SECTION 5

Conclusions and Recommendations

This section presents our conclusions regarding the present state of development and use of scenarios for climate-change applications, and some recommendations for specific changes or initiatives to advance current practice to make scenarios more useful.

Before doing so, we briefly reprise some key definitional points, because uses of the term scenarios are so divergent. We have defined scenarios as descriptions of future conditions produced to inform decision-making under uncertainty. This definition distinguishes scenarios from assessments, models, decision analyses, and other decision-support activities. Scenarios may be developed and used in conjunction with these – for example, scenarios can provide descriptions of potential future conditions used as inputs to such activities – but are not identical to these, and not alternatives to them.

We have also distinguished scenarios from other types of future statements intended to inform decisions, such as projections, predictions, and forecasts. Relative to these, scenarios tend to be more multivariate (but still schematic), tend to be developed in groups, and tend to presume lower predictive confidence. The last condition is the case in part because scenarios tend to be used in situations where the basis for forecasting is less established because of deeper uncertainties, or for situations that pertain to further in the future beyond the range for which there is high confidence in specific projections, even contingent ones.

Having distinguished scenarios from these related activities, we consider a broad set of scenarios of diverse characteristics and uses, including simple and complex scenarios, quantitative and qualitative scenarios as well as various combinations of the two, and scenarios whose primary use and interpretation is positive or normative. Where we intend our conclusions and recommendations to apply to only certain types or uses of scenarios, we state this explicitly. Unless stated otherwise, they pertain to all types of global-change scenarios we are considering.

5.1 USE OF SCENARIOS IN CLIMATE-CHANGE DECISIONS

Scenarios can make valuable contributions to climate-change decision-making. Many of the decisions that will comprise society's response to climate change – whether mitigation, adaptation, or other responses – involve high stakes, deep uncertainties, and long time horizons. Scenarios can help inform these decisions by structuring present knowledge and uncertainty, prompting critical examination of present assumptions and practices, stimulating new insights, identifying key pitfalls and opportunities, or providing a framework for the assessment of particular decisions. For some decisions, which involve irreversible near-term commitment to choices whose consequences extend over a horizon involving substantial uncertainties, some form of scenario-based reasoning may be essential.

There is a big gap between the use of scenarios in current practice and their potential contributions. Despite their evident value and capability, many climate-related decisions that could benefit from scenarios (e.g., many decisions regarding long-term management and investments in climate-sensitive areas such as freshwater systems or coastal zones) are not using them. Indeed, many such decisions are still being made without considering climate change at all. Conversely, many climate-change scenarios have only weak and indirect connections to practical decisions related to climate-change mitigation or adaptation.

Interest in considering and using climate-change scenarios is sharply increasing. There is increasing interest in considering climate-change scenarios in diverse decision and planning processes. This trend is strongest for planning and decisions concerned with climate-change impacts and adaptation. The trend reflects advances in scientific understanding of climate change, gradual maturation of models and analytic tools, and increasing recognition by decision-makers of the potential importance of climate change. Given the high general concern about climate change and the advance of background scientific knowledge, we expect this trend to continue, and to broaden to other types of climate-related decisions.

Scenarios of global emissions and resultant changes in atmospheric trace-gas concentrations and climate are a core requirement shared by many diverse climate-related decisions. Although climate-change decision-makers and their particular information needs are highly diverse, many will need scenarios of global emissions and resultant climate change, and many more will need information that depends on these. Consistent scenarios of global emissions and climate change, provided centrally at the national or international level, can serve these diverse needs – if they are presented with enough transparency and documentation of their underlying reasoning and assumptions.

Beyond global emissions and resultant climate change, decision-makers' needs from scenarios are highly diverse. Different climate-change decision-makers will have highly variable needs from scenarios, in the factors and variables included, the time and spatial scale at which they are provided, and the nature of uncertainties represented. The means for meeting these additional needs will likely be diverse, too. Some will call for separate, specialized scenario production capabilities. A major distinction in scenario-related needs can be drawn between impacts and adaptation managers, mitigation policy-makers, and energy resource and technology managers.

