

Interpreting the IPCC Emissions Scenarios

by

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Abstract

This paper discusses how two sets of emissions scenarios, generated using the Atmospheric Stabilization Framework, were used by the United Nations Intergovernmental Panel on Climate Change (IPCC). In particular it discusses how the scenarios were specified, what roles models played in developing the scenarios, and how the scenarios were interpreted by participants in the IPCC process. It draws on the results of interviews conducted with 14 participants in the IPCC process.

After looking at how both sets of IPCC emissions scenarios were defined and interpreted it is clear that analysts need to explore the effects of policies in the context of uncertainty. Thus, instead of testing policy options on a single future and/or generating a range of possible futures in the absence of policy intervention, analysts need to investigate the effectiveness of various policy options across an entire set of possible futures. Conducting this sort of analysis would be an important step beyond the IPCC emissions scenarios.

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Interpreting the IPCC Emissions Scenarios

Robert M. Margolis

Introduction

The Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organization and the United Nations Environment Programme during 1988. Initially the IPCC was charged with (1) assessing the scientific information related to the various components of the climate change issue, and (2) formulating realistic response strategies for the management of the climate change issue. To accomplish these tasks the IPCC formed three working groups. Working group 1 (WG1) was to assess the scientific information on climate change, working group 2 (WG2) was to determine the environmental and socioeconomic impacts of climate change, and working group 3 (WG3) was to formulate response strategies to climate change (IPCC 1990b).

Early on in the IPCC process it became clear that the three working groups needed to have a common set of emissions scenarios in order to be able to communicate their findings to each other and the outside world. As one participant in the process described it, “[the emissions scenarios] put us all on a common basis so we wouldn’t be talking about different things.” Thus when WG3 held its first meeting during January 1989—at the U.S. State Department in Washington, DC—the U.S. and the Netherlands were asked to develop preliminary net emissions profiles for several scenarios of the future. The “emissions scenarios” which came out of this process were used as a first basis for analyses by WG1 and WG2, and as an initial reference and guidance for the subgroups of WG3 (IPCC 1991, 13). Since the emissions scenarios

represent important underlying assumptions about the future, which were used by all three working groups of the IPCC, they deserve further scrutiny.

This paper discusses both the original IPCC scenarios and a new set of scenarios included in the 1992 IPCC supplement report. It looks at how the scenarios were specified, what role models played in developing the scenarios, and how the scenarios were interpreted by participants in the IPCC process. It draws on the results of interviews conducted with 14 participants in the IPCC process.

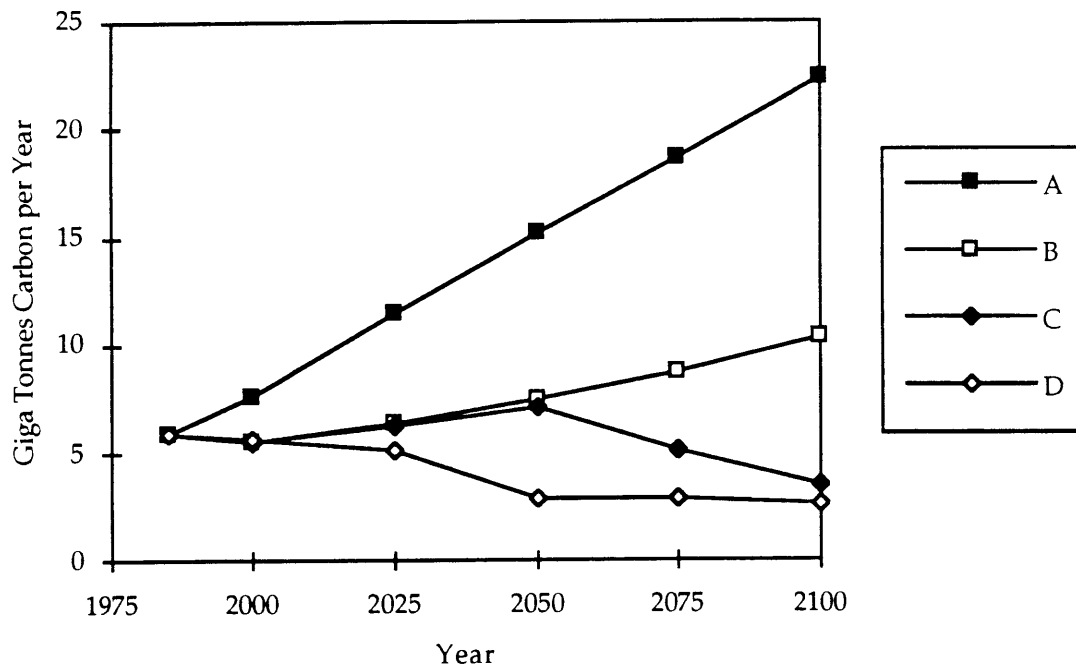
The interviewees included people who took part in the IPCC process from the U.S. government (the Environmental Protection Agency, the Department of Energy, the State Department, the Department of Justice and the President's Council of Economic Advisors); the IPCC itself (the Chairman of WG1, the Chairman of WG3 and the Chairman of the IPCC); Academia (Economists and Scientists); and Non-governmental organizations (NGO's). And they were from a number of countries including: Canada, England, the Netherlands, Sweden, the United States and Zimbabwe. Note that the interviews were conducted on the basis of non-attribution.

The interviewees played significant roles in defining, generating and using the scenarios, and they represented a broad range of perspectives on the IPCC process. The interviews focused on three main areas: how the participants thought about the models, how they interpreted the model results, and how they perceived the analysis underlying the model results. The questions used during the interviews are included in Appendix A.

Specification of the Scenarios

Initially WG1 requested that WG3 produce three scenarios: Scenario A would lead to a doubling of equivalent CO₂ concentrations by the year 2030,

Figure 1: IPCC 1990 CO₂ Emissions Scenarios



Source: IPCC 1991, 26-29.

