving a variety of relevant ministries, agencies, and experts are useful to identify options. These help to gain detailed sectoral input, and a wide stakeholder input at an early stage of the process.

• Analysis will gain traction if it is robust in the eyes of stakeholders. Where technical expertise and capacity are available, multiple complex models or integrated tools can bring together economic, social, and environmental impacts that are more likely to explore some of the dynamic effects of policy choices that can help inform long-run strategic choices. This will help if it provides tangible outputs such as identifying costs and wider benefits, growth, and jobs security that are clearly presented to stakeholders.

Apply an iterative process to analyze options, identify priorities and combine them into pathways for near and long-term green growth transformation.

• The initial stages may be based on quite simple analysis, but complexity often increases over subsequent iterations as more options and types of impact are incorporated into the analysis. There should be an ongoing plan for development of the approach.

Use pathways (or scenarios) to identify the scale and pace of change required in different sectors and highlight the choices and actions that need to be made over time, along with uncertainties.

• Scenarios can act as a bridge between a government’s overarching vision and the more detailed implementation plan. They can be a powerful way to communicate the feasibility of green growth goals and can help show the
impact of different technology options. Scenarios can help decision-makers by showing the effects of factors that can be influenced (such as technology support) and factors that are outside the scope of influence (such as world oil prices). Scenarios are also used for sensitivity analysis of model results.

- Scenarios are more effective when they are aligned with the decision variables and political context in question. Greening growth often requires behavioral change and structural economic adjustment, which is typically a slow process. Pathways can provide a way of exploring realistic timescales to allow for these transformations.

- Clear assumptions and broad and meaningful involvement of relevant stakeholders are crucial to developing credible green growth pathways. The cases show how important it is in any analysis that the interest of the stakeholder be put in place as well as ensuring that the approaches used are inclusive and legitimate. The choice will depend on available resources, both in terms of data, time and expertise. Across all the case studies, there were good examples of scenarios being used to encourage consideration of appropriate ambition levels in order to increase impact.

- Uncertainties in the approach should be acknowledged even if they cannot be formally assessed. Robust accounting for uncertainty is difficult, so the best option is to seek agreement among stakeholders on the nature and extent of uncertainty in the scenarios.

1. Introduction

This chapter aims to answer the question: **What tools, methods and approaches have been used to effectively identify, analyze, and prioritize options, and articulate alternative pathways to inform green growth plans?**

What do we mean by options, tools, methods, and scenarios?

The term **option** here describes a technology, behavior, technique, action or practice that leads to an improved environmental, social, and economic outcome compared to the status quo. An option is not to be confused with the policy instruments used to achieve this (covered in **Chapter 5 on Policy design and implementation**). So for example, wind energy and Bus Rapid Transit systems are options, but feed-in tariffs or fuel standards are policy instruments.

**Tools and methods** are analytical devices ranging from formal proprietary models to less formal spread sheet analysis for evaluating the costs and impacts of particular options. **Approaches** refer to broader frameworks that bring together all the estimated impacts and offer a way of prioritizing amongst the different options. This includes the use of scenarios to explore possible future pathways. **Scenarios** are one particular approach – they are coherent, internally consistent and plausible descriptions of a possible future state of development, and the **pathway** to reach it. They are not forecasts; rather, each scenario is one alternative image of how the future can unfold.

The chapter first outlines means for identifying, prioritizing, and analyzing options. It then shows how scenarios can be used as a bridge between high-level vision and detailed analysis of options, and also to aid decision-making under uncertainty by illustrating alternative future pathways. The target audience for this chapter includes policy analysts, strategic decision-makers, and planning officials engaged in commissioning and interpreting the analysis, and the development partners.

A number of myths regarding the analysis of options and pathways exist, and this chapter shows that they deserve reconsideration because reality is often more subtle than ‘common wisdom’ suggests, see Table 1.

There are important linkages between this chapter and the questions covered elsewhere in the report. The discussion here does not assess the overall process for formulating and deciding on a green growth plan, but rather aims to illustrate how tools and approaches have been selected and used as inputs to these processes. It provides a bridge between the technical discussion of tools in **Chapter 3 on Assessing and communicating benefits of green growth** and the discussion of **Planning and co-ordination processes discussed in Chapter 1**.

Whilst the planning cycle might be envisaged as a top-down progression from vision through to implementation, the experiences reviewed here show that bottom-up approaches are also often used. These provide feedback from sectoral plans into strategy in an iterative way (Figure 2). Various types of analytical tools and approaches are used to support planning by facilitating the transfer of data and assumptions between different levels and stages of decision-making.
### Table 1:

**Myths and realities**

<table>
<thead>
<tr>
<th>Myth</th>
<th>Reality</th>
</tr>
</thead>
</table>
| The more complex the analysis the better.                          | • Starting simple is okay.  
• The 80:20 rule (80 per cent of the result can be obtained with 20 per cent of the effort) is a useful guide.  
• Analysis is a guide to decision-making, not an end in itself.        |
| All good analysis starts with a MAC curve.                         | • Tools need to match the issue and country context, drawing on available information and expertise.  
• It is possible to address multiple dimensions green growth even in a simple framework. |
| We know what the future holds, let’s ‘just do it’.                 | Uncertainty is not a reason for inaction, but:  
• Identify unknowns and explore a range of scenarios.  
• Revisit and adapt tools as new information emerges and government circumstances change.  
• Think about flexible and adaptable approaches.                     |
| The donor knows best.                                              | The selection of green growth tools and approaches:  
• Should be based on local issues and needs, and suitable to the local context.  
• Can face challenges, including funding limitations, donor and political priorities, and political timeframes. |
| Public involvement is burdensome, expensive and unnecessary.       | If public engagement is implemented well,  
• The public can be a resource that can be tapped for information, brain power and creativity.  
• The time investment will earn itself back in lower resistance and better plans. |

### Figure 2:

**Scope of chapter**

![Scope of chapter diagram](image-url)
This review combined a broad-based literature review with a more detailed analysis of good practices in a number of more specific cases.