Impacts and adaptation managers need scenarios that project impacts relevant to their specific responsibilities, and the major determinants of vulnerability and adaptive capacity. Impacts and adaptation managers include both national officials and others responsible for more specific domains of impact. These decision-makers need climate-change scenarios, driven by specified global emissions scenarios, to provide information about potential climate-related stresses on their areas of responsibility. In addition, they need other environmental and socio-economic infor-

mation specific to their areas of responsibility, at appropriate spatial and temporal scales. Meeting these needs will require both easy access to centrally produced climate scenario information with associated tools and support, and development of decentralized capabilities for developing and applying additional scenario-related information. Many of these specific information needs are likely to be similar in character for many particular locations and types of impact.

Meeting information needs for impacts and adaptation requires a cross-scale organizational structure. These decisions' combination of centralized and decentralized information needs suggests the need for a linked network of institutions at national and sub-national levels to develop scenarios. Such a structure would combine central provision of globally consistent emissions and climate change scenarios; decentralized elaboration of these scenarios with additional variables required for regional impacts and adaptation analyses; and provision of tools and resources to support development and use of scenarios.

Scenarios for impact and adaptation managers should be based on emissions assumptions that include a likely range of mitigation interventions, now and in the future. The emissions assumptions underlying scenarios for impacts managers should be based on the likely range of future global emissions trajectories, including explicit assumptions about what degrees of further mitigation effort are likely over time. This will typically imply a narrower range of emission futures than is considered in scenarios to support mitigation decisions.

Mitigation policy-makers need scenarios that project alternative emissions trends in their own jurisdiction and others, and the major factors that will influence mitigation opportunities, constraints, and costs. Mitigation policy-makers are usually officials who make national policy and participate in international negotiations, but this group also includes sub-national officials when they share mitigation responsibilities or undertake mitigation initiatives. Serious pursuit of greenhouse-gas mitigation will require major policy innovations that carry significant risks of many kinds, including the effectiveness and cost of the policies but also their effects on government budgets, competitiveness of particular industries, opportunities for national technological capabilities, etc. Decision-makers considering such policies will need scenarios of global and national emissions trends, resultant climate change, and aggregate impacts. In addition, they will need to consider many factors specific to their jurisdictions – e.g., national policies, institutions, economic structure, technological capabilities, and the detailed structure of national emissions – and information about the policy environment for their choices, including alternative scenarios of other nations' mitigation strategies, international mitigation decisions, and implementation and compliance.

Scenarios for mitigation decisions should include a wide range of baseline emissions assumptions and should not prejudge the likely level of mitigation effort. Scenarios used to inform mitigation decisions should consider the full range of potential mitigation choices on the agenda, defined relative to baseline assumptions that, as much as possible, reflect only efforts already enacted or committed, including a range of reasonable assumptions about implementation and compliance. This assumption typically implies a wider range of emissions futures than is considered in scenarios to support impacts and adaptation decisions.

Mitigation decision-makers can use target-driven scenarios for backcasting. Mitigation decision-making may also benefit from scenarios that impose explicit future environmental targets such as limits on emissions or atmospheric concentrations, together with assumptions about policy and implementation elsewhere, and reason backwards to explore alternative paths to, and implications and requirements of attaining that goal, including feasibility, costs, and

tradeoffs. These must be defined in ways relevant to the level of decision-making being informed, i.e., alternative national targets to inform national policy-making, in the broader context of alternative global baselines or global targets.

Informing mitigation decisions requires capacity for scenario development at the national level. While core scenarios of global emissions and climate-change can provide some of the required input into mitigation decisions, these decisions require additional information that must be provided at the national or sub-national level where the decisions are being considered, generated in consultation with relevant decision-makers or their surrogates.

Energy resource and technology managers need scenarios that represent the political and economic environment for energy investments, including mitigation policies. Energy resource and technology managers concerned with private responses to mitigation policy primarily need scenarios that represent alternative policy regimes. Emissions and climate change underlie these as influences on policy decisions, but do not capture the most important uncertainties for these decision-makers. While many actors may wish to generate these scenarios privately to keep their assumptions and analyses confidential, there may also be value in multi-party collaborative scenario-building exercises in which today's policy-makers and corporate planners jointly examine what range of policy, economic, and energy regimes is plausible or likely over the 30- to 50-year time horizons relevant for investment and technology-development decisions.

Scenarios must be periodically revised and updated. For all types of decisions and decision-makers, developing scenarios, applying them to inform decisions, and refining scenario methods, are iterative processes. Limitations to present scenarios or methods do not in general justify delaying consideration of such decisions, any more than scientific uncertainties do. Still, scenarios must be periodically updated, based on new knowledge, experience, and priorities, as well as further developments in scenario-related methods. Such updates are needed much more frequently than the decision time horizons.