Scenario B to a doubling of equivalent CO₂ concentrations by the year 2060, and Scenario C to a doubling of equivalent CO₂ concentrations in the year 2090 with stabilization of atmospheric concentrations thereafter.¹ Later in the process the Netherlands and some other countries were not satisfied with the range of scenarios selected and consequently urged the addition of a fourth scenario: Scenario D which would lead to a stabilization of equivalent CO₂ concentrations well below the doubling level (Rotmans 1990, 195). The four 1990 IPCC CO₂ emission scenarios are shown in figure 1.

¹In the WG3 report “equivalent CO₂ concentrations” is defined as “the concentration of CO₂ that, by itself, would produce the increase in direct radiative forcing produced by all of the greenhouse gases” (IPCC 1991, 18).

Clearly, the scenarios were defined in a restrictive manner. That is, the modelers were given target years for doubling of equivalent CO₂ concentrations, and then they constructed scenarios to meet the given targets through trial and error (i.e., by adjusting input assumptions). Essentially the modelers were asked to produce a set of desired results in a consistent manner.

When discussing the scenarios with participants in the IPCC process it became clear that there was not a lot of analysis behind the choice of 2030, 2060, and 2090 as the equivalent CO₂ doubling dates. This was clearly articulated by one participant from the EPA. He described the meeting at which the scenarios were initially defined as follows:

People said there should be a business as usual scenario, and that would mean that CO₂ would double around 2050, and then somebody else said, yeah but when you look at all the other gases it would happen sooner, and so they said well O.K., let's bracket 2060. And we ended up with 2030 and 2070 or something like that, and somebody said that's not a big enough gap so it became 2030 and 2090. Then primarily because the Dutch pushed for it at a subsequent meeting, with some other countries, they said we should have at least one scenario that stabilizes well below a doubling. And so the fourth scenario was added.

This quote illustrates that the scenarios were initially defined to provide reference scenarios, or different paths of emissions which would result in different impacts. That is, WG1 wanted a set of emissions scenarios which would lead to a range of impacts from very high to low.

In fact, originally there was a sense that A was a high scenario, B was a middle scenario, and C was a low scenario. In other words, originally the scenarios were intended to map out the variation that could occur in the future. They were not defined to be "policy scenarios." Further they were not intended to be interpreted as predictions of the future. The report by the

“Expert Group on Emissions Scenarios” was very clear on this point. As stated in the Expert Group report, “These scenarios were not intended to be forecasts of possible development outcomes or of likely policy options, but would serve as a first step in the analysis of a plausible range of global climate change scenarios” (IPCC 1990a, 1).

Controversy Over Labeling the Scenarios

During the IPCC process the scenarios names were modified. Essentially the labels became Scenario A or Business As Usual (BAU) or 2030 High Emissions, Scenario B or 2060 Low Emissions, Scenario C or Control Policies, and Scenario D or Accelerated Policies. The label changes reflect how the interpretation of the scenarios changed throughout the process. A member of the subgroup which developed the scenarios described how he felt about the transition as follows:

When we did the scenarios originally, that is the first three scenarios, they weren't intended to be policy cases. They weren't called policy cases. But if you look at how they were developed, they were in some cases almost policy implementations, or things that could be considered to be policies that generated these results. Then they came back to do the final report and said, well gee these look a lot like policy cases. And they became policy cases, and there was a big brawl over that, because a lot of people didn't want them to be called policy cases. . . You could look at them and say in some sense that if you believed your assumptions in the business as usual scenario then you would have to have policies that got you [to lower emissions], that forced the deviation. In that sense they are policy scenarios .

This quote helps to illustrate that in one sense the struggle over what to name the scenarios reflects changing perceptions of the meaning of the scenarios throughout the process.

However, perhaps more importantly, since the scenarios are central to defining climate change as a political issue, the struggle is also about how to

define climate change as a problem. For example, interpreting the IPCC emissions scenarios as a set of scenarios which cover a range of possible futures, including uncertainty yet independent of policies, says nothing about our ability to use policy responses to avoid climatic disruptions. The first interpretation only indicates that the future is highly uncertain. While the second interpretation, viewing the scenarios as representing business as usual and increasingly stringent policies scenarios, tells a very different causal story: Policies aimed at reducing emissions of GHG's can help us avoid major climatic disruptions.

In the policy world an issue is not a problem until someone thinks they have a solution. Thus participants in the policy process who want to see action taken on the climate change issue would like to interpret the scenarios as BAU and increasingly stringent policy scenarios. In other words, in the context of the political debate, they want to construct a convincing "causal story" linking policy intervention with reductions in climatic risks. On the other hand, there are participants in the policy process who want to interpret the scenarios simply as a range of possible futures. While they may believe that increasing the atmospheric concentrations of GHGs will result in significant climatic change, they may be skeptical about the effectiveness of policy intervention. In addition, there are participants in the policy process who would argue that there is not even a proven causal link between increased atmospheric levels of greenhouse gases and climatic change.

Probably the most controversial IPCC decision was to use the name "Business As Usual" for Scenario A. Here participants disagreed pointedly both about how they thought Scenario A should be interpreted and the meaning of the term "Business As Usual." For example, to some BAU means a projection of present trends into the future, while to others it means a

prediction of the future in the absence of policy intervention. The difference in wording is subtle but the difference in meaning is very significant. This controversy was expressed in a number of different ways during interviews conducted with participants in the process. For example, a representative to the IPCC from the State Department viewed the phrase BAU as being misleading:

The phrase BAU was in and of itself misleading, because it did not take into account the changes that necessarily result as a consequence of new information and new technology development. In other words, if we did nothing between now and ten years from now, there would be more change than the BAU scenario allowed because of what is normal, because BAU is dynamic, it's not static. And the basic problem there was that they posited a proposition that BAU is static, that it's not dynamic, that it doesn't change. And it changes significantly, at least when forced by significant new information, significant new business opportunities, commercial development, etc. So the concept itself was misleading.

From this perspective since the name BAU implies a static future, it would probably lead to higher emissions than would be produced by a dynamic view of the future.