Summary of case studies reviewed in this chapter:

<table>
<thead>
<tr>
<th>Ref</th>
<th>Country</th>
<th>Case study</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>British Columbia</td>
<td>Encouraging green growth through provincial and local government planning action</td>
<td>Since 2007, the Canadian province of British Columbia has introduced a variety of legislation to encourage GHG emission reductions that includes a carbon tax and requires that all local governments set a GHG reduction targets at the municipal level. Emphasis was placed on providing local governments with the tools and resources they need to set priorities and develop green growth plans. 180 of 189 local governments have signed on to the Climate Action Charter.</td>
</tr>
<tr>
<td>b</td>
<td>India</td>
<td>National Energy Map for India: Technology Vision 2030</td>
<td>The National Energy Map for India: Technology Vision 2030 demonstrates the use of optimization tools to analyze energy security and green growth. An integrated modeling framework was used to develop and analyze various scenarios of energy demand and supply for each category of resources as well as sectoral end-use demand.</td>
</tr>
<tr>
<td>c</td>
<td>Kenya</td>
<td>Low Carbon Climate Resilience Plan</td>
<td>The 2010 National Climate Change Response Strategy, 2013 National Climate Action Plan, and a 2012 green economy scoping study have been funded through various bilateral and multilateral organizations. This has impacted the choice of tools, processes, and methods used to define, analyze, and compare green growth pathways, scenarios and options.</td>
</tr>
<tr>
<td>d</td>
<td>Mexico</td>
<td>Special Climate Change Program</td>
<td>In 2009, Mexico published the country’s long-term climate change agenda together with the medium-term goals for adaptation and mitigation. It is a broad program to address the impacts of climate change in Mexico and reduce greenhouse gas emissions across all sectors. In evaluating options for the country’s low carbon development, government estimates and inventories were supported by various studies and provided analyses on the economy-wide impacts of moving to a low carbon pathway.</td>
</tr>
<tr>
<td>e</td>
<td>South Africa</td>
<td>Long-Term Term Mitigation Strategies (LTMS)</td>
<td>The focus of the LTMS was on mitigation that also embarked on green growth path and opportunities. It serves a turning point in South Africa’s climate policy, showing the vision, policy framework and strategic directions towards a low carbon pathway. It developed scenarios that create top and bottom emission levels up to 2050. These scenarios define the space within which the mitigation action occurs.</td>
</tr>
<tr>
<td>f</td>
<td>Netherlands</td>
<td>The Waal River Area</td>
<td>Waal river, part of the Rhine delta in the Netherlands, started a program called WaalWeelde, a new governance model that was adopted by the provincial government. The model organizes a process to bring bottom-up ideas about redesigning floodplains and management measures into the decision-making institutions. It reviews how a variety of analysis tools was applied and what the decision-making processes entailed in the context of the green planning of a 80 km Rhine-Waal river section downstream from the Dutch-German border.</td>
</tr>
<tr>
<td>g</td>
<td>United Kingdom</td>
<td>Carbon Reduction Plans</td>
<td>Electricity sector de-carbonization is a central feature of the UK green growth plan which is based on the deployment of three technology pathways (renewable resources, nuclear power and carbon capture and storage), and the implementation of new support mechanisms. This case reviews the wide range of analytical approaches used, and then focuses on the role of the Committee on Climate Change.</td>
</tr>
</tbody>
</table>
2. Prioritizing and analyzing green growth options

The choice of tools and approaches should be deliberate, and cover economic, environmental, and social aspects. The choice of tools should follow, not drive the questions to be asked by the analysis.

For green growth strategies driven either by top-down or bottom-up process, the analysis stage involves an iterative cycle of identifying, prioritizing, and analyzing the available green growth options, see Figure 3.

The initial stages may be based on quite simple analysis, but complexity often increases over subsequent iterations, requiring more sophisticated sector-specific tools.

Many tools and approaches are based on long-established techniques, but a wide range of specific interfaces have been developed over recent years, often by international organizations aiming to increase accessibility to policy makers. Tool selection is important, as it frames the scope of issues that can be addressed. Pragmatic issues such as requirements for data, technical expertise and other resources are key constraints. However, choice of analytical tools should be driven by the strategic priorities, not vice versa. Models or approaches used in one country may not work best in another country.

The choice of approach depends on the scope of issues to be addressed (see Table 2). Analysis will often start simply, by assessing the costs and benefits of individual options (top-left quadrant). As the analysis progresses, more comprehensive approaches can be developed to address multiple dimensions of green growth (moving to the right of the table) and system-wide impacts (moving to the bottom of the table). This broadening-out of the analysis, for example using multi-criteria analysis is important since a narrow cost-effectiveness comparison misses many relevant aspects of green growth such as jobs, resource savings, health issues, and security. Choosing the most appropriate approach also needs to take account of available resources (human, financial, and data) as discussed above. The list of models in the table is illustrative, not complete. References in the table relate to where particular tools have been used in the case studies reviewed.

Models are incomplete representations of reality. They do not give a final answer on prioritization, since this needs interpretation and political consideration. Therefore, close attention needs to be paid to appropriate interpretation of inputs, assumptions, and outputs of any tools used. This requires good communication of the approach from analysts to decision-makers and other users. Whichever tools and approaches are used, it is important to address their limitations through other elements of the decision-making process. This might be through broader but less formalized analytical approaches, or by combining outputs from different types of tool in a more holistic analysis.

It is common to use a variety of tools to prioritize green growth options. Combining top-down approaches driven by the vision and strategy, with bottom-up analysis of concrete actions and options, can improve the consistency and robustness of results, and address limitations of individual tools.

2.1 Identifying options

The first step for any analysis is to identify the range of options available, to gather basic information about their social, technical, and economic characteristics. Identification and prioritization of options and actions is iterative, not a one-off event. In most cases, the analytical approach evolves to become more complex during successive rounds. In many countries, initial assessments of options will have already been carried out at a sectoral level, or ideas and data can be drawn from other countries that have undertaken such reviews. Building on this, expert elicitation can be used to collate a ‘long list’ of initial ideas and available data on economic, social, and environmental impacts and benefits.