5.2 USE OF SCENARIOS IN CLIMATE-CHANGE ASSESSMENTS

Large-scale, official assessments are the major use for scenarios at present and are likely to remain an important use. Large-scale, official assessments represent the most prominent demand for climate-related scenarios at present, and are likely to remain major users, particularly for coordinated scenarios of global emissions and resultant climate-change.

Within assessments, scenarios mainly serve to support further analysis, modeling, and assessment. When scenarios are used in assessments, certain users are clearly identified: e.g., climate modelers are major users of emissions scenarios, while impacts assessors and modelers are major users of climate-change scenarios. These users have specific scenario needs, and close consultation is possible between scenario producers and users to meet these needs. Substantial progress has been made in providing useful scenarios for these groups, at both the national and international level. These efforts should be continued and expanded.

The presentation of scenarios in assessments leads to many additional, unforeseen uses. Scenarios presented in large-scale assessments gain prominent dissemination that results in their being put to many uses their developers did not foresee. Scenarios should pursue clarity of documentation and transparency about underlying reasoning and assumptions, to improve the ease of use and reduce the risk of misunderstanding in such derivative uses, although they cannot anticipate all information needs of an open-ended set of diverse potential uses.

In assessments, scenarios can strongly influence issue framing. Also because of

their prominent dissemination, scenarios presented in major assessments can exercise substantial influence over the framing of policy discussions or provide simple, widely used metrics of the seriousness of the issue. They may consequently exercise broad influence over many decisions that depend upon such aggregate perceptions of seriousness. The prospect of such influence further heightens the responsibility for transparency in production of scenarios.

Scenarios contain unavoidable elements of judgment in both their production and use. Although they draw on relevant data, knowledge, and analysis, scenarios inevitably contain elements of judgment. In addition to putting serious responsibilities onto scenario developers, this implies that there is no authoritative way to resolve arguments over whether a scenario is plausible or not. When a wide enough range of potential futures is considered, some scenarios are likely to draw criticism, in part motivated by opposition to their foreseeable implications for action. Any scenario can be attacked as unreasonable, speculative or unlikely, and close enough scrutiny of any scenario can usually reveal inconsistencies, but these do not provide sufficient basis for excluding a scenario from consideration. Indeed, scenarios designed to represent extreme events, or to lie near one end of a distribution of potential outcomes, should by definition appear unlikely. The most productive response to such criticisms lies in transparency about the process, reasoning, and assumptions used to produce scenarios. Such transparency can shift arguments to underlying uncertainties, and help limit biases in the production of scenarios.

5.3 CHARACTERISTICS OF "CORE" EMISSIONS AND CLIMATE SCENARIOS

Centrally provided scenarios of emissions and climate change can help inform mitigation and adaptation decisions at national and sub-national scale, but these will usually require additional information as well. Central scenarios can provide information about trends in world emissions, underlying socio-economic conditions at the scale of major world regions, and the large-scale pattern of global policy response. They can also provide access to climate-model scenario output, plus tools, data, and support for producing finer-scale scenario information needed for particular impact and adaptation applications. Mitigation and adaptation decisions and associated assessments at national or smaller spatial scale will need more detailed and finer-scale climate and socio-economic information than can be provided by centralized scenarios, so these must be extended and/or modified by national and sub-national scenario processes.

Scenarios of emissions and resultant climate change should be global in scope and century-scale in time horizon. Core emissions and climate-change scenarios should specify major climate-relevant emissions and other perturbations, globally and for major world regions. They should extend over a time horizon of at least 100 years (including some that extend 200-300 years to support assessments of sea level rise), with interim results at roughly decadal resolution.

Emissions scenarios of several distinct logical types will be needed to serve diverse purposes. These will include some combination of alternative baselines, alternative levels of incremental stringency of mitigation effort, and specified future targets to support backcasting and feasibility analysis.

For some uses, emissions scenarios should be coupled to explicit scenarios of alternative socio-economic futures. For these scenarios, the range of potential socio-economic and policy futures considered should be wider than has been considered to date, including scenarios of policy failure and conflict, and a wide range of stringency and timing of mitigation effort. For example, what if development stagnates in major world regions? What if world emissions grow sharply for several decades with little control effort, followed by a subsequent shift to stringent mitigation efforts? What

if part of the world makes a lot of effort and part makes very little? Considering such varied future histories is crucial for considering long-term risks and opportunities from major mitigation choices.

