Transition Paths to a New Era of Green Industry: Technological and Policy Implications

Robert Lempert

Talk delivered at the
Science Forum on Science, Technology, and Innovation for Sustainable Development
a parallel event of the World Summit on Sustainable Development (WSSD)
Johannesburg, South Africa
August 31, 2002

For more information or to order RAND documents, see RAND's URL (http://www.rand.org) or contact Distribution Services, RAND, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138, phone (310) 451-7002; Fax: (310) 451-6915; Email: order@rand.org

Published 2002 by RAND
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
201 North Craig Street, Suite 102, Pittsburgh, PA 15213

Thank you, It is an honor to be here today.

CHALLENGE

My task today is to look into the future. I have been asked to discuss the types of actions we must take in the near-term to help ensure that science and technology will decouple economic growth from environmental impacts over the course of the 21st century. There are, of course, three absolute certainties when talking about the long-term future.

First, the 21st century is absolutely certain to surprise us. Technologies will appear that, for good or bad, will completely disrupt our expectations. The environment, for good or bad, will respond to human influence in ways we don't expect. Political and cultural changes will make commonplace practices and values unimaginable today.

Second, it is good that we will be surprised, because achieving sustainable development will require radical, hard-to-imagine changes in our technology and institutions over the course of the coming century.

Third, big UN meetings like the one we are all attending will, by necessity, produce at best incremental changes. Such meetings require consensus, and the parties to this meeting bring so many different interests, values, and expectations about the future to make it difficult to agree on anything but the smallest steps towards sustainable development.

Thus we face a profound dilemma. We need radical change over the coming decades to achieve sustainable development. In the near-term, we will have trouble agreeing anything beyond lowest common denominator steps. Perhaps most insidiously, we can not predict the long-term consequences of our actions. This makes it very difficult to

agree upon the near-term implementation targets necessary to ensure accountability among governments and business which make promises but may or may not follow up with sufficient action.

Despite these challenges, I will argue that approached properly, there is reason for hope.

SHAPE THE FUTURE, DON"T PREDICT IT

The task before this Earth Summit is an archetypal example of what we would call long-term policy-making. In long-term policy-making our actions today are strongly influenced by our expectations and hopes about what will happen many decades in the future.

Humans have conducted long-term policy making for millennia, sometimes quite successfully. But the sustainability challenge requires shaping the evolution of social, economic, technological, and environmental systems so complex that even our best intuition will not suffice in crafting a successful response. Fortunately, one new technology – information technology – has begun to usher in a radically new generation of policy assessment tools that may help us rise to the challenge. I want to share with you some insights from this emerging new field of long-range policy analysis and suggest how it might ease this dilemma of enabling radical change with incremental steps.

Long-range policy making is hard for a number of reasons, not the least of which is that it is impossible to accurately predict where we are headed or what actions we must take to get where we want to go.

There are, of course, no shortage of sophisticated predictions of future environmental and economic trends. These predictions usually contain a tremendous amount of useful information. But your common sense is exactly right when it tells you that an expert's predictions of what will happen 50 years from now are obviously wrong. Too often discussions like those at this summit produce lowest-common

denominator consensus because contending factions concentrate on the easy task of proving each other's dire predictions wrong, rather than the productive task of fashioning effective near-term plans that address the deeply uncertain, but nonetheless real challenges we face.

How does one successfully plan for the long-term future? Four principles are crucial.

First, we must always consider multiple scenarios. No single or small number of scenarios can capture the multitude of future possibilities and surprises with which we must contend.

Second, we should seek robust, rather than optimal, strategies, which do "well enough" across a broad range of plausible futures and ways of valuing the desirability of alternative futures. Robust strategies can help build consensus among parties with different values and who hold different beliefs about the likely long-term future.

Third, we should achieve robustness with adaptive strategies, ones explicitly designed to evolve over time in response to new information.

The idea of finding adaptive strategies robust across many futures is not new. Recently, ecologists have embraced the notion of "resiliency." More generally, some of our most basic and successful social institutions, such as democratic governments and market economies, are built on the notion that we can't predict the future, policies are always liable to be wrong, and thus we must institutionalize systematic processes of error detection and correction in order to advance towards our goals.

What is new and I think truly exciting is that new information technology can help us design the adaptive, error-correction processes we require in order to meet the unprecedented challenges of the decades ahead. Let me give you a very simple example of this fourth

principle of long-term policy analysis, the use new computer-based tools.