Subsequent rounds of analysis can strengthen this by using more detailed and localized data and considering the potential for dynamic effects and interactions between options and how costs and benefits may change over time.
Data gathering will often rely on expert opinion, but should also involve a range of institutions and stakeholders: a greater level of engagement at the option identification stage is likely to lead to a greater level of buy-in to the outcome of the prioritization process (see for example Waal River case, Case 1). It is important to make sure all stakeholders have familiarized themselves with sufficient information to form opinions (See also Chapter 1 on Planning and co-ordination, for further detail on stakeholder engagement).

There is some tension between efficiency (provided through simple, streamlined analysis with limited space for interaction, iteration and creativity) and robustness (supported through complex analysis or a more elaborate consultative process). At the start of a new process of green growth strategy development, the 80:20 rule (80 percent of the result can be obtained with 20 percent of the effort) is a useful guide. Good practice would be to start with a ‘back-of-the-envelope’ approach, sufficient to rapidly assess potential, and support initial political engagement, then progress to more detailed analysis, see for example the Mexico low carbon plan, (Case 2).

### Table 2:
Different analytical approaches used depending on complexity of issues addressed

| Bottom-up or option-level impact analysis | Individual Green Growth Issue  
(e.g. low carbon energy, sustainable agriculture) | Multiple Green Growth Issues  
(e.g. Sustainable growth / natural resource protection) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-effectiveness analysis^a^</td>
<td>• Marginal abatement cost curves^d^</td>
<td>• Cost-effectiveness analysis^d^</td>
</tr>
</tbody>
</table>
| Cost-benefit analysis^a^                 | • Accounting models (e.g. EFFECT, LEAP^j^, MEDEE, 2050 Pathways)  
• Sector-based and geographical-based  
agri-environmental frameworks | • Multi-attribute analysis                        |
|                                         |                                                   | • Multi-criteria analysis                         |
|                                         |                                                   | • Multi-purpose spatial planning (GIS-based) models |
|                                         |                                                   | • Land-use models (e.g. CLUE)                     |
|                                         |                                                   | • Urban energy systems                            |

Top-down or system-level impact analysis

Optimization approaches

• Energy system models (e.g. Markal^k^, MESSAGE, EFOM WASP)
• Computable general equilibrium models^c^  
• Dynamic stochastic general equilibrium models  
• Integrated Assessment Models

Simulation approaches

• Energy system models^l^ (Energy 20/20, POLES)  
• Macro-econometric models (e.g. E3MG)  
• Ecological macroeconomic models  
• Agent-based models  
• System dynamics models

Notes: 1) Letters in subscript reference country cases. 2) See Abbreviations for full name of each modeling tool.

#### 2.2 Prioritizing options

Prioritization usually proceeds with an assessment of the characteristics of each option according to common criteria. These criteria will depend on the overall scope of the green growth vision and strategy. They will typically include assessment of the costs of the option compared to a business-as-usual alternative, as well as evaluating social, development, and environmental impacts. It is important that the analysis of costs takes account of how these are expected to change over time, as focusing on cost-effectiveness in the short-term means that longer-term strategic trends may be missed.

If the scope of assessment is narrow, the benefits of different options may be directly comparable. For example, in some low-carbon development plans, a single metric (tCO2 equivalent saved) will often be part of the assessment. Each potential option can then in principle be compared simply on the basis of cost (i.e. using a cost-effectiveness analysis). Cost-effectiveness analysis can be combined with estimates of the scope of each option to generate a supply curve. In the case of low-carbon plans for example, simple tools can be used to
Case 1:
**Waal River Area, Netherlands**

Rivers are core to many economies. Economic, social, and ecological functions of rivers include transport, provision of drinking water, agriculture, energy, nature, recreation, and housing. In a densely populated area like the Netherlands, preserving these functions, in the face of many environmental pressures, requires a strategy that resembles a green growth plan. A major concern of the Netherlands, situated in the Rhine delta, is the expected increased river runoff in the coming years due to changing rain patterns. In one area of the Waal river, part of the Rhine delta, the planning for accommodating the additional runoff is done in a structured way in a program called “WaalWeelde” – loosely translated as “Wealthy Waal”. The WaalWeelde program started with a research project focused on the introduction of a new governance model that was later adopted by the provincial government. Flood risks are reduced while balancing conservation, agriculture, and recreation. In the future, renewable energy provision may also be part of the program.

Here, the water security argument could have been implemented in a top-down manner through the Province or the Ministry for Infrastructure and Environment identifying the most suitable overflow. However, this would have probably led to a strategy that would only be optimized on flood prevention, not on the other functions of the river area. Instead, the more local-led “WaalWeelde” program allows for bottom-up ideas about redevelopment of the river area to be brought into the process. On the municipality level, groups were formed that included local people, business representatives, policymakers, and politicians. These groups were supported by experts who used spatial analysis tools to identify ideas that met the flood safety requirements (while balancing other services provided by the river).

Case 2:
**Mexico’s Low Carbon Plan**

In 2009, the Government of Mexico published a national long-term climate change agenda, together with medium-term goals for adaptation and mitigation – Mexico’s Special Climate Change Program (PECC), which sets out a broad program to address the impacts of climate change in Mexico and reduce greenhouse gas emissions across all sectors.

Good base data on emissions and economic activity by sector were available. This enabled rapid analysis to be carried out to estimate sectoral carbon abatement potential in response to political timeframes driven by the UNFCCC process. With more time available, the long-range energy alternatives planning (LEAP) system was then used to help develop their low carbon plan. This choice was pragmatic because it is an established tool, and allowed Mexico to get started quickly with their analysis. The tool requires a moderate amount of local capacity to enable it to be adapted to local conditions. In subsequent analysis, Mexico then developed other more bespoke tools, which required more analytical capacity and expertise. These included CGE, MACC, I-O models and cost-benefit analysis of options. Using a range of tools allowed different aspects of the low carbon plan to be addressed. This helped to improve robustness of the analysis by drawing on the particular strengths and covering for the limitations of each type of tool.
construct marginal abatement cost curves (MAC). Similarly, generation technologies in the power sector are often compared on the basis of their levelized cost of electricity (LCOE).