A representative to the IPCC from the Department of Energy expressed a similar view. He thought that the label BAU was inappropriate:

They [the scenarios] were really miss-named. And that turned out to be important. They got miss-named in the sense that they got named 'Business As Usual,' and nobody really ought to believe that 2030 doubling is BAU, or else you don't believe that technology change occurs. . . I think this is a case where different parts of a government had different agendas within an administration, and so were able to push a more activist agenda with out the more conservative parts of the government catching on. . . As it appeared in the report it sounded like a projection. And that's absolutely what it is not. The reason why I could agree that night in Washington, was because it wasn't a projection. That's the reason I could agree to it. And the reason why we could go forward.

From this quote we see that some people in the IPCC process did not like the causal story implied by using the label BAU.

Contrastingly, there were participants in the IPCC process who thought that a “real” BAU scenario would lead to much higher emissions. One European representative expressed this view nicely:

We were not very happy with that [the name change from Scenario A to BAU] because we think that a real BAU scenario, that involves a kind of attitude of doing nothing, would lead to higher emissions. . . We presented, in an article in *Climatic Change* our ‘unrestricted’ scenario: A scenario with no restrictions in it due to policy measures. That leads to a scenario in 2100 which is twice as high as the IPCC BAU scenario. In our case it leads to about 50 gigatonnes of carbon in 2100. That's very high but is indeed based on the attitude of taking no measures. I think that reflects the way we think in Western Europe about this. In general we are not as optimistic [as people the US].

In the middle of this controversy there were participants in the IPCC process who felt comfortable with the label BAU. For example, a representative from the EPA thought that:

. . . the labeling is probably appropriate given the analysis. Although the original mandate to generate the scenarios wasn't necessarily labeled that way. The labeling probably evolved to fit what the analysis showed. And I think that is probably right, that 2030 is more a BAU, and that the other scenarios probably do represent progressively more stringent policies.

As illustrated by the quotes above, the label BAU could be interpreted in a number of different ways. In the end, with some controversy remaining, the name of Scenario A was changed to “Business As Usual.”²

Clearly there is a certain legitimacy to the controversy over using the name BAU instead of Scenario A. However, one could argue that the

²The most widely read reports, the WG1 report (IPCC 1990b) and policy makers summary of the WG3 report (IPCC 1991), use the label “BAU”. While the more technical reports, the chapter on the Emissions Scenarios of the WG3 report (IPCC 1991, Chapter 2) and the Expert Group on Emissions Scenarios Report (IPCC 1990a) use the label “2030 High Emissions” for Scenario A.

labeling debate was more political than substantive. Using the label BAU did effect how the IPCC reports read, but it did not really effect the substance of the reports. On the other hand, using the label BAU significantly influenced how the scenarios were perceived by people both inside and outside of the IPCC process.

The controversy over the names used for the emissions scenarios led to calls for the IPCC to define, more clearly, how the scenarios should be interpreted. For example, critics wanted to know if they were scenarios, predictions, projections or forecasts (Global Environmental Change Report 1991). This ultimately led to the creation of a new set of emission scenarios which were included in the 1992 IPCC Supplement Report (IPCC 1992). Before discussing the new set of scenarios, however, it is worthwhile to ask if the analysis underlying the original scenarios supported how they were interpreted.

The ASF Generated Scenarios

The main modeling tool used to generate the emissions scenarios was the Atmospheric Stabilization Framework (ASF).³ The primary feature of a modeling framework, like the ASF, is that it enforces consistency. For example, in the ASF if you make assumptions about reducing emissions from the building sector by increasing conservation, then the model forces the system to tell you that less electric power will be generated, and so your ability to reduce emissions in the electric utility sector will be less than before. In

³Another model used by the IPCC was the Integrated Model for the Assessment of the Greenhouse Effect (IMAGE) which was developed by RIVM in the Netherlands. However, the Dutch did not independently design a set of emissions scenarios. Instead, they used IMAGE to confirm that the ASF generated emissions scenarios would lead to the requested atmospheric concentration levels. Also, IMAGE is very similar in structure to the ASF. In fact, IMAGE uses the Edmonds-Reilly model in its energy module (Rotmans 1990).

other words, it keeps you from double counting and forces you to work within a framework which has fundamental constraints in it. This was the mode that the ASF was used in by the IPCC. Thus while the ASF was primarily used to get a consistent set of numbers, it also helped keep the political process from getting completely away from the constraints of reality.

For each of the four emissions scenarios (e.g., doubling by year X) two “detailed” scenarios were generated using the ASF: a higher economic growth scenario and a lower economic growth scenario. The reason, according to the expert group report, for generating two scenarios for each requested emissions scenario was to try to capture some of the uncertainty about the “many equally plausible yet divergent paths that the world could take to reach the equivalent CO₂ doubling levels” (IPCC 1990a, 1). Yet, in constructing the higher and lower growth scenarios the only parameter that was modified was the rate of economic growth. It is true that the future rate of economic growth is one of the most important variables influencing GHG emissions; however, there are other important, and uncertain, variables which influence GHG emissions significantly. For example, population growth rates will influence GHG emissions a great deal and are uncertain, yet the IPCC used a single population projection in all of its scenarios. Thus the higher and lower growth scenarios give a very limited sense of the possible “divergent paths.”

After the eight higher and lower economic growth scenarios were created, they were used to generate four “average” emissions scenarios for each GHG. The average scenarios were simply an average of the higher and lower economic growth scenarios. Thus a total of twelve emissions scenarios for each GHG were created. The average emissions scenarios for CO₂ are

shown in figure 1. The high, low and average growth CO₂ emissions scenarios are shown in Figure 2a-d.