We start with the claim that any successful sustainability strategy must be robust over a very wide range of plausible futures. This figure shows one such "landscape" of plausible futures. [Fig 1] The landscape's horizontal and vertical axes depict two key uncertainties intimately related to today's session -- the average global rate for economic growth and the decoupling rate, that is, the reduction in emissions intensity per unit of economic output over the 21st century. Each point on this landscape represents a particular scenario. Thus, the upper left-hand region portrays futures where decoupling reduces pollution much faster than the economy grows. The lower right-hand region portrays futures where the economy grows much faster than decoupling reduces pollution.

To Avoid Surprise Need to Consider a Wide Range of Plausible Scenarios

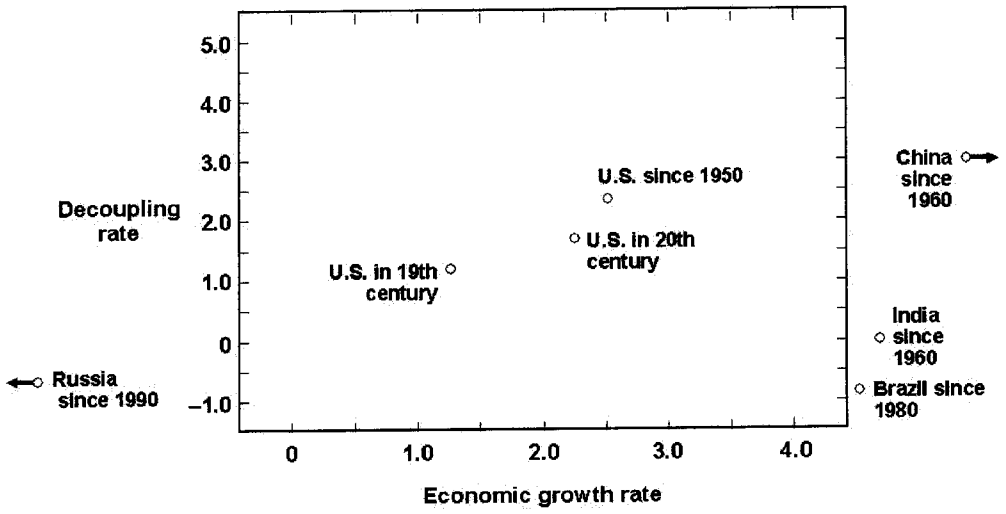

Figure 1

The landscape aims to capture the full range of plausible futures for the 21st century. It depicts average economic growth rates ranging from a catastrophic deflationary trend to an unprecedented level of sustained high global growth. The span of decoupling rates is similarly heroic. Anchor points on the landscape serve to compare its futures to the range of historical trends. Note that the landscape spans a much wider range than characterized the changes in the United States over the 19th and 20th centuries but a narrower range than that spanned by the performance of several other nations over the last several decades. I will claim that this landscape seems sufficiently expansive to capture the plausible range of future for the 21st century.

We start with strategies that represent alternative choices about near-term policies that affect decoupling rates – for instance, some combination of R&D and environmental taxes [Fig 2]. Policy-makers begin by implementing a particular choice of fixed policy and continue until future decision-makers recognize our inevitable errors and fashion their own best response.