For a review of applications of MAC curve analysis in recent low-carbon development plans, see for example Pye et al. (2010), who conclude that such cost-effectiveness approaches are often an appropriate starting point for prioritization in cases where data availability is limited. However, MACC analyses have limitations because they are only based on measurement of cost against a single benefit. If all benefits can be expressed in financial terms, an alternative is to carry out formal cost-benefit analysis (CBA) to rank the options. However, the monetization of different types of benefit for such analyses is at best contentious, and at worst impossible (Jacoby, 2003).

In some circumstances, cost-effectiveness assessments may not be the most appropriate metric for prioritization, and multiple tools may be required to cover different objectives, as was the case in British Columbia. It is important that the scope of a country’s green growth plans do not become limited by the analytical tools used. In least-developed countries (LDCs) for example, a focus on cost-effective GHG abatement potential may be an inappropriate distraction from core development priorities in a context where GHG emissions are already very low. Whilst MAC curves have been used in LDC contexts (for example in Ethiopia’s Climate-Resilient Green Economy strategy (FDR Ethiopia, 2011)), the scope of development priorities should often be significantly wider.

Multi-criteria analysis (MCA) can help prioritize options when comparing different types of benefit or trade-offs that cannot be expressed in simple financial terms. MCA has been used in a number of low-carbon economic development plans (MAPS). Several different techniques for MCA are available (Hobbs and Meier, 2000). They usually involve scoring different attributes for each of the different options, and then weighting between attributes so that an overall score can be derived, allowing a comparison between options. The scoring and weighting used in an MCA is relatively subjective (although because these weightings are explicit, this can be considered as strength of MCA compared to other analytical approaches). MCAs usually incorporate expert review or wider stakeholder engagement to elicit these scores. The outcome of an MCA is affected by the procedures used, so ideally use of multiple different methods is recommended (Bell et al., 2001).

With respect to handling uncertainty in decision-making, MCA can incorporate uncertainty as a criterion in itself, which could be considered when evaluating options (in addition to dealing with uncertainty via scenario analysis discussed in the next section).

A less formal approach is multi-attribute analysis, where options are not scored or ranked, but assessed according

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**Case 3: British Columbia: Provincial and local government planning and action**

The Canadian province of British Columbia released a Climate Action Plan in 2008, and has taken action on many fronts to achieve its climate change goals, including an interim target of a six per cent reduction of GHG emissions below 2007 levels by 2012.

British Columbia provided a range of planning and prioritization tools for municipal governments. This encouraged ‘getting it right, now’ while undertaking ongoing research and analysis of actual outcomes of the implementation of policies and programmes identified by the tools to ‘get it right’ over the long term. Tools and approaches for prioritization of green growth options and pathways can and should be improved on an on-going basis. The identification of green growth priorities and options is not static, but a continual process.

However, achieving an integrated overview of multiple outputs is not easy, and model limitations need to be recognized. The British Columbia Climate Action Team (2008) noted that the results of the modeling are important to set goals and to enable measurement of progress toward these goals, but the team cautioned “against focusing too intensely on economic models that, at best, can provide only plausible estimates. The goal of reducing emissions – as much as possible wherever possible – must not be eclipsed by concerns about differing assumptions based on uncertain variables.”

UNEP and UNDP have produced useful step-by-step guidance to multi-criteria analysis for pro-development climate policy. See:


to their impacts on different development criteria. This was carried out for Rwanda’s National Strategy for Climate Change and Low Carbon Development (Republic of Rwanda, 2011). Even without formal scoring, this can help to structure expert workshops to identify areas of priority. Dividing options into simple categories can also help prioritization. In Inclusive Green Growth (World Bank, 2012), choices are split according to their local and immediate benefits on one axis, and on the other axis their risk of creating lock-in or irreversibility (see Case 3). Initial prioritization would then be followed by more detailed analysis of each option.

Running multiple models and approaches helps address their individual limitations, giving a richer and more nuanced analysis. However, attention is needed to ensure co-ordination between different sets of analysts. Ultimately, prioritization is a political decision, requiring interpretation of available evidence, and therefore it is essential that there is good communication between analysts and decision-makers regarding interpretation of model inputs, assumptions and outputs.

### 2.3 Choosing tools

Analytical tools are widely used in green growth planning, allowing transparent linkages between assumptions and consequences. Tools need to be carefully selected because the choice will determine the framing of the problem and the kind of policy questions that can be answered.

The choice of tool will often evolve through successive iterations of analysis. The choice may be pragmatic; in situations where there is little data or resources for modeling, simple approaches such as spreadsheet-based cost-effectiveness analysis of individual options can be an appropriate starting point. Ideally, a plan should be developed that allows progression towards analysis that includes multiple impacts, and feedbacks at the system level.

The case studies show the importance of choosing tools which have an appropriate scope that reflects the scale, definition and ambition of the green growth actions being considered. Across the cases reviewed, there is wide variation in the level of complexity of analysis. The choice is to a large extent driven by the availability of data and to also to some extent the availability of analytical expertise (see Kenya Case 4). As a minimum, good analysis requires sound data on key environmental and social indicators (including estimates on future trends), together with data on the potential actions that can be taken to improve these. All the cases reviewed used multiple analytical approaches, often combining bottom-up models capturing technological detail with top-down models to assess macro-economic impacts and feedbacks. Analyzing green growth through these multiple perspectives helped to improve robustness by addressing individual model limitations.

When data and resources permit a more detailed analysis, it is important to include the effect of interactions between these options. Examples of interactions include reductions in benefits when multiple options are implemented in the same

<table>
<thead>
<tr>
<th>Inertia and/or risk of lock-in and irreversibility</th>
<th>Local and immediate benefits</th>
<th>HIGHER (Policies provide local and immediate benefits)</th>
</tr>
</thead>
</table>
| LOWER (Action is less urgent)                 | • Lower-carbon, higher-cost energy supply  
• Carbon pricing  
• Stricter wastewater regulation | • Drinking water and sanitation, solid waste management  
• Lower-carbon, lower-cost energy supply  
• Loss reduction in electricity supply  
• Energy demand management  
• Small-scale multipurpose water reservoirs |
| HIGHER (Action is urgent)                     | • Reduced deforestation  
• Coastal zone and natural area protection  
• Fisheries catch management | • Land-use planning  
• Public urban transport  
• Family planning  
• Sustainable intensification in agriculture  
• Large-scale multipurpose water reservoirs |

Table 3:

Example of simple matrix used to help prioritize green growth options

Sources: World Bank (2012)
sector feedback into wider economic variables such as prices and demand for goods, rebound effects, and competition for resources including land, water and capital. In order to analyze such interactions, green growth options usually need to be incorporated into more formalized models.