Figure 2a: IPCC 1990 CO₂ Emissions: Scenario A

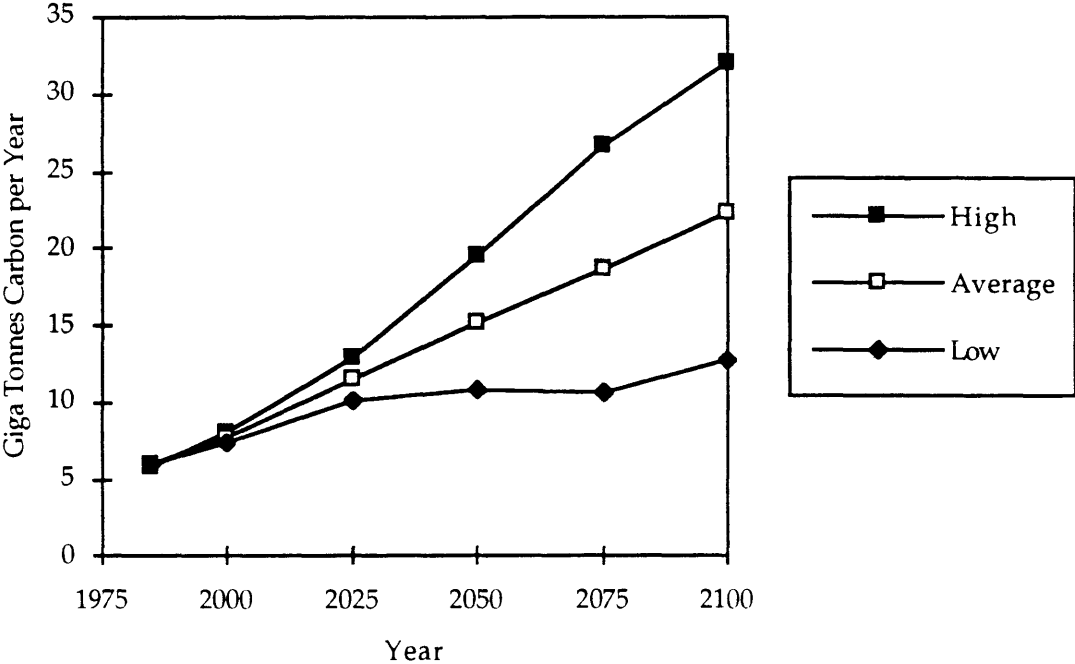


Figure 2b: IPCC 1990 CO₂ Emissions: Scenario B

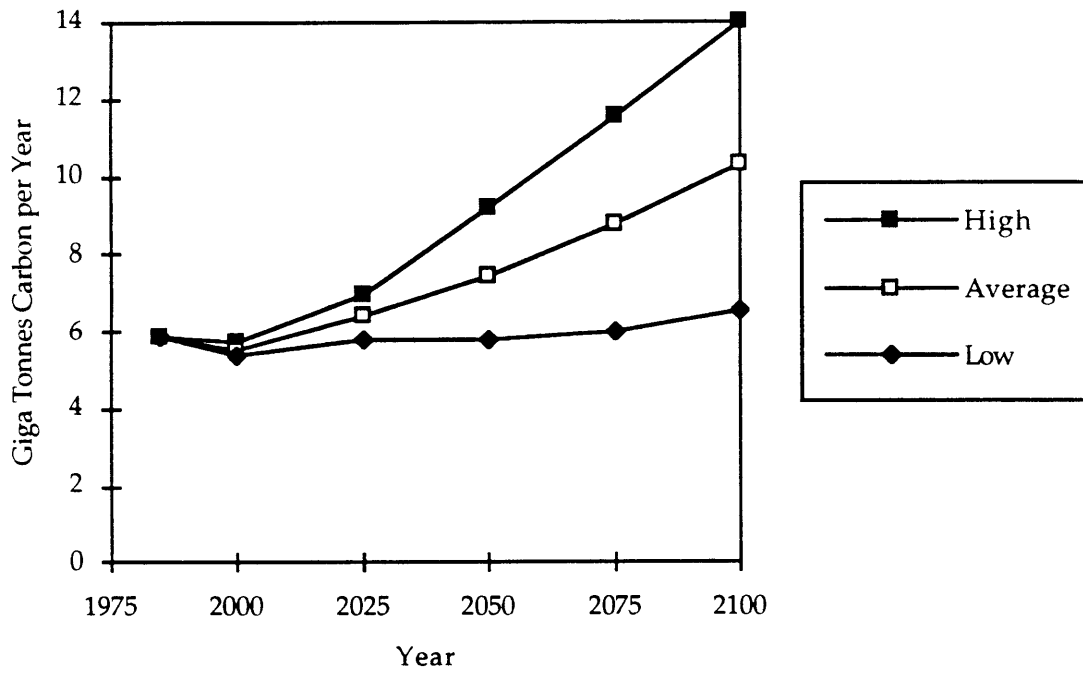


Figure 2c: IPCC 1990 CO₂ Emissions: Scenario C

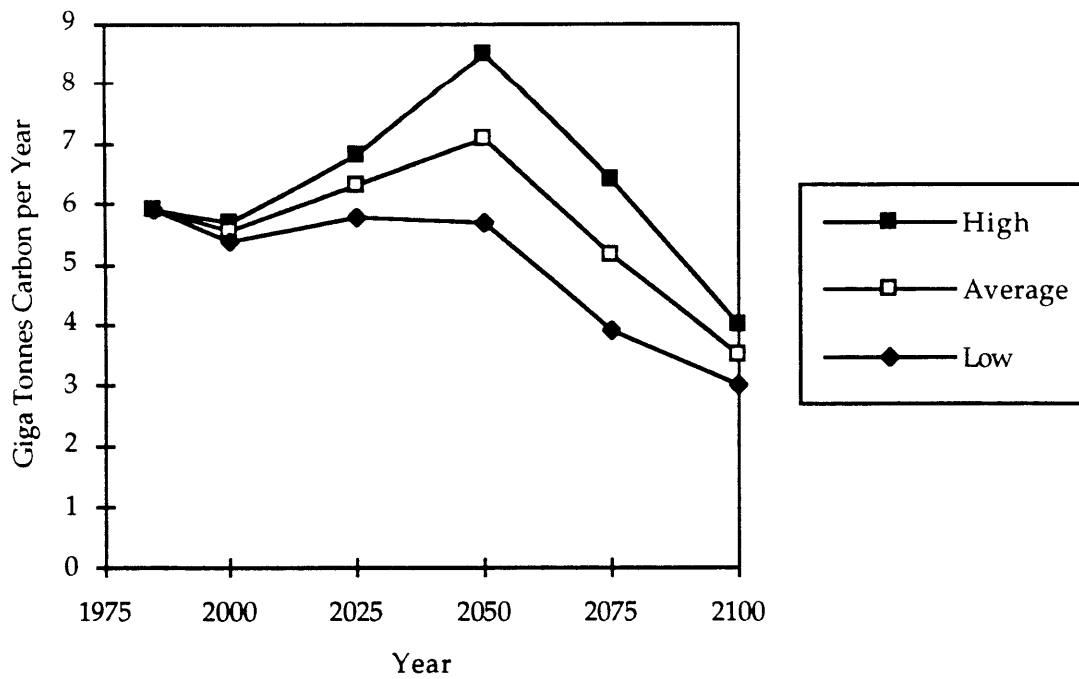
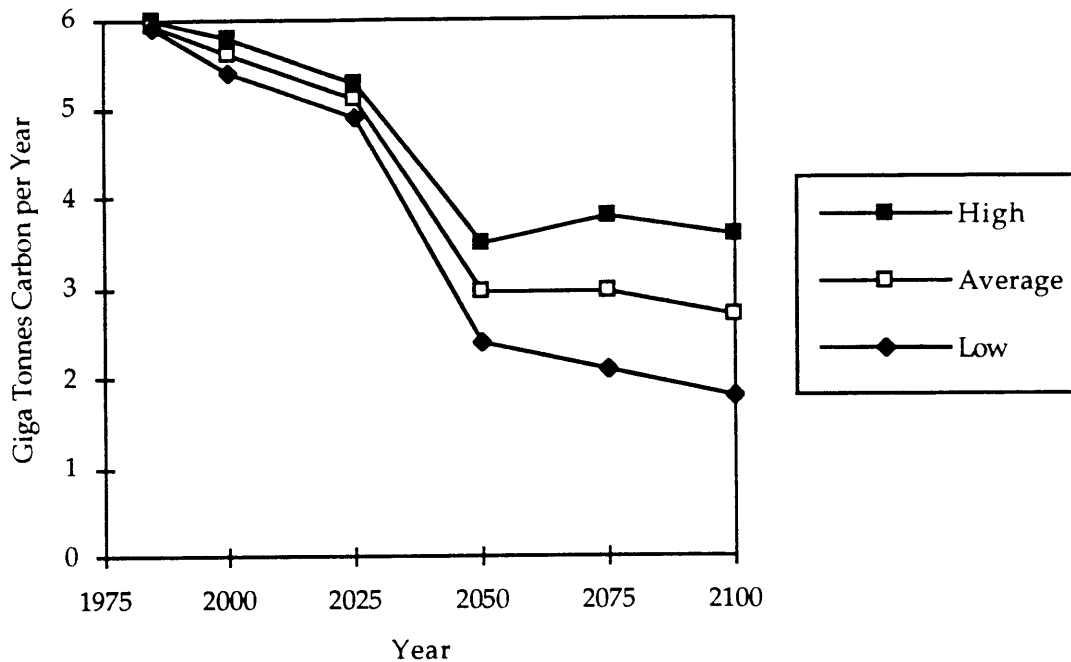


Figure 2d: IPCC 1990 CO₂ Emissions: Scenario D



Source: IPCC 1991, 26-29.

In addition to producing emissions scenarios, the ASF produces atmospheric concentration, forcing and warming scenarios. However, in the IPCC process only the ASF-generated average emissions scenarios were used. The IPCC WG1 used these average emissions scenarios as inputs into their own models to calculate scenarios of trace gas concentrations, equivalent CO₂ concentrations, radiative forcing, warming and sea level rise. By using the average emissions scenarios WG1 essentially filtered out the uncertainty captured by the high and low growth scenarios.

Details of the Scenarios

In constructing the scenarios there were several key variables that were not manipulated (IPCC 1990a, 2). They included: the global population

Table 1: IPCC 1990 Scenario Assumptions

	Scenario A	Scenario B	Scenario C	Scenario D
Population	World Bank	World Bank	World Bank	World Bank
GNP	High/Low	High/Low	High/Low	High/Low
Energy Supply	Carbon Intensive	Gas Intensive	Non-Fossil Intensive	Early Non-Fossil Supply