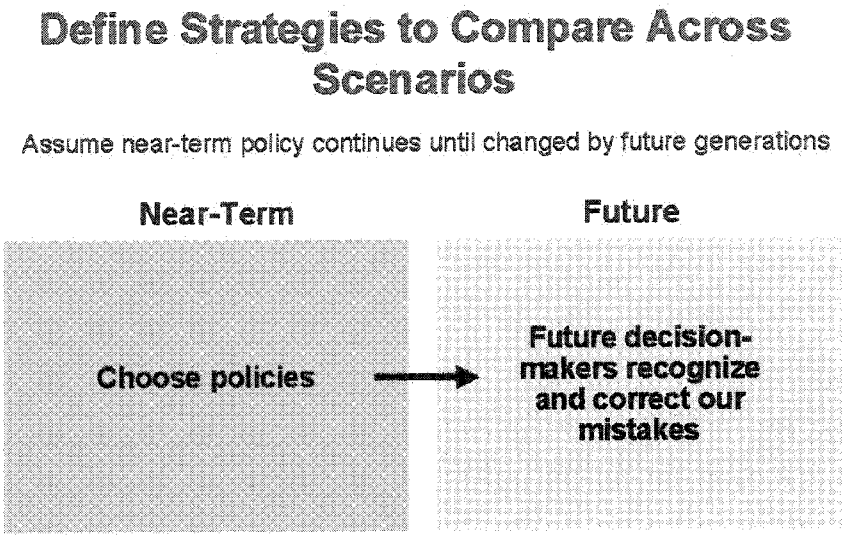

Figure 2

We can now compare the performance of such alternative strategies across this landscape. This figure uses color coding to show the performance of one such strategy -- business as usual. [Fig 3] I will defer a detailed discussion of how we did these calculations and the measures we use to compare the performance of various strategies. I have papers in the back and would be happy to answer questions. However, the story I am going to tell you is largely insensitive to the choice of models and value system. BAU does very well over those regions where the decoupling rate exceeds economic growth. Its does very poorly in futures where economic growth rates exceed decoupling rates. Historic performance straddles the edge. Clearly Business as Usual is a very risky strategy.

Business as Usual is Not Robust

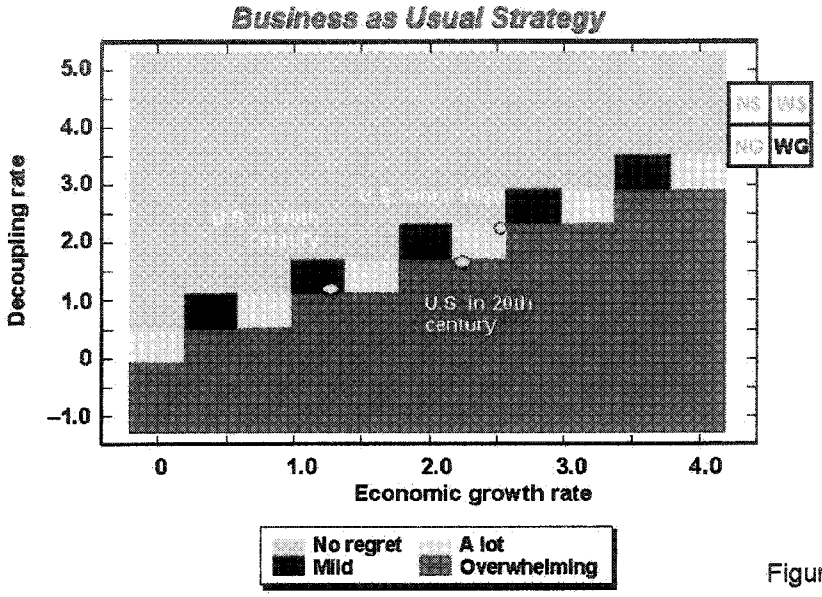

Figure 3

The problem is that no fixed policy is robust across the full range of plausible futures. This slide compares the performance of Business as Usual with a Crash program. [Fig 4] The later eliminates the risk of catastrophe but is costly in many futures. We can use the computer to examine tens of thousands of such scenarios. We always have the same problem. A transition path ideal for some futures always fails miserably in others. Since people disagree about the future we face, that is, where we are in this map, this type of uncertainty makes it difficult to reach consensus on commitments to any serious steps to confront the challenges ahead.

