SUMMARY

Natural gas demand in the United States has been increasing for the last 15 years and is projected to grow substantially in the next 20 years. Meeting this growing demand will require an accompanying increase in supply, which is expected to come mostly from additional production in the United States. The prospect of increased U.S. production has led to ongoing efforts both to better assess our nation's natural gas resources and to develop policies for identifying and developing available resources.

Such efforts are drawing attention to the intermountain areas of the Rocky Mountains, which are relatively rich in hydrocarbon resources, particularly natural gas. National resource assessments indicate that the Rockies contain approximately 15 percent of the nation's technically recoverable (resources plus reserves) future natural gas supply. Although production in the region currently accounts for only about 9 percent of the natural gas produced in the United States, this figure is increasing rapidly as demand increases and resources in more established regions—such as Texas and the Gulf Coast—are depleted.

In the Rockies, 60 percent of the potential gas underlies federal land, compared to just 2 percent in the onshore areas of Texas and the Gulf Coast states. Thus, growth in production in the Rockies means that energy-related land use decisions will increasingly become the responsibility of federal land managers from such agencies as the Bureau of Land Management and the Forest Service. Given the rapid increase in natural gas production in the Rocky Mountains, it is increasingly important for these agencies to take a strategic view of federal land use decisionmaking—one that allows them to understand the differences between resources in different areas and thus to prioritize lands under consideration for development.

ASSESSING NATURAL GAS AND OIL RESOURCES

Federal land use planning is the process by which priorities for various land uses are established. This process incorporates a variety of considerations and attempts to weigh the merits of multiple resources (commodities or uses that the land may provide), including energy resource development and other consumptive uses, environmental management and conservation, and protection of recreational and cultural resources. The values of various resources are determined in a variety ways and documented in resource assessments. Such resource assessments play an important role in the land use planning process.

In the case of natural gas and oil, resource assessments historically focus on the amount of resource. However, additional attributes of energy resources affect the energy resource value of an area. A comprehensive assessment would include as much information about the resource as possible to help distinguish among resources in different areas. Attributes of energy resources that influence their value include the following:

- How much resource might be recoverable,
- How much resource might be available at different costs, and
- How much resource is associated with lands having different values of key environmental measures.

In this report, we present a new approach for assessing natural gas and oil resources that incorporates these elements. This methodology provides a more complete understanding of energy resource characteristics than conventional assessments do, by accounting for the economics, or real dollar costs, associated with production and by moving some of the environmental protection considerations, or social costs, upstream in the decisionmaking process. The key steps in our approach are shown in Figure S.1.

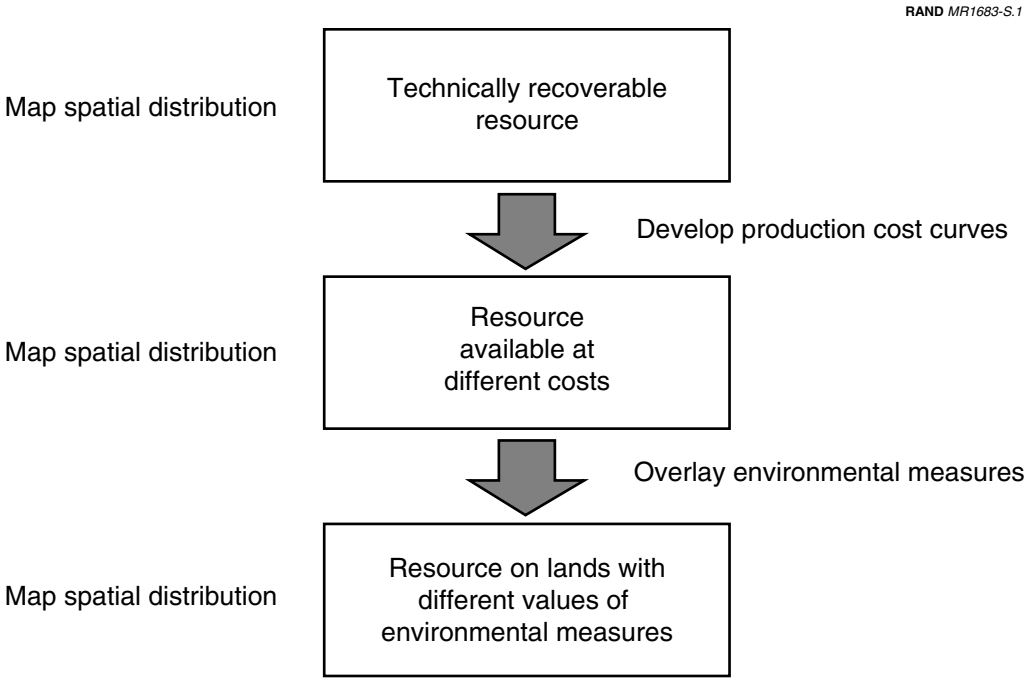

Figure S.1—Summary of Approach

In addition to helping inform the federal land use planning process, the comprehensive resource assessment proposed in this study is intended to improve decisionmaking in a number of other arenas. Potential benefits of this approach in these different areas are summarized below.