Scenarios should reflect various explicit degrees of coordination, depending on their intended uses. Some uses will require groups of simple coordinated scenarios to provide standardized inputs for downstream modeling and analysis – e.g., standard emissions scenarios as inputs to climate models and standard climate scenarios as inputs to impact assessments – for exploring present uncertainties and tracking developments of knowledge over time. Other scenarios should be based on multiple models using common input assumptions. Non-standardized scenarios produced at the initiative of researchers and modelers should also be produced, which explore alternative assumptions or meet specific user needs, provided these meet basic standards of quality control, transparency, and documentation.

Some scenarios should seek to link qualitative and quantitative elements. Some scenarios of socio-economic conditions, whether produced to support global emissions scenarios or impacts assessments, should include both qualitative and quantitative elements and sustained analytic efforts to link the two. Qualitative or narrative scenario elements can provide a vehicle to explore major historical uncertainties with large implications for global emissions, climate change, and vulnerability to climate impacts; provide a coherent rationale and logical structure to connect assumed trajectories for multiple variables, including both quantitative and qualitative ones; and provide guidance to other analysts or users who may wish to extend the scenarios by elaborating additional detail. Achieving these benefits will require more sustained effort to integrate model-based projections of quantitative variables with qualitative and narrative scenario elements, to iterate between these, and to critically examine each element in light of the other, than has been made thus far. These efforts should seek to connect alternative qualitative and narrative scenarios not just to alternative parameter values in quantitative models, but also to alternative forms of causal relations and model structures. Generating multiple alternative model quantifications based on the same narrative and associated causal logic is one promising route to enriching understanding of uncertainties in key quantitative variables such as future economic output and emissions.

5.4 SCENARIO PROCESS: DEVELOPER-USER INTERACTIONS

There is value in collaboration between scenario developers and users, particularly at the beginning and ending stages of a scenario exercise. The appropriate degree and means of this collaboration vary substantially among scenario exercises. User engagement is most important in the initial scoping and design of a scenario exercise, and in the evaluation and application of the scenarios generated. The value of user engagement in details of scenario development, quantification, elaboration, and checking, depends on the specific case.

The ease of achieving such collaboration and its value are likely to be greater when scenario users are clearly identified, few in number, and similar in their interests and perspectives. When potential scenario users are identified, relatively few, and relatively homogenous, close and intensive collaboration between users and developers is likely to be most productive. When potential users are numerous and diverse, intensive engagement may be infeasible and more structured processes for consultation, representation, and information exchange are needed. While progress has been made in new methods to allow larger numbers to participate in scenario exercises, further development of such methods is needed.

5.5 COMMUNICATION OF SCENARIOS

Effective communication of scenarios is essential, in forms useful to audiences of diverse interests and technical skills. Scenarios must be communicated effectively to their potential users, including both technical and non-technical audiences. In addition to the contents or outputs of scenarios, communication should include associated documentation, tools, and support for their use. Various methods should be used to promote broad dissemination of scenario information; for instance, presentations, reports, websites, and centralized data distribution centers. To facilitate user understanding of results, various methods should be used to communicate numerical and technical information, including multiple tabular, summary, and graphical formats, ideally with user-interactive capabilities.

Transparency of underlying reasoning and assumptions is crucial. Scenario communication should include transparent disclosure of underlying assumptions, models, and reasoning used to produce the scenarios, to support the credibility of scenarios, to alert potential users to conditions under which they might wish to use or modify them, and to inform criticism and improvement of scenarios. This should include explicit identification of the major uncertainties represented in each scenario and the sources of underlying information, whether drawn from the scientific literature, formal expert-elicitation exercises, or informal judgments of the scenario team. It is possible in virtually all cases to formulate simple, accessible, honest descriptions of why a scenario was undertaken, why it was necessary, what was done, how and why, and why it merits respect as a reasonable judgment.

5.6 CONSISTENCY AND INTEGRATION IN SCENARIOS

Any scenario should be internally consistent in its assumptions and reasoning, to the extent this can be established given present knowledge. Carefully pursuing consistency within individual scenarios can be an intensive and time-consuming process, but is crucial to avoid problems that can discredit a scenario exercise.