Energy Demand	Moderate Efficiency	High Efficiency	High Efficiency	High Efficiency
Control Technology	Modest Controls	Stringent Controls	Stringent Controls	Stringent Controls
CFCs	Protocol/Low Compliance	Protocol/Full Compliance	Phase-Out	Phase-Out
Deforestation	Moderate	Reforest	Reforest	Reforest
Agriculture	Current Factors	Current Factors	Declining Factors	Declining Factors

Source: IPCC 1990a, 24.

growth rate, the extraction costs of fossil fuels, the size of the resource base for fossil fuels, the uncontrolled emission rates from energy production and consumption, the starting emission budgets for each greenhouse gas, the atmospheric response to changing greenhouse gas concentrations, and basic lifestyle preferences.

On the other hand, there were a number of key variables that were altered in order to obtain the target equivalent CO₂ levels (IPCC 1990a, 1). They included: the rate of economic growth, oil prices, energy supply, energy demand, energy efficiency, rates of deforestation and reforestation, CFC and halon production and use, and agricultural activities. Table 1, which is

adapted from the Expert Group report, describes the major assumptions used to construct the scenarios. It is worth noting that in creating the IPCC “policy scenarios” three of the main areas where assumptions were modified (energy supply, energy demand, and control technologies) are related to energy policies.

