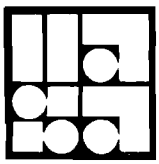

# Assessment of Alternative Energy/Environment Futures for Austria 1977-2015: Final Summary Report

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# ASSESSMENT OF ALTERNATIVE ENERGY/ENVIRONMENT FUTURES FOR AUSTRIA 1977-2015

## FINAL SUMMARY REPORT

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The views and conclusions expressed in this report are the author's alone and should not be ascribed to the Austrian National Bank, the National Member Organizations of IIASA, its Council or other staff of the International Institute for Applied Systems Analysis.

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Amt der Kaerntner Landesregierung, Abteilung Landesplanung
Bundeskammer der gewerblichen Wirtschaft
Bundesministerium für Gesundheit und Umweltschutz
Bundesministerium für Handel, Gewerbe und Industrie, Energiesektion
Brookhaven National Laboratories, U.S.A.
Energy Research Center (University of Wisconsin)
Institute for Environmental Studies (University of Wisconsin)
Kernkraftwerk Planungsgesellschaft
Magistrat Linz, Hygieneinstitut
Österreichische Elektrizitätswirtschafts AG (Verbundgesellschaft)
Österreichisches Institut für Bauforschung
Österreichisches Institut für Raumplanung (ÖIR)
Österreichische Mineralölverwaltung (ÖMV)
Österreichisches Statistisches Zentralamt (ÖStZ)
Österreichisches Wirtschaftsforschungsinstitut (WIFO)
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The 28 members of the Austrian energy and environmental communities who participated in the first two workshops at IIASA played a crucial role in structuring the research program.

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# I. INTRODUCTION

This study had two primary objectives:

(1) To examine alternative energy futures and strategies for Austria and to consider some of their environmental implications.

(2) To investigate and apply appropriate concepts and methodologies for energy/environment management and policy design in Austria.

The establishment of these objectives was based upon the conviction that in Austria, as in most regions and nations of the world, there is an urgent need for the development and application of methods for studying regional energy systems and for testing the impact of alternative policies. In view of the major role which energy plays in the determination of environmental quality, this study was designed to aid in the integration of energy and environmental management from a systems perspective.

"Regional," in the context of our previous studies, is not strictly defined as subnational or as a specific class of geographic units; rather, it refers to a region, appropriately bounded so that it is possible to speak of energy and environmental systems from a physical, socioeconomic, or administrative perspective, or from all three. At the beginning of this study, we intended to limit its scope to a selected few Austrian Länder (states); we quickly realized that Austria's size and vigorous interregional links precluded anything less than a national study.

## A. Institutional Format of the Study

The study was conducted in an institutional format which promoted frequent interaction with the individuals and institutions for whom the results are intended. After the initial organizational phase of the study within IIASA, a major three-day workshop was held in January 1977, with a broadly-based representation of energy/environment specialists and decision makers from the Austrian private and public sectors, at both the regional and national levels. This workshop played a crucial role in determining the critical issues which the study would address. It also served to establish links to various institutions through which information could flow during the remainder of the research program. Several of these institutions played important roles in the research by providing data or conducting analysis. A second workshop (July 1977) served to evaluate the study to that point, and to establish priorities for the final phase. The

Austrian participants in that workshop also suggested the format in which the conclusions and methods resulting from this study should be communicated and transferred to the energy/environment community. A concluding conference was held at IIASA in November 1977, during which the study's final results were presented to the Austrian energy and environmental communities.

## B. Critical Issues Studied

The issues studied were chosen through an iterative procedure, beginning with suggestions at the first workshop, followed by exploration by the IIASA team to see whether they could be analyzed within the time and resource limitations. One major decision was that this study, like previous ones, would address broad medium- to long-term strategies and policies, rather than issues related to day-to-day operational problems. Consequently, the time horizon of the study is 2015; however, greater attention is devoted to the earlier part of the time period. Although there was a broad spectrum of issues raised, the major issues fell into the following categories.

### Energy Demand

A central issue in Austria is the probable and possible levels of future energy demand. Important aspects of the demand issue are its relationship to the rate and structure of economic growth, to demographic factors, to human settlement and land use patterns and technologies, to transportation systems design, to industrial structure and technology, and to energy-use technologies in general. As in many other countries, the relationships between energy use and social well-being are hotly debated.

