Research Frontiers in the Economics of GHG Mitigation and Climate Change Adaptation in California

Alan H. Sanstad, Ph.D.

PIER Strategic Planning Meeting

California Energy Commission

August 21, 2008

Outline

- The role of economics in climate policy
- PIER accomplishments since 2003
- Identifying “knowledge gaps”
- Two areas for continued PIER focus
- Economic simulation modeling in GHG mitigation and climate impact analysis
  - Recognizing limitations
  - Key challenges
  - New directions, non-PIER research

The role of economics in the GHG and climate policy process

- Very broadly, economics plays both an “input” and a “framing” role:
- Input: Cost and benefit estimation, such as
  - GHG supply curves
  - “Least-cost” technology planning
  - Climate damage costs and valuation of avoided damages
- Framing: Numerical simulation modeling to integrate information, represent policies, and identify preferred policies
  - This encompasses a range of models, including “engineering” models that incorporate cost-minimization or other economic criteria

PIER contributions since 2003

- PIER's climate change economics funding has yielded results on a range of topics, and provided substantial support to California policy-making; examples include
  - Computable general equilibrium (CGE) modeling
  - Climate impacts analysis, particularly on water resources and agriculture
  - Cost and abatement potential estimation, including carbon sequestration and non-CO2 gases
  - Analysis of the role of government in promoting environmentally-beneficial technological change, e.g., in renewables
  - Analysis of design principles for a California regional GHG emissions trading system

Advances in the state-of-science, and a changed policy environment, since 2003

- Various developments including the IPCC Fourth Assessment Report have promoted consensus regarding the need for policy
- California GHG policy has moved from “whether and when?” to “here and now“
- National policy formation is underway

How should we identify key "knowledge gaps?"

- Given the evolving scientific and policy environment, this question needs to be interpreted somewhat differently than before
- More resources are being allocated to various aspects of California GHG and climate economics by other state agencies, utilities, and other stakeholders including both NGOs and private firms
- There is therefore both a need and an opportunity for PIER to more finely target its resources in this area – per the PIER criteria

Areas for continued or expanded PIER focus

- On selected topics, empirical analysis and data development that both clearly warrants public R&D and complements efforts of other agencies
  - Costs and potential of carbon sequestration is a good example
- Multi-disciplinary and/or cross-cutting work on climate change adaptation
  - Adaptation research relatively less developed and fairly fragmented – there is a need to integrate economics with other methods as well as institutional analysis
  - PIER can make an important contribution to the knowledge and expertise base

Changing intellectual frontiers of GHG and climate economics

- In general terms, the 2003 roadmap reflected conventional wisdom:
  - Empirical work ultimately serves to generate model inputs or otherwise inform modeling
  - Simulation models define integrating frameworks – particularly CGE models
  - Multiple models can be linked to generate larger modeling systems
- The limits of this paradigm are becoming increasingly clear

The dilemma of numerical economic energy and environmental modeling

- “Modeling is for insight, not for numbers”
  - This tenet reflects the view that, roughly speaking, economic phenomena are too complex to support the classical methodology of formulating, parameterizing, and validating “true” models
- But regulators want and need numbers
  - In California, AB32 and other GHG policies tend to be quite detailed and both number and model intensive
- Now what?

- The following slides summarize several key problem areas in the economics of mitigation and adaptation that are particularly challenging to current modeling methods

Uncertainty and risk

- In both GHG mitigation and climate change adaptation, uncertainty is pervasive and fundamental
- Although the manifestations are somewhat different in the long and the short runs, this is not solely a problem of very long-run analysis
- Examples:
  - What were 1990 California GHG emissions?
  - How much energy will California efficiency policies and programs save in the next 3 years?

- With few exceptions, our models, methods, and modes of thinking are deterministic
- It is generally not straightforward to “graft” uncertainty analysis onto deterministic models in a useful way –
  - Sensitivity and uncertainty analysis are not equivalent

Complication and (in)-consistency

- Glass ½-full: There is a great deal of information for California regulators to draw upon
- Glass ½-empty: The number of disparate information types and sources, models, stakeholders, decision-makers, etc., is large and growing, and integration is becoming harder
- This only in part a management and coordination problem – it is also a source of increased uncertainty and therefore a technical problem
  - Information developed for one purpose may or may not be well-suited for another, especially in the realm of modeling

Policy discontinuity and the “design envelope” of current methods

- AB32, the CPUC’s new energy efficiency initiatives, and other policies are aimed at bringing about *radical* changes in California’s energy system and economy
- But with very few exceptions, the standard models and methods focus on and/or are designed to analyze *incremental* changes – for example, both
  - “Bottom-up” energy efficiency analysis
  - “Top-down” CGE economic modeling

- ARB's AB32 Scoping Order organized around "wedges" – savings available from specific sectors and measures – not least because this is the form in which information is available
- But:
  - Most of the inputs were obtained under "all else being equal" assumptions
  - In part for this reason, the sum of incremental measures in practice will play out in complicated, non-additive ways
- Existing models cannot fully address this problem (in part because it's in the inputs) – it becomes another source of uncertainty

The problem of the very long run

- What is a “scenario”?
  - “Not a forecast or projection”
  - A “description of a plausible future”
  - “A statement of what *might* happen, not what will happen”
  - A “thought experiment”
  - Etc.