These broader tools and models tend to be sector specific. For example, in the energy sector ESMAP (2012) reviewed models used for developing low-carbon development plans in seven countries. They note that energy sector models usually fall into the following categories:

- **Optimization models** such as MARKAL, used for example in India, EFOM and WASP. Advantages include a powerful ability to identify the (theoretically) least-cost solution for meeting a particular goal or target from a wide range of potential technical options available, taking into account constraints such as technology availability, demand requirements and emissions limits. Weaknesses include an assumption that real-world decisions are driven by least-cost, and that markets are complete and operate perfectly. They can also be relatively data intensive and complex, reducing transparency.

- **Simulation models** such as ENPEP-Balance, Energy 20/20, POLES. These models simulate the behavior of energy producers and consumers in response to prices, income, and other signals. They can simulate uptake of technologies in a more realistic way than optimization models, although the assumptions about future uptake depend on subjective inputs from the analysts. This could be viewed as a weakness. Require detailed assumptions about behavioral factors can make the models complex and sometimes opaque.

- **Accounting Models** such as EFFECT, LEAP, MEDEE,MESAP, and 2050 Pathways. These include descriptions of key performance characteristics of the energy system allowing users to explore the resource, environment and social cost implications of alternative future ‘what if’ energy scenarios. These usually have a simple, transparent and flexible structure suited to evaluating the outcome of scenario-based policy decisions that are defined outside of the model. They do not include any prior assumptions about optimal choices or market behavior.

Energy systems models which take a probabilistic approach are increasingly used to address issues of uncertainty and risk. Examples include a stochastic version of MARKAL (UCL Energy Institute, 2013) and ESME, an energy system design tool developed by the Energy Technologies Institute (Energy Technology Institute, 2013).

Economy-wide models on the other hand have less technical detail, but allow analyses to assess interactions between policy choices and macro-economic variables such as growth and employment effects. For example, in the ESMAP low-carbon study for Poland (World Bank, 2011), a top-down dynamic stochastic general equilibrium (DSGE) model of Polish economy was used to assess the potential macroeconomic impact of GHG abatement measures. It was based on 2000 variables covering 11 economic sectors as well as general production factors and public expenditure. A regional computable general equilibrium (CGE) model was also used to analyze the macroeconomic impact of implementing the European Union’s climate mitigation package.

The literature on top-down energy-economy analysis differentiates between optimization and simulation models. The former draws on neo-classical economic theory that assumes that economies are fairly close to equilibrium conditions. Models include CGE, DSGE and optimal growth models. Most integrated assessment models take this approach. Simulation approaches on the other hand allow for greater deviations from equilibrium conditions.

Further details and downloadable resources on many of these tools can be found at www.climatesmartplanning.org.
Approaches include macro-econometric models, ecological macroeconomic models, agent-based macro-models, and system-dynamic models. Scricciu et al. (2013) provide a review and useful categorization of these models, arguing that non-optimizing models can better capture socioeconomic system dynamics and the role of macroeconomic policies for sustainability governance, particularly in developing country contexts where economies are far from the ‘idealized’ equilibrium position assumed by CGE models.

Governments need to carefully scrutinize the assumptions and theoretical underpinnings of the models they choose to represent their economies, and ideally use more than one type of model to compensate for model limitations. Some studies incorporate both top-down and bottom-up approaches. For example, in the low-carbon analysis undertaken for Kenya, a dynamic, recursive computable general equilibrium model, GEEM-Kenya, was developed to inform climate investment choices and long-term development impacts in Kenya. This ‘top-down’ CGE model incorporated a ‘bottom-up’ analysis of emission forecasts and abatement opportunities that were validated locally as part of the National Climate Change Action Plan process (Sawyer and Peters, 2012).

Hybrid models such as TIMES-MACRO can embed simple CGE models into a more detailed techno-economic model or modeling framework that mix optimization and simulation approaches for different sectors (For example PRIMES model (E3Lab, 2013) and IEA Energy Technology Perspectives).

Integrated tools can bring together economic, social and environmental impacts into a single framework. An example is the Threshold 21 (T21) model (Millennium Institute, 2013) that has been used to carry out scenario analysis of adaptation options in Kenya and applied in other countries (Africa Adaptation Programme, 2012).

Urban systems models are also increasingly used to analyze urban development in light of green growth, particularly in relation to rapidly growing cities (Keirstead and Shah, 2013).

Options available for sustainable agriculture need quite different analytical approaches from those in the energy sector. Analytical frameworks for agri-environmental policy analysis assess issues at sector and geographical levels. Sector disaggregation breaks the agriculture sector down into different crop and livestock activities and enterprises types. Geographic disaggregation looks at issues as they relate to areas which share common soils, climate, and types of agricultural production, ultimately even undertaking analysis at the farm, field, and sub-field level (For example the SAPIM model (OECD 2010)). The same goes for integrated information and scenario tools such as those used for multiple-purpose spatial planning; they are predominantly GIS-based although they sometimes combine 3D functions.

Land-use models include the ‘Conversion of Land Use and its Effects’ CLUE model (Veldkamp and Fresco, 1996) which simulates land-use conversion and change in space and time as a result of interacting biophysical and human drivers. For a more recent example of the application of this model to the case of land-use simulation modeling in the farming-pastoral zone of Northern China, see Chen et al. (2008).

Bringing together analysis of options across multiple sectors with different types of environmental impact is possible within integrated assessment models. These can incorporate analysis of climate change, land-use change and
agriculture into a single platform, for example IMAGE, AIM, and MiniCAM (US Department of Energy, 2009). These tend to be sophisticated and complex models, usually with either a global or large-scale regional coverage. Given the broad coverage, detailed assessment of individual technologies and options tends to be limited, so they are more useful for assessing large-scale strategic decisions.