### Energy Conservation

The potential energy conservation measures and their impact are major issues. Although some conservation measures have already been implemented, there is extensive ongoing debate on this topic.

### Energy Supply Options and Strategies

The choice of fuels and energy supply technologies is a third high-priority issue, closely linked to the first two above. Decisions on the implementation of nuclear technology in Austria will in all likelihood continue to be based in part on estimates of future growth of electricity demand; low growth in electricity demand, in part due to major implementation of conservation measures, could weaken some of the arguments for the nuclear system. In a similar manner, the seriousness for Austria of scarcity or even shortfalls of petroleum will in part depend on the level and

the structure of petroleum demand. The possibility that alternative energy sources, e.g., coal and the sun, will play a major role over the next several decades is under active discussion. Austria's reliance on other countries or specific regions of the world for fuels is an important economic and political issue.

### Environmental Impacts and Protection Strategies

Concern about the environment, especially public health and safety, is currently very high and is strongly linked to alternative energy supply strategies. Nuclear power is central to this concern. Air pollution is of increasing interest, as Austria is just now defining air pollution standards and examining alternative strategies and trade-offs associated with them.

The above four categories certainly do not exhaust all of the important energy-related issues, nor can all of them be answered or even addressed in this limited study. However, we have attempted to provide a good perspective from which public discussions on these and other issues can proceed.

## II. DESCRIPTION OF METHODOLOGY AND OVERVIEW OF ENERGY SCENARIOS

### A. Methodology

Views about the future--scenarios, forecasts, predictions--constitute the language of energy policy debate, the frames of reference for decision and policy analysis, and the bases of opinions about what is or what is not inevitable. Our study used scenario building as a formal quantitative approach to policy analysis and the examination of energy/environment strategies.

Broadly described, scenario building is a detailed examination of possible futures and their consequences. This set of futures may provide a better view of what is to be avoided or facilitated, the types of decisions that are important, and the points in time after which various decisions can no longer be made. Important policy issues and related trade-offs can be examined by so-called sensitivity studies in which only one or a few parameters are varied and the resulting scenarios are compared.

In order to specify a "policy set" or framework within which a scenario was built, we developed a means for expressing a scenario in terms of a limited number of characteristics. As shown in the first column of Table 1, we relate those characteristics to four overall scenario properties, namely, Socioeconomic Structure, Lifestyle, Technology, and Environment. Within these four general categories, a larger number of assumptions about future events and/or policies and strategies are built into the scenarios.