In scenario exercises that use multiple models to explore potential uncertainties in future conditions, consistency between models should be pursued primarily through coordination of inputs, not outputs. Use of multiple models in parallel to produce alternative descriptions of future conditions can improve understanding of uncertainties, if models are run under consistent assumptions about exogenous inputs. Forcing models to generate consistent trajectories for endogenous outputs poses several risks, including suppressing variation from alternative causal structures that could provide valuable insights into uncertainties, and encouraging over-confidence from spurious precision. For quantities that are exogenous in some models and endogenous in others, the appropriate treatment varies case by case, but it is not generally desirable to force multiple models to convergent values of such variables without more detailed examination of the underlying uncertainties.

Imposing consistent outputs in multi-model exercises can be useful, however, when these outputs represent common goals for policy evaluation. For example, consistent constraints on some environmentally relevant target such as emissions, atmospheric concentrations, or radiative forcings, can be used to examine inter-model uncertainties in the technological, economic, and resource conditions associated with meeting the specified targets.

Transparency in reporting scenario and model differences as well as underlying assumptions and reasoning can help mitigate the effects of inconsistencies among scenarios. Ideally, multiple scenarios in an exercise should differ only on those elements intentionally chosen to distinguish them, and be consistent in all other factors. However, this is not always possible, particularly when scenarios are produced using different models. Pursuing maximal

transparency about the models, assumptions, and reasoning underlying each scenario – perhaps by issuing detailed diagnostic reports that include explicit discussion of points of weakness, uncertainty, and disagreements, and the means used to resolve them – can mitigate any resultant confusion.

5.7 TREATMENT OF UNCERTAINTY IN SCENARIOS

Some scenario exercises should include more explicit characterization of likelihood judgments than has been practiced so far. The advantages of being more explicit about the probability judgments that underlie scenario exercises are likely to outweigh the disadvantages. Such specification should be pursued further than has been done in major global-change scenario exercises to date, although not necessarily in all scenario exercises. The means available to express these judgments are of widely varying specificity, ranging from agreed terminology[202] to explicitly quantified probability distributions. All such judgments should include explicit acknowledgement of their inevitably subjective elements and appropriate caveats to help users avoid mistaking them as objectively true.

Explicit probability judgments are easiest to produce and least controversial in scenarios generated using quantitative models of climate change or specific impact domains. Scenarios generated using such models can be conditioned on specific assumed values for socio-economic inputs such as emissions, and can represent explicitly and quantitatively the effects of specified variation in initial conditions or unknown parameter values. These devices are also available, although in less widespread use, in economic models used to project emissions. These devices aid in constructing distributions of key quantitative characteristics, such as measures of global or regional climate, or of prominent quantitative impact measures, such as changes in river flows or sea level, although they neither capture all relevant uncertainty nor avoid the inevitably subjective nature of such probability judgments. Explicit probability judgments are more difficult and controversial when they involve socio-economic factors for which quantitative models are not available, and that do not depend in well understood ways on identified quantitative parameters. Such factors include major technological innovations, large-scale changes in attitudes or norms, or policy response.

Attempting to include explicit probability judgments is likely to be most useful and successful when key variables are few, quantitative outcomes are needed, and potential users are numerous and diverse. The case for assigning explicit likelihood judgments is strongest when scenarios' most salient components are quantitative projections of a few key variables, such as emissions or average temperature change over the globe or some region, because the technical barriers to assigning probabilities are least severe in this case. The case is strongest when a primary purpose of the scenario exercise is to provide inputs to other quantitative assessment activities, or to inform decisions that primarily depend on one or a few key quantitative variables, because such uses are most likely to require probability judgments. The case is strongest when the set of potential scenario users and uses is large and heterogeneous, because this situation provides the least opportunity for informal communication of implicit judgments of likelihood or priority through intense, sustained collaboration between scenario developers and users.

Attempting to include explicit probability judgments is likely to be least useful and successful when scenarios specify multiple characteristics, including prominent narrative or qualitative components; when the purpose of a scenario exercise is sensitivity analysis or heuristic exploration;

[202] See, e.g., the consistent uncertainty language proposed for IPCC reports by Moss and Schneider 2000.

and when potential users are few, similar, and known. When scenarios are primarily construed as rich, qualitative narratives that present major alternative historical and socio-economic trajectories, the technical obstacles to explicit probability assignment are greatest and the likely confidence in scenario developers' subjective probability judgments lowest. When the main purpose of a scenario exercise is to stimulate critical or creative thought, to probe the limits of a model or decision strategy through sensitivity analysis, or to explore ways of meeting a specified target, explicit probability assignment provides little or no benefit. When users are few, similar, and specifically identified, they can be intensively involved in scenario production, allowing effective informal communication of likelihood judgments without stating them explicitly. Under these conditions, scenario exercises can also be structured to engage users in the potentially instructive activity of assigning and discussing their own probability judgments, rather than putting that responsibility exclusively on the researchers or analysts developing scenarios.