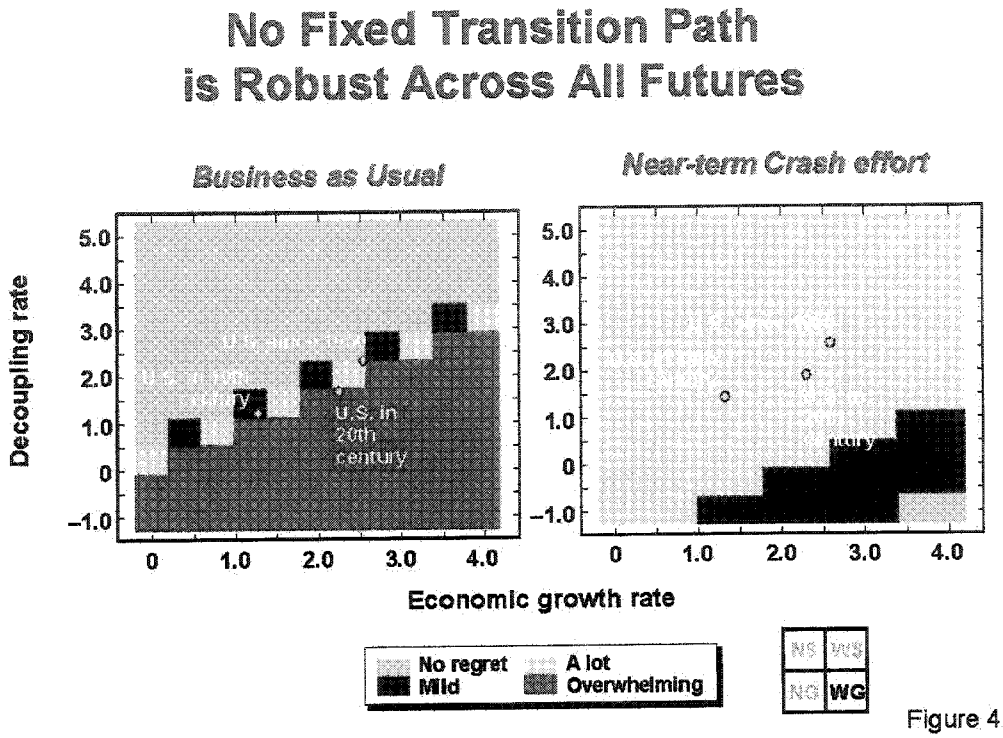

Figure 4

Nonetheless, there is a way forward. In this very simple example, we can pursue a different sort of strategy. Instead of specifying a set of policies, we set near-term milestones for the performance of intermediate system variables, in this case emissions intensity. [Fig 5]

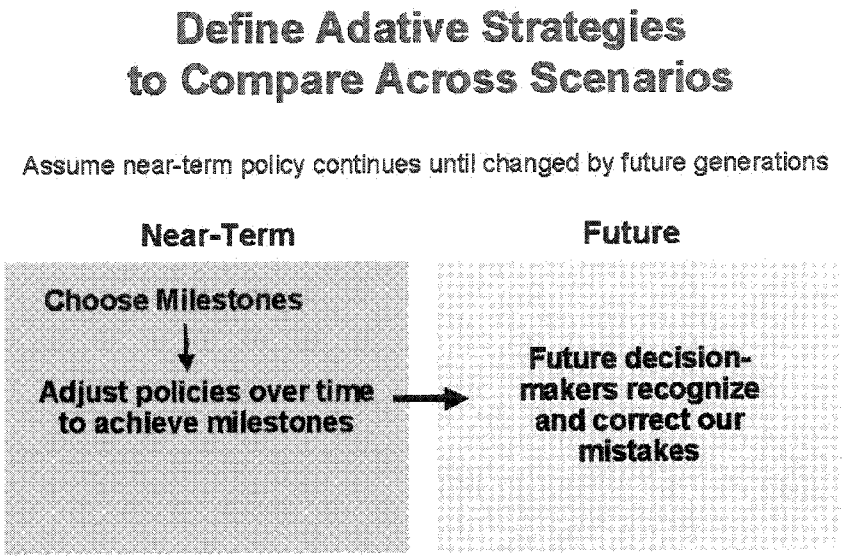

Figure 5

We can then use the computer to help us find specific performance milestones which generate strategies robust across a very wide range of futures, as shown in this map. [Fig 6] In futures where the technology optimists are correct the milestones are superfluous and cost nothing. In futures where the challenges are great, the milestones are critical.