# Table 1
## OVERVIEW OF SCENARIOS

| SUMMARY CHARACTERISTICS | | SCENARIO S1 (Base Case) | SCENARIO S2 (High Case) | SCENARIO S3 (Low Case) | SCENARIO S4 (Conservation Case) |
|---|---|---|---|---|---|
| STRUCTURE | Population | Average Austrian Growth Rate of 0.22%/yr. | | | |
| | Human Settlements | Migration Important: Rural to Urban, Vienna Declining, Western Cities Grow More Rapidly | | | |
| | Economy | Medium Growth Rate<br>1970-1985: 3.30%/yr<br>1985-2015: 1.76%/yr | High Growth Rate<br>1970-1985: 3.43%/yr<br>1985-2015: 2.73%/yr | Low Growth Rate<br>1970-1985: 3.23%/yr<br>1985-2015: 1.21%/yr | Low Growth Rate<br>1970-1985: 3.25%/yr<br>1985-2015: 1.21%/yr |
| LIFESTYLE | Personal Consumption | Current trends in Personal Consumption | Higher Consumption than S1 | Lower Consumption than S1 | Lower Consumption than S1 |
| | Transportation | Car ownership<br>300 vehicles/ 1000 population | Car ownership<br>400 vehicles/1000 population | Car ownership<br>250 vehicles/1000 population | Car ownership<br>300 vehicles/1000 population |
| | Housing | Bigger new homes<br>(0.8 $m^2$/yr)<br>Emphasis on electrical appliances and convenience fuels | New home size increases faster than S1<br>High emphasis on electrical appliances and convenient fuels | New home size increases more slowly than S1<br>Less emphasis on electrical appliances and convenient fuels | Bigger new homes<br>(0.8 $m^2$/yr) as S3<br>Emphasis on conservation |
| TECHNOLOGY | Industry | Overall decrease in energy intensiveness through significant penetration of energy conserving technology | General increase in intensiveness | Overall decrease in energy intensiveness through significant penetration of energy conserving technology | Significant decrease in energy intensiveness through vigorous development & implementation of energy conserving technology |
| | Transportation | Car efficiency<br>8.9 ℓ/100 km | Car efficiency<br>12.3 ℓ/100 km | Car efficiency<br>8.9 ℓ/100 km | Car efficiency<br>7.0 ℓ/100 km |
| | Housing | 1971 insulation standards | 1971 insulation standards | New homes 40% better than 1971 insulation standard by 2000 | New homes 55% better than 1971 insulation standard by 2000 |
| | Energy Supply | Decreased emphasis on coal<br>Electricity demand grows more rapidly than total end-use energy demand | | | |
| | | Medium nuclear growth<br>Adequate oil and gas supply | High Nuclear growth<br>Adequate oil and gas supply | Low nuclear growth<br>Adequate oil and gas supply | No nuclear growth<br>Constrained oil supply |
| ENVIRONMENT | Environmental Regulations | Proposed $SO_2$ oil desulfurization regulations by 1981 plus U.S. emission limits of $SO_2$, all sources, by 2000. | | | |
| | | .50 of U.S. emission limits on $SO_2$, point sources, by 2015 | .42 of U.S. emission limits on $SO_2$, point sources, by 2015 | .71 of U.S. emission limits on $SO_2$, point sources, by 2015 | Same as S3 |
| | | U.S. transportation emissions controls on automobiles | | | |
| | | 1.18 of U.S. emission limits on particulates, industry point sources, by 2015 | 1.0 of U.S. emission limits on particulates, industry point sources, by 2015 | 1.60 of U.S. emission limits on particulates, industry point sources, by 2015 | Same as S3 |
| | | 1.0 of U.S. emission limits of particulates, electric power plant, by 2015 | | | |

The general framework summarized in column 1 of Table 1 is used only to provide the exogenous functions, boundary conditions and constraints for the family of models and data bases used to calculate the details of the alternative energy environment futures.

As indicated in Table 1, four scenarios were examined in detail. The main assumptions underlying these scenarios were chosen primarily on the basis of the first IIASA Workshop on Austrian Energy/Environment Systems which had the participation of many members of the Austrian private and public sectors. As described in the following sections, many of the exogenous inputs, particularly in the socioeconomic area, were provided by collaborating individuals or institutions in Austria.

## B. Scenario Overview

The four energy scenarios summarized in Table 1 were chosen to allow examination of the issues enumerated in Section I of this report. To aid in the study of energy demand, the scenarios were based upon alternative world and regional economic assumptions that resulted in three different growth rates (medium, high, low) for the Austrian economy. These were coupled with various other policies and assumptions as shown in the table to develop scenarios S1 (Base Case), S2 (High Case), and S3 (Low Case). Because of the great concern about eventual restrictions on petroleum supply, S4 (Conservation Case) was built upon the lower economic growth of S3 to explore the effectiveness of fuel shifts and conservation measures for avoiding gaps between petroleum supply and potential demand.

The achievement of emission limits for $SO_2$ and particulates was coupled to the economic assumptions and growth rates.

# III. SUMMARY OF MAJOR FINDINGS

The findings of the study are not the result of any single scenario but were rather deduced from the analysis of the entire set of scenarios and sensitivity studies.

The major findings of the study are as follows:

## A. Energy Demand

(1) Total energy demand will probably increase at a rate considerably lower than in the past two decades. If these lower demand estimates are valid, they require major rethinking of energy supply policies that are based on higher overall projections.

(2) An overall "societal energy intensiveness", defined roughly as primary energy use per unit of GNP, will probably decrease over the coming few decades.

(3) Electricity will supply an increasing fraction of total end-use energy. Nevertheless, growth of electricity generation will be much lower than historical rates. Needs for future facilities should be examined in light of their dependence on the structure and rate of Austria's economic development.