Centrally provided scenarios of global emissions and climate change should attempt to include explicit probability judgments. Because of the large, diverse set of users for these scenarios, explicit likelihood judgments should be provided for ranges of key quantitative outputs, including global emissions and global-average temperature change. Scenarios should typically include several paths that span a wide range of judged uncertainty, e.g., 95 percent to 99 percent. The associated probability judgments may include some that are unconditional and some that are conditioned on specific assumed prior conditions. Such estimates should be provided by multiple groups using diverse methods. As for all such probability judgments, their unavoidably subjective nature and the specific assumptions on which they are conditioned should be stated explicitly and prominently

.

Providing explicit probability judgments allows scenario users to choose whether to use them or not. Some users may choose to use these explicitly in their subsequent analysis or decision support, while others may use them only to help decide which scenarios to use, and still others may disregard them entirely. Users may select a different group of scenarios or a different subset of the uncertainty range for various reasons, including differences in risk aversion, differences in the scope of their decision authority, or differences in their assumptions about decisions by other actors (present or future). Presenting complete descriptions of scenarios together with underlying assumptions and reasoning, including probability judgments, preserves all these options for users.

Scenario exercises should give more attention to extreme cases. Some uses of scenarios require consideration of low-probability, high-consequence extreme cases, such as loss of a major continental ice sheet or major changes in meridional ocean circulation. Consequently, such scenarios should be included in large, general-purpose scenario exercises producing emissions or climate-change scenarios, together with more likely middle-case scenarios. When extreme scenarios are included in an exercise, it is especially critical to be explicit and transparent about the reasoning and assumptions underlying each scenario, and scenario developers' judgments of relative likelihoods.

In addition to enhancing the utility of scenario outputs, probabilistic methods can contribute throughout the scenario development process. Developing scenarios requires making many judgments about unknown characteristics and developing many arguments and pathways to link these. Scenarios based on quantitative models typically require specifying many exogenous inputs and parameters. Even narrative scenarios require specifying values of multiple characteristics, both qualitative and quantitative. Explicit discussion of uncertainties and associated probabilities can help structure

and facilitate many aspects of the scenario development process, including deciding appropriate ranges of variables to consider, defining boundaries of what outcomes are considered plausible, elaborating associated causal mechanisms and linkages, discussing and integrating knowledge and judgments from multiple participants, and clarifying disagreements. Explicit conversation about probabilities can support insights throughout these processes, in addition to supporting communication of scenario judgments to users.

5.8 EXPANDING AND SUSTAINING CAPACITY FOR PRODUCTION AND USE OF SCENARIOS[203]

Present scenario capacity is inadequate. Although scenario-based reasoning is required for many aspects of global change assessment and decision support, the present capacity to produce, disseminate, apply, evaluate, and adapt scenarios is inadequate. There has not been enough continuity to enable effective learning, because scenarios are typically produced *de novo* for each major application. There has not been enough transparency about methods, reasoning, and assumptions. Constructing integrated scenarios and exploring alternative methods has been difficult, in part because scenario exercises have tended to be dominated by use of quantitative models, separated along disciplinary lines. Inadequate resources have been devoted to methods development, for scenarios and related decision-support tools Finally, there has been no systematic evaluation and critique of scenarios or their application.

To help fulfill these presently unmet needs, CCSP should establish a program to:

- ***Commission scenarios for use in assessments and decision-support activities.*** This task includes facilitating agreement among relevant producers and users on standard scenarios in cases where multiple assessment activities require standard scenarios for comparability, and convening and supporting a diverse collection of more extensive and detailed scenario-related exercises, by multiple groups using a wide range of models and approaches.
- ***Disseminate scenarios with associated documentation, tools, and guidance materials.*** This task includes multiple forms of support and program-building for diverse groups seeking to apply, modify, and extend existing scenario-based information at various regional and sectoral scales, through providing data, models, tools, resources, and associated documentation and technical support, in multiple forms and through multiple media.
- ***Commission various groups to evaluate scenarios and their applications and to develop improved methods.*** This task includes defining and promulgating standards for quality control – which, given the need for diverse approaches, would principally concern matters of process such as transparency, documentation, evaluation, and dissemination of results and supporting information. The task also includes broad efforts to develop scenario-related skills, tools, and methods, e.g., by providing resources for methods development and evaluation projects; conducting and establishing procedures for evaluation of particular activities and programs; and convening workshops,

[203] Recommendations made in this report regarding programmatic and organizational changes, and the adequacy of current budgets, reflect the judgment of the report's authors and the CPDAC and are not necessarily the views of the U.S. Government.

conferences, etc., to evaluate progress overall, or in particular methodological areas.