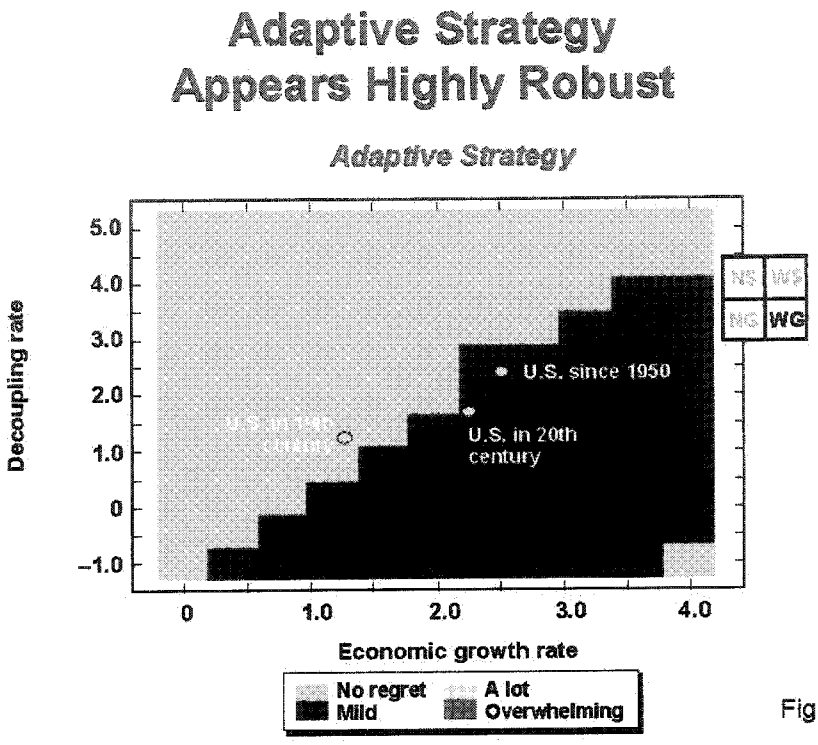

Figure 6

EXAMPLE OF CLIMATE CHANGE

This example I showed was very simple. How might these ideas apply in real life to a problem such as climate change?

Climate change is clearly an area where we need long-term radical change. To halt climate change, the world will have to run a much larger economy on something other than fossil fuels, or use fossil fuels in a completely different way. Over the last decade, the most visible public policies for climate change have focused on very aggregate indicators of progress, in particular levels of national greenhouse gas emissions. By this indicator, most countries have not done very well. However, below this radar screen we have made important progress in a number of dimensions – the use of renewable energy is growing rapidly and some governments and businesses are beginning to conduct innovative policy experiments that help us learn how to effectively put

a price on carbon emissions so as to create economic incentives on firms to reduce them.

Are such efforts enough to catalyze the long-term transition we need in the face of the many potential surprises, good and bad, that we face? Probably not. But I would argue that levels of national emissions reductions are not a good indicator of the robustness of these initial steps. As an analogy, if you had measured average national use of the internet in the early 1990s, it would have given little indication of the deluge about to occur. To assess near-term climate policies, we need indicators of the potential for radical technological and institutional change. We need to determine what level of effort across the portfolio of near-term actions will make us robust across the futures we face. We then need to use these indicators to hold the key players accountable, that is, make sure their good intentions are pursued with sufficient diversity and level of effort.

INCENTIVES

Before closing, let me say a quick word about the incentives that cause firms to invest seriously in new technologies. Most large firms appear to follow a common process in deciding when to invest in the new capital equipment that often embodies new technologies. First, they decide how much capital they have available to invest in any given year. Next, they allocate resources to "must do" investments required for maintenance to keep their plants running and to comply with environmental and safety regulations. Finally, they invest their remaining resources in new plants, products, and technologies that help them achieve their corporate goals, such as becoming the leader in new, fast growing markets.

This process has important implications as we think about the near-term actions necessary to catalyze radical transitions. In each firm investments in new environmental technologies must compete for

resources with a host of other investment opportunities. To garner scarce investment, it is rarely sufficient for a new technology to merely save the firm money. It must be among the options that move the firm most aggressively towards its corporate goals.

Thus, innovation in society's ability to create incentives for firms to invest new environmental technologies are as at least as important as innovation in the technologies themselves. Policy experiments in tools such as emissions trading and transparency of environmental information can create the market forces that are crucial near-term components of a robust strategy.

CONCLUSIONS

The world faces the extraordinary challenge of helping vast numbers of people lift themselves from poverty without overwhelming our natural environment. This challenge will require radical change in much of our technology and many of our institutions. Many of the initiatives discussed at this Summit give cause for hope, because they are precisely the sorts of near-term actions we need to catalyze these radical changes.

But by their very nature, radical changes in dynamic, complex systems are completely unpredictable. Thus, we face a significant challenge in reaching consensus on appropriate targets and timetables for ensuring key parties implement the necessary near-term actions. Fortunately, information technology is fostering new policy assessment tools that can help identify the portfolios of near-term actions that can best catalyze radical transitions, acknowledging their unpredictability and the many values different parties will use to evaluate their ultimate impact.

The spotlight on this Summit will focus on next week, when heads of state gather to ratify a declaration of minimalist standards and goals.

We should not underestimate the positive impact of such declarations, which gradually raise the bar for acceptable behavior.

But the challenges we face may not be solved by incremental change. This Summit also plays a second, crucial role, by providing a global stage for those who want to expend their own energies at demonstrating radical solutions – be they a zero-emissions, hydrogen powered-automobile or a sustainable forestry project in the tropics. Because in a nutshell, they way we solve deeply uncertain, long-term policy problems which require radical change is to set up a mechanism for slowly advancing minimal standards and offer the radical innovators the realistic hope that if their innovation really works, it will someday become the new standard.

Thank you.