Where technical expertise and capacity are available, a range of institutions running multiple complex models can lead to a richer data-set, and is more likely to expose some of the dynamic effects of policy choices that can help inform long-run strategic choices (see UK Case 7). This complexity does, however, lead to its own challenges of communicating with policy-makers, since drawing clear conclusions from potentially conflicting studies becomes more difficult.

2.4 Communication of results

Aiding communication between different levels of government and different stakeholders in the decision-making helps to improve the efficiency of consultation, and tools can facilitate this. A particular example is the Vaal river case, where a dashboard was developed so that practitioners and policymakers could experiment themselves with the different options in the area. For similar reasons, an open-access multi-user tool (DECC 2050 calculator, http://2050-calculator-tool.decc.gov.uk) was developed in the UK which allows users to select different energy options. The department encourages use of the tool by the public to increase awareness of different energy technology choices, and potential trade-offs that might be needed, and their cost implications. This is significant since one of the political barriers to ambitious action is the difficulty of securing support from the public, which may be broadly supportive of climate action but wary of price rises.

The case examples suggest that there is rarely a direct correspondence between model output and policy decisions; the two are usually separated by layers of interpretation and political debate. Across the cases, it was found that analysts and modelers need to devote more attention to better communication, both with decision-makers and with the public.
In the British Columbia (BC) case, (see Case 6), the green growth plan required increased levels of co-ordination between provincial and local government, and communication and buy-in from local populations. Vancouver’s Greenest City Action Plan for example involved consultation with over 35,000 people. More broadly, the BC case shows the need to ensure that such consultations have sufficient representation of multiple community groups appropriate to the scope of the green growth plan. The BC plan includes land-use issues, therefore the planning process needed to gather input from wide consultations with industry, academia, non-governmental organizations, faith-based groups, youth, First Nations (aboriginal peoples in Canada), communities, provincial ministries, and local governments.

In the case of the Government of India’s Low Carbon Strategy, (Case 5), engagement was needed across multiple government departments in order to maximize the possibility for integrating low carbon development into India’s wider 12th five-year economic plan. An expert group appointed by the Planning Commission was tasked with identifying key focus areas for the plan, and then ensuring the necessary communication and co-ordination of these tasks within the overall planning process.

In the Kenya case, stakeholders were engaged at multiple points in the analysis. All assumptions and findings of the analysis were validated through a comprehensive stakeholder process that included local experts from government, business, research organizations and NGOs. Input from sector expert groups that ensured the low-carbon assessment was informed by technical sector-specific expertise and information. Adaptation priorities were identified through a qualitative assessment that focused heavily on stakeholder consultation.

3. Developing pathways and scenarios to inform decision-making

Use scenario analysis to identify the scale and pace of change required in different sectors and highlight the choices and actions that need to be made over time, along with uncertainties.

Scenarios are coherent, internally consistent and plausible descriptions of a possible future state of development, and the pathway to reach it. They are not forecasts; rather, each scenario is one alternative image of how the future can unfold. A set of scenarios is often adopted to reflect the range of uncertainty in projections. This can help improve the robustness of a decision in dealing with uncertain future conditions.

Scenarios act as a bridge between a national ambition, and the more detailed analysis of options and implementation plans to achieve it. This provides a framework for decision-makers to consider the implications of different ambition levels and choices.

Scenarios can be developed for different contexts. Some are storylines to illustrate the ‘big picture’ consequences of key economic variables for example the Shell Scenarios (Shell, 2014). They can also be used to communicate the feasibility of green growth goals, helping stakeholders to understand the actions that are implied, over different timescales of a goal such as going carbon neutral (Lazarus et al. 2011). In other cases, scenarios are tailored to particular decision choices, allowing policy-makers to explore several ‘what-if’ alternative futures. They can also be used as a sensitivity analysis tool to...
assess the extent to which policy actions or instruments need to be adjusted to deal with uncertainties.

While scenarios draw on the same data and analytical tools as options analysis previously discussed, there is wider discretion in the way they are set up. This can often reflect the pre-dispositions of the organization involved, and can therefore be quite political.

In order to be credible, scenario development needs based on clear assumptions, and to be designed appropriately to answer the policy questions being addressed. Experience has shown that to be effective, “scenario-modeling tools need to be open access so that the assumptions can be scrutinized and to enable a degree of customization” (ESMAP, 2012). Some scenario tools such as the UK 2050 Pathways calculator (DECC, 2013) are explicitly designed to encourage users to develop and test their own scenario assumptions. The Mexico case (Case 8) illustrates how stakeholder input can help to achieve robust and credible scenarios.

Choosing priorities and pathways requires clear assumptions, reasonable data, and active stakeholder engagement. The choice of tools and approaches should follow from the questions that need to be answered, not drive the analytic direction. Scenario analysis can be used to identify the scale and pace of change required in different sectors and highlight the choices and actions that need to be made over time, along with uncertainties. Experience has found that iterative processes to analyze options, identify priorities, and combine them into pathways can increase realism and acceptability to stakeholders.

Scenarios help to support discussion and decision-making about ambition levels. What defines ‘appropriate ambition’ is clearly very context specific. But it should be defined as an outcome of the green growth planning and consultation process, not predetermined by the analytical framework used. However, the way scenarios are set up often reflect the pre-dispositions of the organization involved, and can therefore be quite political.

Scenario development is typically a dialogue between analysts and decision makers. Based on an agreed set of assumptions, the analysts will produce a number of scenarios for discussion and assessment by policy makers. Often, there are two or more rounds of refinement where the analysts revise the scenarios as requested by policy makers – either to have more detail, explore variations on a certain pathway, or to test sensitivity or robustness to various assumptions.

In order to be credible, scenarios need to be based on clear assumptions, and be designed appropriately to answer the policy questions being addressed. Experience in seven countries as analyzed by ESMP (2012) has shown that “data sourcing and scenario modeling were central […], and have been cited by those who worked on the studies as key components in the consensus building that took place. To be effective in this context, scenario-modeling tools need to be open access so that the assumptions can be scrutinized and to enable a degree of customization.” One way of engaging with expert opinion for generating scenarios is through Delphi processes (Bailey et al., 2011). Some scenario tools such as the UK 2050 Pathways calculator (DECC 2013) are explicitly designed to encourage users to develop and test their own scenario assumptions.