(4) The continued dominance of the industrial sector in energy use suggests that policy measures for altering energy-use patterns must focus largely on this sector. However, energy demand growth in the next few decades appears to be greatest in the service sector of the economy; the lowest growth will likely be in the transportation sector.

(5) There is considerable potential for energy conservation by means of improved insulation practices in the residential sector. Because of the institutional barriers related to initial costs, the realization of the economic benefits of this potential may require vigorous government support of conservation measures.

B. Energy Supply

(6) Nuclear power could play a major role in electricity generation over the next several decades. However, during the time period considered, the continued slowing of electricity demand growth, coupled with further vigorous conservation measures, could make future nuclear plants unnecessary if hydropower were exploited fully.

(7) Coal is generally considered to be an unattractive long-term supply option for Austria. However, our economic analysis of the Austria energy supply system, based on a resource allocation model for the year 1990, indicates that a shift toward increased reliance on gas and petroleum, would be cost effective.

(8) Extrapolation of most previous Austrian energy forecasts yields a continuation of the trend toward a greater reliance on petroleum and natural gas. However, assessment of world petroleum resources and future demands demonstrates a serious gap between potential petroleum demand and supply in Austria in the 1990s, even under the assumption of low growth (Conservation Scenario S4). It would be possible from a technical standpoint to close the gap in the conservation case by shifting to

coal in the industrial sector. In the service and residential sectors, a continual reliance upon, or shift back to, coal and wood could help to avoid shortfalls in rural areas. In urban areas a shift to district heat (possibly coal-fired) could decrease the reliance upon petroleum.

C. Environment

(9) Potential system-wide environmental impacts due to energy use and supply in Austria are appreciable. Because of continuing energy demand growth, the system-wide impacts would not significantly decrease over the time period studied, despite introduction of improved pollution control technology.

(10) Air pollution will be the largest contributor to energy-related impacts on public health. These air pollution impacts will be concentrated in the five major urban areas of Austria, namely, Vienna, Salzburg, Graz, Linz, and Innsbruck.

(11) Desulfurization of fuel oil for use in urban residential and service sector buildings would be an effective and important measure for protecting the public from sulfur emissions.

(12) Regional and local environmental effects due to Austria's energy system are significant. However, there is also a family of effects whose significance is better assessed from a global perspective. Examples of these are long-term climate modifications due to $CO_2$ emissions from combustion of fossil fuels, and potentially dangerous flows of fissionable material within the nuclear fuel cycle. Such global concerns can and must be addressed from an international perspective to avoid the "tragedy of the commons" on a global scale.

## IV. CONCLUDING OBSERVATIONS

This Summary Report has presented the essence of the results of our study. It has focused on the examination of alternative energy futures and strategies for Austria and some of their environmental implications. A final detailed report will be published in 1979.* It contains more detailed results and descriptions of methodology. A current list and copies of documentation of methods, models, etc. used in this and our previous studies are available at IIASA and should be considered a supplement to this Summary Report. The results of the study were also presented in more detail at a conference for Austrian planners and energy/environment specialists in November 1977.

The Summary Report has excluded any discussion of the second major objective of our study, namely, the investigation and application of methodologies for energy/environment management and policy design in Austria. WE DO BELIEVE THIS SECOND OBJECTIVE IS OF GREAT IMPORTANCE, AND THAT AUSTRIA COULD DERIVE BENEFITS FROM INCORPORATING SOME OF THESE CONCEPTS AND ANALYTICAL TOOLS INTO ITS EXISTING SET OF POLICY DESIGN TECHNIQUES. The Austrian institutions that helped with the study have already begun to use the concepts and tools informally. During the concluding months of the study, we devoted major attention to the documentation of models, data bases, and information systems, both at IIASA and at the collaborating institutions in the United States. A major report on methodology will be published in 1979. The appropriate Austrian agencies and institutions should examine their specific needs and capabilities to make the strong commitment that would be required for a successful transfer of methodology.

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* Foell, W.K. et al., Assessment of Alternative Energy/Environment Futures for Austria 1977-2015, International Institute for Applied Systems Analysis, Laxenburg, forthcoming.