A comparison of the assumptions underlying the scenarios, as shown in table 1 , raises a fundamental question: Should changes in the values of key variables be interpreted as policy intervention or uncertainty about the future? A couple of examples will help illustrate the importance of asking this question:

- On the energy demand side essentially what varies between the scenarios are assumptions about the rate of improvement in energy intensity. But one could ask if these are just different assumptions about efficiency improvement rates or higher efficiency improvement rates achieved by implementing a particular set of policies. Note there is a great deal of disagreement about what the appropriate rates for autonomous energy efficiency improvements are in the absence of policy intervention.
- On the energy supply side in Scenario A there is a large increase in the use of coal in the future, while in Scenario B there is a large increase in the use of natural gas in the near future, some of which would have been uneconomic according to the model. But one could ask if the increased use of natural gas is due to an actual policy change or just a change in assumptions. Perhaps a range of assumptions should be used to reflect uncertainty about the size of the resource base and future costs of extraction.
- Scenarios C and D have large increases in the use of non-fossil sources. But one could ask if this is a result of policies or does it just reflect uncertainty about future technological developments. For example, some proponents of Photovoltaics claim that over the next 15 years low cost solar PV will become a viable option with or without policy intervention.

Thus, how one interprets the changes in scenario assumptions (i.e., as specific policies or simply uncertainty), effects how one views the resulting scenarios (i.e., either as an uncertainty range or a policy range).

The text of the expert group report (IPCC 1990a) supports interpreting the changes in assumptions between Scenarios A and B as representing uncertainty about the future, and the changes in assumptions required in order to achieve Scenarios C and D as representing policy responses. The WG3 report also encourages this interpretation of the scenarios. For example, the WG3 report states that:

The 2030 High Emissions and 2060 Low Emissions scenarios may be viewed as two different paths that global greenhouse gas emissions could follow over the next several decades. The latter case assumes sizable improvements in energy efficiency, which may only be possible with government action. The Control Policies and Accelerated Policies scenarios require deliberate actions by governments (e.g., phasing out of CFCs, increasing fossil energy prices or using other measures to ensure penetration by renewables) (IPCC 1991, 16).

Clearly this interpretation of the scenarios gives a false sense of certainty: it uses the average economic growth rates, a single population projection, and completely neglects other important uncertainties in the model such as price elasticities and income elasticities for energy demand.

On the other hand, in the political process scenario A was interpreted as a "business as usual" scenario (i.e., a no policy forecast). At this point it should be clear that the analysis underlying the scenarios supports a different interpretation than the way they were generally interpreted in the process. It is worth asking how this could have happened.

Conflict Between Policymakers and Analysts

A basic source of confusion, when using model generated scenarios in a policy context, stems from conflict between what policymakers want and what modelers are capable of providing. Most modelers understand that a model like the ASF can not forecast the future accurately. However, policymakers want to be given forecasts, not internally consistent scenarios. One of the people interviewed, who has been involved in a range of model driven policy debates, stated this concisely:

Policymakers of course want forecasts, scenarios are not of great interest. To say 'if we do nothing this might happen' is not satisfying. The question is 'if we do nothing what is likely to happen?, what are the uncertainties?' So, you actually do want a forecast, I believe, for the BAU case. You want some baseline from which you can explore the effects of policies. Once you recognize that, then I think you want to describe it as a forecast, not try to hide it as a scenario, and indicate the level of uncertainty that attaches to it as a forecast.

However, even if an analyst presents model generated results as a forecast with a given level of uncertainty, it is still difficult to prevent policymakers from focusing on a single—best guess, mean or median—forecast. One of the modelers interviewed expressed frustration about being in this situation as follows:

When you present only one figure, with only one line, they [the policymakers] will always accept that line, but if you are uncertain of that it is always difficult presenting these cases. I demonstrated my model in the Dutch parliament, and I gave them three different scenarios: pessimistic, optimistic, and a moderate one. All the policymakers chose the middle one, the moderate one. That's always the kind of logic/attitude they have. They don't really believe in the optimistic and pessimistic ones.

Thus the conflict between what policymakers want to be given and what models are capable of providing, helps explain how the original IPCC

scenarios were interpreted. As described above, in an attempt to include some uncertainty in their analysis, analysts created high and low growth scenarios for each of the four average scenarios. However, participants in the process focused almost exclusively on the average results of scenario A (i.e., the BAU scenario).

There are at least two important lessons we should learn from the IPCC experience: 1) modelers need to be more sensitive about how their results will be interpreted in the policy process, and 2) participants in the policy process need to move beyond trying to interpret every model result as a forecast. The challenge for modelers is to find a way to communicate the meaning of their analysis effectively. For example, when using scenario based analysis one option might be to refrain from giving a median or best guess scenario. Another possibility, for incorporating uncertainty into an analysis, would be to use a probabilistic approach. However, approaches which generate results that explicitly incorporate uncertainty, are likely to make policymakers uncomfortable. One person interviewed, who has been involved in energy modeling for over a decade, expressed this conflict succinctly:

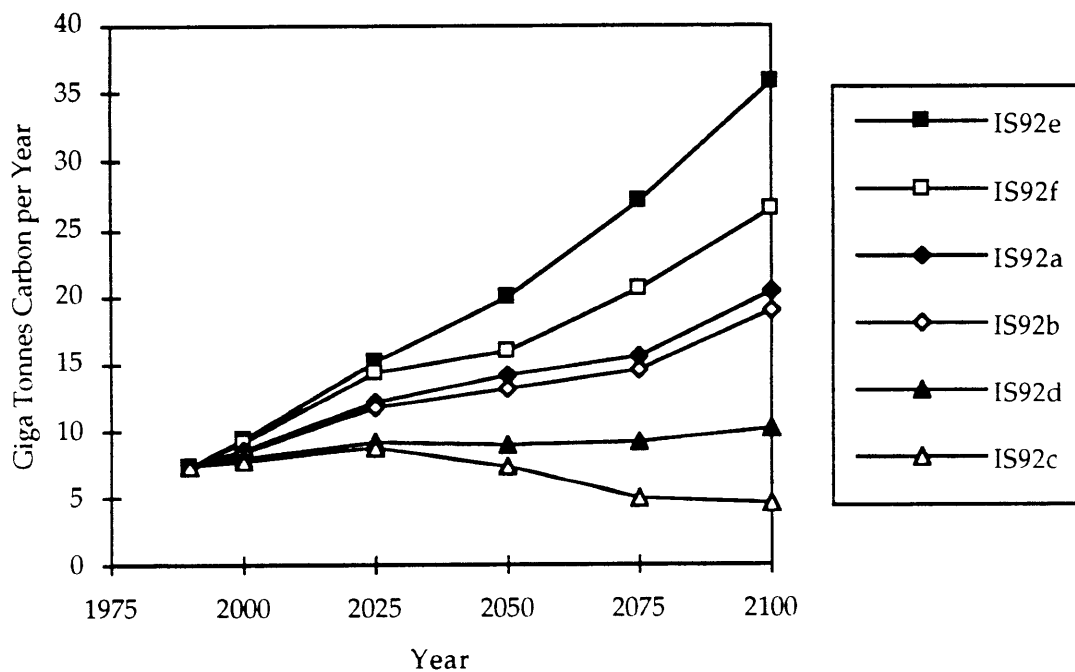
Policymakers don't like to be told that between the 5th and 95th percentile there are about 2 orders of magnitude between what emissions can be in 100 years from now. Which makes perfect sense if your thinking about how different futures could turn out to be over the course of a century, and yet a policymaker doesn't want to know that.