Other examples include:

**UK**

Successive rounds of policy-making on climate change mitigation since 1997 have involved engagement of more ministries (including Treasury), and more agencies such as the electricity system operator. Because the climate change mitigation plans involve interventions in complex systems like electricity markets, they require a greater degree of expertise available across multiple institutions. This has been important to increase the credibility of analysis with investors and other stakeholders as it demonstrates that the detailed technical issues are being incorporated. This requires frequent and effective dialogue between institutions and analysts to encourage effective co-ordination between different tools and methods.

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**Case 8:**

**Mexico Low Carbon Plan**

In Mexico, the government-led initiative mandated all branches of the government to prepare development and sectoral plans. Development of initial scenarios for carbon emission was driven by the need to meet rapid timeframes of the UNFCCC, and used relatively simple calculations of potential, based on extrapolation from data on current emissions. Subsequent rounds of analysis could build on this, adding more detail and complexity, which in turn depended on using more sophisticated modeling approaches.

Broad engagement across government was achieved through establishing an Inter-Ministerial Climate Change Commission. The Commission engaged key ministries and some research institutes to facilitate continued dialogue throughout the process and maintain the high level of interaction among the different stakeholders.

The scenario analysis exercise followed on from political commitments which set targets for reducing GHG emissions. The analysis helped establish a body of evidence suggesting that Mexico can move to a low carbon pathway while generating certain economic opportunities. The analysis was premised on an early action, i.e. starting investing in low carbon technologies now, in a phased manner, reflecting their cost, technological maturity, and ease of implementation. This helped align the strategy with wider economic goals for the country.
Kenya

Scenario assessment provided the evidence base for prioritizing low-carbon actions. Bottom-up analysis of mitigation opportunities in six sectors were combined to demonstrate a feasible low-carbon pathway and compare it to a baseline and reference case. The options and pathways identified through the tools and processes were presented to the Kenyan government and stakeholders. After discussing the trade-offs and the differences in priorities across the scenarios, they ultimately made decisions on priority green growth options and pathways. These stakeholder processes were an essential and critical component of the process to ensure that decisions were ground-truthed, accounted for local realities, and that priority actions were doable in the Kenyan environment. The results of Kenya’s climate change analysis were used as inputs to the process to develop the government’s Second Medium Term Plan (2013-2017).

British Columbia

The BC case shows the importance of timing, where many of the policies and actions were designed with a phase-in period. The intent was to give people time to change their habits and equipment and avoid high transition costs. Evidence is emerging that the government’s programs and policies, especially the carbon tax, are having a positive effect on meeting its GHG emissions reduction goals. Although there was an initial backlash against the carbon tax, it is helping to reduce GHG emissions while keeping income and corporate taxes low. Per capita consumption of all petroleum fuels in 2012 had dropped 16 percent since 2008 when the tax was introduced (Reivers and Schaufele, 2012). The development of Vancouver’s Greenest City Action Plan included consultation with over 35,000 people. Multi-stakeholder groups made the final decisions on green growth priorities and pathways at the provincial and local levels. Continued assessment of tools and their results can improve decision-making. BC encouraged the use of a range of tools at the community level, and assessed the progress toward targets every two years. This helps to maintain an efficient process that is oriented toward results, by assessing outcomes against projections, and adjusting the tools, policies, and programs based on progress.

3.1 Incorporating uncertainty

Most illustrative pathway and scenario analyses do not try to investigate all variables. They will usually focus on a few key elements such as macro-economic variables, key policy design
choices, technology choices, or behavioral or technological change scenarios. Sometimes multiple variables are changed simultaneously, and grouped to develop ‘storylines’ around self-consistent visions of potential futures.

Scenarios based on projections may tend to assume continuation of current trends, which can be a weakness when assessing how these may change in more radical visions. One technique for overcoming this is back-casting which presents a normative vision of potential futures, and then aims to address the question of how we get there from here (Go et al, 2008; Gomi et al., 2010; and Robinson et al., 2011). A strength of back-casting is the ability to think beyond the limitations of current technologies and practices. A weakness of the approach is the potential lack of bounds, or rationale for the choice of future ‘vision’.

Normative approaches to scenario development are common, particularly in a policy-making context where targets are set through the political process, and scenarios are developed to show how they can be achieved. One way of ensuring that normative approaches are technologically feasible is to link them to technology pathway studies such as IEA (2012) or GEA (2012), which aim to map out in detail the potential for future technological developments and supply-chain in relation to particular technologies over the longer-term.

Another use of scenario analysis is to assess sensitivity of green growth strategies to external variables over which decision-makers do not have control. These might include:

- National economic variables such as population, GDP growth or sectoral output;
- International variables such as demand for exports, energy prices, or major political changes affecting development pathways;
- Technology variables including availability and cost, possibility of breakthrough developments or barriers;
- Physical impacts such as climate change or natural disasters.

The diverse political interests of different institutions leads to significant variations in the scenario approach, with some taking a more normative approach taking environmental performance as a given, whilst others explore a wider range of outcomes that may not necessarily meet policy targets. The purpose of the scenarios is to explore sensitivities, such as to fuel prices, growth rates etc., and to assess the extent to which government policy may need to be adjusted to deal with uncertain outcomes for these variables.

The large number of models together with scenario analysis has allowed for interesting comparative analyses, helping to pull out key differences and similarities. Much work for example is being undertaken under the Transition Pathways to a Low Carbon Economy project (University of Bath, 2013) to compare different low carbon electricity sector scenarios. Broader comparative analyses have been done by the Energy Research Partnership (2013) in Energy innovation milestones to 2050 and the UKERC (2013) in Comparing Low-Carbon, Resilient Scenarios. Other bodies such as the Department of Energy and Climate Change and the Climate Change Committee have commissioned work that has allowed for comparison, for specific sectors, and for systems analysis.