Federal Land Use Planning

The proposed assessment approach could help distinguish among lands with similar amounts of natural gas or oil. Areas with similar amounts of technically recoverable resources may have very different amounts of economically recoverable resource. Similarly, areas can be classified according to how much of the resource is on lands that are potentially more vulnerable to negative environmental impacts. Together, this information would further characterize energy resources and could help inform the process of setting priorities for energy-related land use decisions.

National Energy Planning

Assessing the merits of different policy options, such as increasing energy efficiency standards, investing in energy technologies, or pursuing expanded production would be facilitated with an understanding of the costs associated with each. Assessing the economically recoverable resources would help constrain costs and returns associated with production, which are currently unclear.

Production costs also exert a strong influence on fuel choices and amounts of fuel imports. Planning for future energy supplies thus strongly depends on estimates of energy resource production costs.

States, Utilities, and Producers

As states become more dependent on natural gas for electricity generation, state planners need to understand the resource potential. Prices from various potential sources are influenced by the amount of resource at different production costs. Similarly, utilities, many of which are making long-term investments in gas-fired power plants, could make better investment decisions with this type of information.

Economic Effects of Resource Extraction

An understanding of the economically recoverable resource as well as the potential environmental concerns associated with its production may also help define the effect that energy resource production might have on the local, regional, and national economies. A realistic understanding of the economic impacts at all scales depends on the amount of development and production activity that will actually occur.

ADVANTAGES AND LIMITATIONS

The proposed assessment approach can help federal and state land managers and policymakers at all levels set priorities and strategically plan for long-term resource use. Several aspects of this methodology are new and offer supplementary benefits to decisionmakers. Our approach

- Treats economic costs and environmental characteristics as integral attributes of energy resources that affect their value,
- Links the economic analysis with the spatial analysis, enabling decisionmakers to consider relative priorities for development based on the economic viability of the resource,
- Overlays the distribution of resources under various economic assumptions with distributions of environmental characteristics of lands associated with energy resources,
- Is intended to be applicable to other areas of the Rocky Mountains as well as to other regions of the nation, and
- Offers an additional tool for energy forecasters to provide further spatial and temporal refinements to their long-term resource estimates.

At the same time, this approach is preliminary in several aspects and has limitations and uncertainties. It is designed to enhance and supplement the regional assessment of gas and oil resources for the purposes of strategic (long-term and large-scale) planning of energy resource development on public lands. The method is not intended to be used to replace detailed economic or environmental analyses on specific leases. Also, this approach is intended to be part of a broader set of information sources used by decisionmakers in guiding land use and other energy development–related policy. We do not intend to define particular areas where drilling may be inappropriate. Rather, our intent is to provide a framework for assessing the value of energy resources.

Several assumptions are embedded in the spatial distribution of resources, production cost functions, and overlay analyses. Sensitivity of the results to these assumptions is an important consideration in interpreting the results. Also, uncertainties about the effect of gas or oil development on environmental measures mean that these overlays should be used to signal the need for further study and analysis of likely impacts and opportunities for mitigation.

NATURAL GAS IN THE GREATER GREEN RIVER BASIN

We have initially applied this method to the Greater Green River Basin, located primarily in southwestern Wyoming. The Greater Green River Basin contains substantial amounts of natural gas, with estimates of resources plus reserves of 135 to 160 trillion cubic feet (Tcf). This constitutes approximately 10 percent of the nation's total. Our results for this region reflect a reasonable range of assumptions regarding economic and environmental considerations. These results, which are summarized

in Table S.1, are instructive for developing the methodology further and providing insights that may help inform strategic energy resource planning in this basin.

Economic Analysis

By estimating separate costs for each resource unit ("subplay"), resource category, resource type, and depletion increment, separate costs were estimated for over 1,200 distinct analysis units throughout the basin. The analysis indicates that, depending on the economic scenario, 35 to 45 percent of the natural gas resources could be produced profitably at a market price of $3/MMBtu, which is similar to recent prices in Wyoming. Up to 65 percent could be profitably produced if the market price were $5/MMBtu.