However, since uncertainty is a central feature of climate change, it would be inappropriate to present results in a way that would encourage interpreting them as being more certain than they actually are. It was concern over this issue, in conjunction with the labeling controversy, which led to the creation of a new set of IPCC emissions scenarios.

The 1992 IPCC Update

The IPCC decided to “update” its original emissions scenarios at its fifth session held in Geneva during March 1991. At this meeting, the U.S. and the Netherlands were asked to co-chair the task-force to update the scenarios.⁴ The result of this process was a set of six emission scenarios, which were included in the 1992 IPCC Supplement Report (IPCC 1992). The new set of emissions scenarios are shown in figure 3. Taken together the six new scenarios (IS92a-f) are intended to replace the original scenario A.

Figure 3: IPCC 1992 CO₂ Emissions Scenarios



Source: IPCC 1992, 12 & 13.

⁴During its fifth session the IPCC decided to address six tasks in order to update its First Assessment Report. The six tasks included: assessment of net greenhouse gases emissions; predictions of the regional distributions of climate change and associated impact studies; issues related to energy and industry; forestry-related issues; vulnerability to sea level rise; and emissions scenarios (IPCC 1992).

The process of updating the scenarios created a lot of controversy within the IPCC. For example, one NGO representative described the situation after the emissions task-force met in the U.K. during July 1991 as follows:

There was no consensus and I think a lot of people in IPCC now appreciate, whether it was intended or not, the value of having an initial target to shoot at because then some of these discussions become a lot less relevant. You know if you say, well, whatever the BAU scenario, however it is constructed, you have to end up doubling CO₂ equivalent in roughly 2030, then a lot of these other debates become less significant.

It is interesting that during the process of redefining the scenarios, representatives from the coal industry and World Energy Conference vehemently argued that the energy demand and coal consumption, projected in the original BAU scenario, were much too high. They argued that the BAU scenario does not take into account a great deal of intrinsic energy efficiency that will happen in the absence of policies.

The supplement report points out that scenario IS92a is basically a modified version of original scenario A with a number of recent developments incorporated into it, such as: the London Amendments to the Montreal Protocol; revised population forecasts by the World Bank and United Nations; publication of the IPCC Energy and Industry Sub-group scenario of greenhouse gas emissions to 2025; political events and economic changes in the former USSR, Eastern Europe and the Middle East; re-estimation of sources and sinks of greenhouse gases; revision of preliminary FAO data on tropical deforestation; and new scientific studies on forest biomass (IPCC 1992, 10). Thus the updated scenario IS92a is described as if it is a new base-case forecast.

At the same time the supplement report states that the new scenarios should not be interpreted as forecasts:

Scenario outputs are not predictions of the future, and should not be used as such. . . They are inherently controversial because they reflect different views of the future. The results of short-term scenarios can vary considerably from actual outcomes even over short time horizons. Confidence in scenario outputs decreases as the time horizon increases, because the basis for the underlying assumptions becomes increasingly speculative. Considerable uncertainties surround the evolution of the types and levels of human activities (including economic growth and structure), technological advances, and human responses to possible environmental, economic and institutional constraints. Consequently, emission scenarios must be constructed carefully and used with great caution (IPCC 1992, 10).

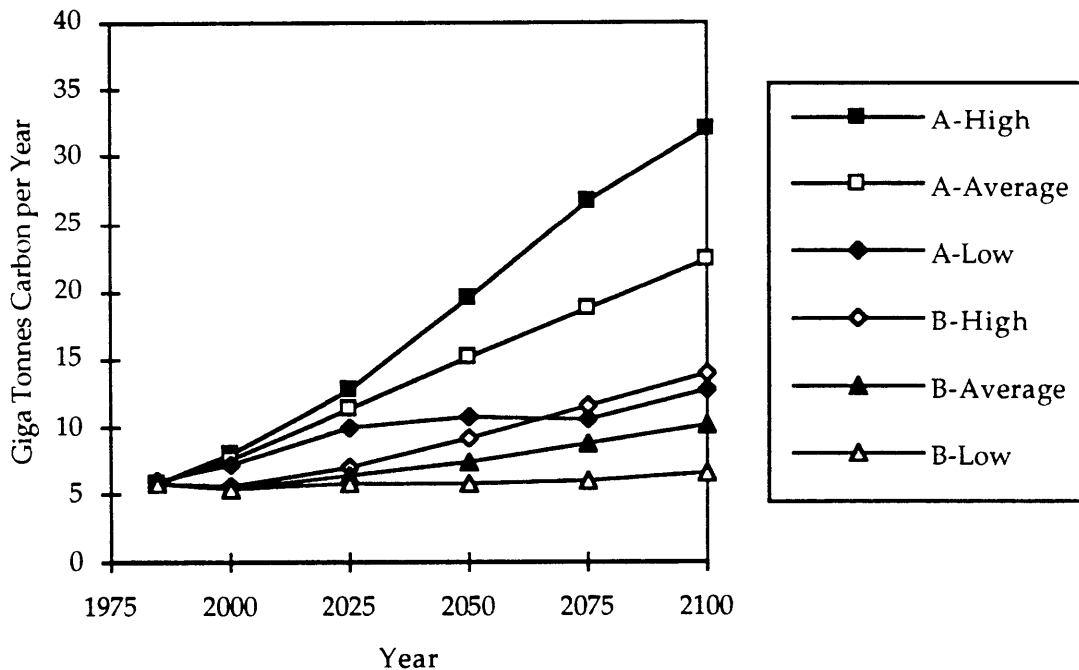
This disclaimer is probably in response to complaints that the original scenarios were presented/interpreted as forecasts. Yet given how IS92a was constructed and presented, it is possible that it will also be misinterpreted.