An example from the literature is a ‘real options’ approach for planning investments in large new multipurpose dam alternatives along the Blue Nile in Ethiopia in a world of climate change uncertainty (Jeuland and Whittington, 2013). The approach incorporates flexibility in design and operating decisions over the location, size and sequencing of new dams, and reservoir operating rules. The analysis uses a simulation model that includes linkages between climate change and system hydrology, and tests the sensitivity of the economic outcomes of new dams to climate change and other uncertainties. The real options framework enables the identification of dam investment configurations which offer the ‘best bets’ in an uncertain climate.

### Case 10:

#### UK Carbon Reduction Plan Scenarios

The diverse political interests of different institutions leads to significant variations in the scenario approach, with some taking a more normative approach accepting environmental performance as a given, whilst others explore a wider range of outcomes that may not necessarily meet policy targets.

- The National Grid ‘Future Energy Scenarios’ range from a renewable-dominated electricity system to a gas-dominated system. The scenarios are not constrained to meet current UK targets. The purpose of this analysis is to understand the impact on transmission system requirements of a wide range of different potential outcomes.
- Department for Energy and Climate Change projections assume that existing renewable policies will deliver the targets. The purpose of the scenarios is to explore sensitivities, such as to fuel prices, growth rates etc., and to assess the extent to which government policy may need to be adjusted to deal with uncertain outcomes for these variables.

An example from the literature is a ‘real options’ approach for planning investments in large new multipurpose dam alternatives along the Blue Nile in Ethiopia in a world of climate change uncertainty (Jeuland and Whittington, 2013). The approach incorporates flexibility in design and operating decisions over the location, size and sequencing of new dams, and reservoir operating rules. The analysis uses a simulation model that includes linkages between climate change and system hydrology, and tests the sensitivity of the economic outcomes of new dams to climate change and other uncertainties. The real options framework enables the identification of dam investment configurations which offer the ‘best bets’ in an uncertain climate.
3.2 Engaging and communicating with stakeholders

Though scenarios and pathways are popular tools for policy analysis, their subjective nature can foster a skeptical attitude amongst decision makers and stakeholders, unless they are engaged in the process. It is important to remember that the aim of scenarios and pathways is to bring consideration of future impacts into current decisions, but in a flexible way that permits learning and adjustment as the future unfolds. The examples of good practice reviewed here show that scenario analysis can support policy makers to make informed policy decisions under conditions of high uncertainty and complexity.

These experiences also demonstrate the political nature of green growth planning, which often pervades the analysis. Some actions can be taken to try to de-politicize the process. In the UK, the Climate Change Committee was established as an independent body to advise the UK Government on emissions targets and report to Parliament on progress made in reducing GHG emissions and preparing for climate change. In British Columbia, experience also shows that an approach of repeated, iterative assessment of progress towards targets and goals improves the results orientation and efficiency of policies, and enables models to be updated with learning. Nevertheless, even with such institutional arrangements, the process of aggregating diverse messages from multiple models, approaches and stakeholders, and using these to drive policy action, requires strong political leadership. This is covered in greater detail in Chapter 1: Planning and co-ordination, but examples of good practice emerging from the case studies in this chapter include:

Kenya
In Kenya, high-level chairing of the task force to oversee the development of the National Climate Change Action Plan helped generate interest and engage powerful ministries such as treasury and planning. The principal secretaries of the energy and planning ministries became personally interested in climate change, which was instrumental in taking decisions to develop a geothermal NAMA in the energy sector, and mainstream the action plan in Kenya’s Second Medium Term Plan (2013-2017).

British Columbia
Using a range of different planning and analysis tools can help with engagement of stakeholders. In British Columbia, a variety of tools developed by NGOs, private sector and government encouraged wider participation and buy-in of different communities to the process of developing green growth plans. This led to green growth planning becoming institutionalized in many municipal governments, helping the issue survive political transitions. Taking planning and action to the community level ensures the engagement of a wide range of stakeholders, which helps to raise awareness and buy-in for action. Although in some cases, this process of localization is not complete.

Waal River, Netherlands
In the Waal river case, exploring green growth options at a localized level rather than based on a top-down centralized approach from Ministry for Infrastructure and Environment helped develop a more holistic analysis that incorporated multiple aspects of river management. This was an important element in defining what green growth means in this context, ensuring that the analysis of future pathways would address the concerns of those most affected by them. The local scale of the actions included in the analysis is likely to have resulted in a greater level of buy-in from local participants. This allowed multi-stakeholder groups to make the final decisions on green growth priorities and pathways at the provincial and local levels, and ensured the tools resulted in the best possible information.
There are several outstanding questions that remain to be resolved. These divide into two categories, analytical issues relating to approaches and tools used, and process issues relating to how the analysis is managed.

**Analytical issues**

*How to analyze and compare different kinds of impact?*
When there are multiple impacts, assessing interactions and trade-offs ideally requires a common ‘scale’, but this cannot always be achieved. Formal use of multi-criteria analysis seemed relatively uncommon in this review. Further work is required to assess whether this is a ‘missing’ element of analysis, or whether other approaches provide reasonable substitute.

*How to choose between simple tools and more complex, academically rigorous models?*
Simple models require less resources, are easier to communicate, and allow outsiders to challenge assumptions. On the other hand, complex economic models provide important insights into interactions and feedbacks. Using multiple tools and models is one solution, but raises further questions about how to integrate disparate results into a coherent inputs to policy decision-making.

*How can uncertainty be better handled in the analysis?*
Uncertainties are large and important, but incorporating them tends to make analysis more complex. The impact of uncertainty is difficult to analyze in a rigorous way and more work is required to draw lessons for green growth policy analysis.

**Process issues**

*What characteristics make the translation of analysis into policy-making more or less successful?*
Further work is required on how analysis specifically feeds into policy decision-making, and which types of analysis were most successful or appropriate for helping to inform these decisions. Negative examples might also be useful to assess, i.e. what happens when analysis provides evidence against a particular course of action that already has political buy-in and momentum.

*How can uncertainty be better communicated?*
In addition to the technical difficulties of analyzing uncertainty, more work is needed in how communication about uncertainty can be improved in the dialogue between analysts, politicians, and the public.
References