The spatial analysis shows that the fraction of technically recoverable gas that is economically recoverable at a given price varies substantially from place to place. This result illustrates the value of the combination of economic and spatial analyses: When looking at specific areas, the concentrations of economically recoverable resources does not necessarily correlate directly with the concentrations of technically recoverable resources. This is illustrated in Maps 2.2 and 3.1 in the maps section, which show these concentrations. The circles highlight an example of an area where the difference between the concentration of technically recoverable and economically recoverable gas is considerably greater than the basinwide average, whereas the squares show an area where the concentrations of technically and economically recoverable gas are very similar.

Table S.1

Summary of Results

		Cost ($/MMBtu)	
		3	5
Economically recoverable gas	Tcf:	47–68	70–104
	% of TRR:	35–45	52–65
Percentage of economically recoverable gas on lands			
With high terrestrial vertebrate species richness[a]		17	17
Within 2,000 m of sensitive species locations		14	14
Within 6,500 m of sensitive species locations		65	65
With surface water, wetlands, or riparian habitats		9	10
Near human settlements		5	6
With high surface slope[b]		8	8
With high aquifer recharge rate[c]		9	9
With shallow groundwater[d]		9	10
Subject to no access[e]		10	10
Subject to restricted access[e]		31	30

NOTES: Ranges for economically recoverable gas reflect different economic scenarios. Results for environmental measures are for the USGS-based scenario only; percentages shown do not necessarily apply to separate areas and so are not additive.

[a]>119 species/area.

[b]>25%.

[c]>2 inches/year.

[d]<16 feet.

[e]Results are based on aggregated lease stipulations from the Department of Energy study (Advanced Resources International, Inc., 2001) and are not related to environmental measures analyzed in this study.

Environmental Considerations

The environmental measures analysis provides additional understanding of the gas resources in the Greater Green River Basin. In this analysis, we examined seven environmental measures:

- Terrestrial vertebrate species richness,
- Proximity to sensitive species observed locations,
- Surface water and riparian habitat zones,
- Proximity to human settlements,
- Surface slope,
- Aquifer recharge rate,
- Depth to groundwater.

The first three measures address primarily ecosystem quality, the fourth represents issues related to human use of the area, and the final three measures examine primarily water quality. We also considered land that is subject to existing federal land access restrictions. Measure values were grouped into bins defined primarily by the statistics of the data for the basin, as well as regulatory and scientific considerations in some cases. Maps of the spatial distribution of the lands with different measure values were then generated. Note that using statistically derived bin values does provide a relative sense of environmental concern for this specific area, and in so doing provides useful guidance. However, because these values are not based on empirically derived relationships between gas and oil development activities and potential environmental impacts, they say little about actual environmental risk and in that sense the environmental measures need to be developed further.

The relative proportion of economically recoverable gas on lands having different values of environmental measures is presented in Table S.1. For the most part, the concentrations of economically recoverable gas are in areas having relatively lower potential environmental concern with respect to the environmental measures we considered. As with the economic evaluation, however, environmental overlay results for certain areas within the basin differ from the basinwide average values shown in Table S.1. Some areas with relatively high gas concentrations coincide with riparian habitats, high terrestrial vertebrate species richness, and shallow groundwater. Such insights may be particularly useful in areas, such as north of the LaBarge Platform, that may appear quite promising judging by the economic analysis alone.

The connection between environmental measures and sensitivity to environmental impact is complex, and actual environmental impacts would not necessarily result from development in areas of nominally greater environmental concern. However, our results suggest that in some areas there may be more costs associated with mitigating potential impacts than in some other regions. This information would be useful to public land managers who may need to prioritize their efforts in permitting lands for exploration and production.

The results generated from this approach can provide decisionmakers with more information about natural resources that can help guide strategic resource planning, help prioritize difficult decisions that are being made about access to federal lands, and help understand the potential consequence of those decisions.

IMPLICATIONS FOR THE ROCKIES

The primary objective of this study was to develop a methodology that incorporates economic and environmental considerations into energy resource assessments. The methodology was developed with a focus on the Greater Green River Basin because of its overall high resource potential and its diverse range of deposit types and depths, which results in a large range in development and production costs. In doing so, we have highlighted some aspects of natural gas resources in the Greater Green River Basin that may not be directly evident from technically recoverable resource assessments. However, the value of this approach is expected to be even more evident when it has been applied to all the basins in the Rocky Mountains and eventually to all basins in the country. Just as a basinwide evaluation using a consistent methodology allows federal land managers to compare and prioritize areas within the Greater Green River Basin, a Rockies-wide evaluation will allow these managers to make the same type of comparisons and prioritizations among areas within different basins.