In addition to scenario IS92a, the supplement report includes five other scenarios (see figure 3). The additional scenarios were designed to incorporate a range of assumptions for population growth rates, economic growth rates, energy supplies, and restrictions on CFCs and other gases (IPCC 1992, 11). They were not designed as policy scenarios. Instead, they were developed with the recognition that there is considerable uncertainty about how future greenhouse gas emissions might evolve in the absence of policies (IPCC 1992, 10). However, the relative likelihood of the scenarios was not analyzed, and so it is unclear what sort of uncertainty range the scenarios provide.

It is useful to compare the new set of scenarios to the original scenarios. As discussed above, the analysis underlying the original scenarios supports interpreting the changes in assumptions between scenarios A and B as representing uncertainty about the future. Additional uncertainty is captured by the high and low economic growth “detailed” scenarios. Thus,

the range between the high economic growth scenario A and low economic growth scenario B, as shown in figure 4, could be viewed as the implicit uncertainty in the original scenarios. It is intriguing that the new scenarios span a range only slightly larger (4.6-35.8 GtC in 2100) than the range spanned between the high economic growth rate scenario A and low economic growth rate scenario B (6.6-32.0 GtC in 2100). This tells us that while the details of the 1990 and 1992 IPCC emissions scenarios are quite different, the range of uncertainty included in the scenarios is actually very similar. However, in summary documents the 1990 emissions scenarios were presented as if they did not include uncertainty.

Figure 4: IPCC 1990 CO₂ Emissions Scenarios A & B



Source: IPCC 1991, 26-7.

Conclusions

The analysis underlying the first set of IPCC scenarios acknowledged that the future is uncertain, yet much of the uncertainty implicit in the analysis was filtered out during the political process. The interplay between analysts and policymakers, discussed above, highlights the need for modelers to be more sensitive about how their results will be interpreted in the policy process, and for participants in the policy process to move beyond trying to interpret every model generated result as a forecast.

The new set of scenarios in the 1992 IPCC supplement report responded to two distinct issues. First, the scenarios were intended to update the original BAU scenario: they incorporated events and new information which had occurred since the completion of the 1990 IPCC reports. Second, the new scenarios responded to critics, who claimed that the original set of emissions scenarios were misleading. Thus the new scenarios were designed to explicitly include uncertainty about the future. However, the IPCC did not analyze the relative probability of the six new scenarios. In fact, the supplement reports states that the, "IPCC WG1 does not prefer any individual scenario" (IPCC 1992, 10). While this is a step forward, there is still the likelihood that policymakers will focus on a single scenario such as IS92a. In fact, when the supplement report discusses uncertainty in the climate system, it focuses on scenario IS92a.

In addition, while the new set of scenarios do incorporate uncertainties in population growth rates, economic growth rates and technology development, they do not include other important uncertainties in the model, such as energy price elasticities and energy income elasticities.

Finally, after looking at how the first two sets of IPCC emissions scenarios were defined and interpreted it should be clear that analysts need to

explore the effects of policies in the context of uncertainty. Thus, instead of testing policy options on a single future and/or generating a range of possible futures in the absence of policy intervention, analysts need to investigate the effectiveness of various policy options across an entire set of possible futures. Conducting this sort of analysis would be an important step beyond the 1992 IPCC emissions scenarios.

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Appendix A: Interview Questions

- 1) Models: How energy-economic-environmental models and their results were used throughout the IPCC process.
 - 1a) Do you think the models were used to ask the proper questions?
 - 1b) What do you think the proper role of models/model results should have been in the IPCC process?
 - 1c) How do you think the models (the way they present results, etc.) might be modified to make them more useful in the process?

- 2) The Model Results (Scenarios):
 - 2a) How were the model results presented to you?
 - 2b) How familiar are you with the Emissions Scenarios? (unfamiliar, somewhat familiar, familiar, very familiar)?
 - 2c) How did you interpret the emission scenarios? What did the scenarios tell you? What was the information content of the scenarios? Did they tell you that it would be easy/ hard, feasible/infeasible, expensive/cheap to achieve them?
 - 2d) Do you think that the emission scenarios affected the way the participants thought about the issues? How?
 - 2e) What information did you want but found that you did not get from the emission scenarios? (i.e.: specific policy proposals, discussion of uncertainty, costs)
 - 2f) How did you think about the uncertainty in the scenario numbers? Did you have any ideas/feelings for the level of uncertainty in the scenario numbers, cost, etc.? (completely uncertain, uncertain, somewhat certain, very certain).
 - 2g) In your discussions with other people did you talk about the scenarios, how they were derived, their meaning?

3) Analysis Underlying the Emission Scenarios:

3a) Are you familiar with the analysis underlying the emission scenarios?

3b) What did you think about the analysis? ASF? IMAGE?

4) Is there anything else you think I might be interested in?

Other Questions (if there is extra time):

Process:

- In general how did/do you feel about the IPCC process?
- What do you feel was useful that came out of the IPCC process?
- What do you think the IPCC working groups did well?
- Where did you see areas of substantial misunderstanding?
- How was the IPCC process structured to accommodate dissenting views and different cultural views?

Future:

- Where do you think attention should be focused in the future?
- What do you think the IPCC working groups could have done better?
- What do you think was misunderstood in the three IPCC reports?
- Where do you think the IPCC needs to do more work?