- ***Archive results and documentation related to all these tasks, to provide historical perspective and institutional memory for future scenario-related activities.*** This task includes preserving for retrospective scrutiny a wide range of materials: not just the methods, contents, and results of scenario exercises, but also the progressive evaluations of particular activities and approaches, and of the entire program. In its ongoing development and evaluation of methods, the program should not draw rigid boundaries between scenario development and application and other related methods of assessment and decision support for long-term global change issues.

Several conditions in the design and management of this new program would be required to ensure its effectiveness.

- ***The program should build and maintain strong connections with outside relevant expertise, and analytic and modeling capability.*** While the program must develop enough internal expertise to be a full participant in debates over scenarios and assessment methods, it cannot and should not attempt to impose a unilateral vision of preferred scenarios, methods, or approaches. Rather, it must build and maintain close collegial connections with outside networks of researchers and analysts in multiple fields of expertise, including emissions modelers, climate scientists and modelers, impacts researchers, and resource managers. These relationships would be facilitated by establishing governing mechanisms, such as a senior advisory board, drawn from the broad communities of researchers, modelers, and analysts who are developing and using scenarios and related methods. Although established as a US national program, it must also support, collaborate, and coordinate with parallel activities in other nations and internationally, and with relevant sub-national activities.

- ***The program should integrate and balance goals and criteria related to scientific and technical quality, and those related to utility and relevance to users.*** This balance is needed for the program to support promising but speculative activities, to encourage creativity and diversity of approach, to avoid being captured by any particular discipline or modeling approach, and to be willing to make and explain judgments about quality and promise that reflect both scientific and practical considerations. To achieve this, the program needs broad discretion over the type of projects supported, including sponsoring fairly sharply targeted activities, supporting speculative activities, and investing to develop and assess capabilities that do not yet exist.

- ***The program should be insulated from political control.*** For the scenarios and analyses based on them to be perceived as credible by their diverse users, the program needs enough insulation from political control, at both the national or international level, to prevent scenarios from becoming proxies for conflict over near-term policies, and to allow exploration of the implications of alternative futures that represent plausible risks but that some political actors would find objectionable.

- ***The program should strive for maximum transparency in its own activities, in addition to demanding it from activities it supports.*** The program should strive for maximal transparency regarding inputs, mod-

els, assumptions, and reasoning employed in developing scenarios, as well as any significant disagreements that arose and how they were resolved and any remaining weaknesses recognized by the developers. The broader and more diverse the collection of intended uses and users, the more crucial is transparency of the scenario-production process – because different users may require scenarios produced using different underlying assumptions, and they must be able to track the underlying logic to exercise this choice. This would enhance credibility in the scenario-development process. While calls for such transparency are widely made, experience suggests it is difficult to achieve, particularly for such matters as disagreements or recognized weaknesses that may risk professional embarrassment. Still, achieving more transparency and more widely informed debate on such matters is essential for advancing scenario methods.

- ***The program will require the authority and resources necessary to articulate and promulgate standards for transparency, consistency (e.g., of units and formats), and quality control.*** This task involves facilitating discussions among the community and formulating persuasive guidelines and supporting arguments. It also requires use of incentives such as seals of approval, access to participation in particular processes, access to particular dissemination outlets, and access to resources. A weak "clearinghouse" that solicits, supports, or publicizes scenarios but cannot exercise quality control, propose and stimulate new directions, or convene critical reviews, of the whole enterprise and of particular exercises, is not an adequate model for the program.

- ***The program will require an adequate sustained resources.*** The program must build and maintain a sophisticated analytic capability, and develop skills and institutional memory regarding prior experiences, successes, and failures. This requirement precludes the program being a series of *ad hoc* one-time activities or a part-time, unfunded burden imposed on people and organizations with other full-time responsibilities.