- Scenario methods, including their use with models, have developed as a practical approach to saying *something* about very long run issues
- But in many examples, they only give *illustrative* results, and do not provide a departure point for further analysis
- Some common problems:
  - Extrapolating shorter-run projections
  - Lengthening the horizon of very detailed models, resulting in an “illusion of precision” problem
  - Single deterministic “baseline” or “business-as-usual” scenarios, perturbed by “policy scenarios,” over very long time scales – In all but name, this is forecasting while ignoring uncertainty

From modeling to decision support

- The general challenge is to identify the “next generation” of quantitative methods that are needed to support California’s short and long-run climate policy analysis
- “Better models” are always needed, but we need to imagine frameworks that encompass and exploit, but are not limited to, modeling as it is currently practiced
- This requires both basic research and a strong focus on the problems that regulators are actually trying to solve

Some heuristics

- There are no methodological silver bullets, and definitely no “ultimate” models
  - The trend toward more complex and detailed modeling reaches diminishing returns – the illusion of precision problem
- Everything is an estimate or… a guess
  - Targeted research can *reduce* but not *eliminate* key uncertainties
- All models really are wrong
- We need to put ourselves in the policy-makers’ position:
  - If modeling is for insight, what is for decision-making?

Promising directions and relevant non-PIER research

- There is increasing effort to improve methods for dealing with uncertainty in climate, energy and “integrated assessment” modeling, such as
  - US Climate Change Science Program: Improving treatment of uncertainty in scenario-based analysis
  - CPUC and CEC: Uncertainty analysis in long-term procurement planning

- DWR and CEC: Exploratory modeling and robust-decision making
- CPUC: “Reduced-form” GHG Calculator
- MIT: Uncertainty analysis and attribution with a CGE model

- Contemporary computational and statistical sciences have developed and are continuing to enlarge a potentially very useful toolbox.
- Engineering reliability theory is one example
  - Addresses the problem of system design under uncertainty
- Another example: The US DOE Office of Science, Advanced Scientific Computing Research program on “Multi-Scale Mathematics for Complex Systems,” and “Optimization of Complex Systems” – topics include

- “Mathematical, statistical, and hybrid approaches for treating uncertainty and error from multiple sources having multiple representations and for analyzing and quantifying the effects of uncertainty and error on model predictions, model calibration, and data assimilation analysis”
- “Statistical approaches…that use a limited number of observed data for validating and improving mathematical models”
- “Techniques for integrating models with data to support decision-making”
- “Methods for sensitivity [and] risk analysis, and uncertainty assessment in complex systems”

The challenge of long-run analysis

- The Congressional Research Service recently reviewed six economic modeling studies of the potential costs of Senate bill S. 2191 (the Lieberman-Warner Climate Security Act of 2008), and observed
  - "It is difficult (and some would consider it unwise) to project costs up to the year 2030, much less beyond...***Long-term cost projections are at best speculative, and should be viewed with attentive skepticism***" (emphasis in original).

- To-date, long-run California climate economics studies have primarily focused on impacts and served to develop the rationale and context for near-term GHG mitigation policies
  - For this purpose, standard scenario methods have been effective
- But substantive next steps, on both impacts and long-run GHG mitigation, require going beyond speculation
- We need to step back and consider what specific policy questions on a half-century or century time scale might be asked for which well-grounded answers could be generated that can actually be used in decision-making –
  - *This is not currently clear*

- This again reflects the limitations of conventional scenario logic:
  - To actually make decisions, one needs to know not what *might* happen, but what actually will happen, and if that is uncertain, then contingency planning, hedging, flexibility, robust analysis, etc., are needed
- “Adaptive risk management” is a theoretical concept for this kind of problem
- Among other methods*, un*conventional scenario techniques – such as exploratory modeling – are aimed at implementing this kind of approach

Moving forward

- Both basic and applied research are needed
- PIER economic research has made a significant contribution to the progress of GHG policy in California – new research should reflect evolving policy needs as well as changing state-of-knowledge in the field
- In the context of AB32, a next step is to consider how improved methods might support the implementation of the Scoping Plan as it moves into the regulatory phase
  - As both new information becomes available and “inevitable surprises” occur in implementation, what kinds of analysis can help the regulators respond, adjust, update?
- For long-run GHG mitigation and adaptation studies, new approaches are needed – these are not likely to be variations on existing methods