XA9745310

INTEGRATED RESOURCE PLANNING FOR THE RATIONAL USE OF ENERGY IN SLOVENIA

Overview of analysis with discussion of the role of WASP

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Abstract

Integrated resource planning (IRP) for the rational use of energy in Slovenia is presented in this paper. The main objective of the analysis is the improvement of the overall energy efficiency in Slovenia. Emphasis of the IRP analysis is given on: 1) comparison of demand and supply options and 2) embedding of the planning procedure into a structured analysis procedure to make the planning process more transparent. The Wien Automatic System Planning package (WASP) will be used in the modeling framework for determining the optimal expansion plan for different demand patterns.

This paper provides an overview of the IRP project for Slovenia[1]. The paper consists of three sections. The first section aims at giving an insight on the motivations for the analysis; the second section describes the case studies in structured analysis steps. The role of WASP is discussed in the third part.

1. OUTLINE AND OBJECTIVES

The objective of the Integrated resource planning (IRP) for the rational use of energy in Slovenia is to provide decision support to the energy policy of Slovenia in view of the major challenge being faced by the country, namely the improvement of its overall energy efficiency.

IRP is the planning process that aims at an optimal allocation of all resources to provide a given energy service. IRP is an extension of the more traditional approach of expansion planning of the energy supply sector. The energy system is enlarged beyond the level of final energy delivered to the user, to include energy transformations on the users' premises and processes which provide useful results of energy use, namely energy services.

In the present study, IRP is considered from the national perspective. The IRP approach is applied to the energy supply and use of Slovenia. Two main sectors of energy use are considered in detail: the industry sector and the households sector. The objective of IRP in this case is to provide a policy framework in such a way that the different agents, which supply and

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[1] The overview is based on texts from different authors used as part of the project documentation. Selection and discussion of the role of WASP is prepared by the author.
Integrated resource planning for the rational energy use in Slovenia is an ongoing project. Phase I is financed by the Ministry of Economic Affairs of the Republic of Slovenia and carried out by the following institutions: Jozef Stefan Institute, Energy Efficiency centre, Faculty of Mechanical Engineering of Ljubljana, Milan Vidmar Electroinstitute, and Institute of Ecology.

consume energy, minimize the required economic efforts of the whole energy system. The IRP process, which involves also a structured approach for solving the problem, will identify proper ways and means to implement the policy measures.

The proposed project is in line with the strategic orientation given in the National Strategy of Efficient Energy Use and Supply of Slovenia which stresses in particular the need to promote the rational use of energy by tapping the energy conservation potential and enhancing demand side policies.[2]

The area of concern of this analysis is the energy use and supply in Slovenia, with specific consideration of the efficiency of energy use. Characteristic of the current agenda of decision making is a broad scope of the definition of the problem. An energy strategy is concerned with both energy supply and energy use. Also, the concerns are not only those of economic efficiency and security of supply, but also health, environmental, risk, and social impacts.

The problem is defined on the national level from a general perspective as requested by the Parliament or the Government.

In Slovenia, the most recent round of the comprehensive decision making at the national level started with the preparation of an energy strategy that was requested by the Parliament in 1993. The current strategic document, referred to by the Parliament as the "Resolution on the strategy of efficient use and supply of energy for Slovenia", identifies the possible domains for improvements in both energy supply and use, and the possible directions for a dynamic harmonization of this sector of the society.

The Resolution describes the area of concerns with the following text:

"Due to concerns over increased energy intensity, due to extent of adverse effects on the environment and the necessity to diminish the vulnerability caused by energy dependency, the implementation of the proposed resolution on the strategy can significantly contribute to the affirmation of Slovenia as an energy efficient state, where the supply of energy and the efficient use are sources of stability, reflection of a determination for an efficient, environmentally compatible development and a consequence of the expectations of the people for a better standard of living."

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2 In 1994, real growth of GDP was estimated to be around 5% (1% in 1993), and the increase of industrial production above 6%. GDP per capita amounts to approximately 6.900 US$/capita at current exchange rates. It can be expected that the recovery will continue in the next two years with expected real growth rates of 4% to 5%.
The energy sector plays a particularly important role in the economic transformation process. Energy intensity (GDP/primary energy) is about three times higher in Slovenia compared to countries of the European Union. In 1992, the energy intensity was 184 toe/mECU in the European Union compared to 565 toe/mECU in Slovenia.
Saving measures which are cost-effective even at the present low energy prices are estimated to amount to some 10% in the industry sector and to some 30% in the building sector in terms of final energy (with a 25% p.a. discount rate). With an expected price increase in the forthcoming years and under consideration of more realistic discount rates, the cost-effective potential will even increase.
The energy sector contributes to an important extent to the environmental degradation in Slovenia. Based on figures from 1993, the greatest share in SO_2 emissions comes from electricity generation representing 81 % of all emissions. Also, electricity production contributes by 27 % to NOx emissions and its share in CO_2 amounts to 47% followed only by transport. On the per capita basis, the comparison of emissions between Slovenia and countries of the European Union gives the following results:
Slovenia (European Union): SO_2: 91.3 (34.0) kg/cap NOx: 28.4 (32.5) kg/cap CO_2: 6.3 (8.7) t/cap

2. CASE STUDIES: INDUSTRY AND HOUSEHOLDS SECTORS

The two case studies carried out in the framework of the IRP project are described in the following paragraphs.

Quantification of the problem. Energy use in Slovenia is considerably higher than in West European countries. In comparison to countries of the European Union (EU), the energy intensity is approximately three times higher in Slovenia. In 1992, the total energy intensity was 184 toe/mECU in the EU compared to 565 toe/mECU in Slovenia.

The definition of the problem is based mainly on the draft document on the energy strategy of the Government of Slovenia after discussion with the Parliament. The current version of the document is being analysed in order to define the objectives (directives for expected developments and improvements) and the goals (level of accomplishment).

Scenarios. Two scenarios were adopted: a "PLUS" and a "MINUS" scenario. Short term projections (up to year 2000) of possible developments were available from governmental economic development studies. The long range (up to year 2020) scenarios adopted have been used in other energy studies. For the world-market energy prices no firm linkage with the domestic development scenarios is foreseen.

Strategies. Energy strategies consist of sets of policy measures. The measures proposed in the strategy document of the Government were listed and grouped. For the demand side, the "Energy Conservation Strategy for Slovenia" study is a more relevant source for strategy measures. In this study, measures were quantitatively analysed according to their impact on the energy use. Energy audits constitute further sources on strategy measures. Some additional measures were defined by the IRP project team.

Table 1 summarises the strategies selected. Three strategies were proposed for both case studies, industry and households: a *business as usual*, a *moderate efficiency driven* and an *intensive efficiency driven* strategy.

Data. Relevant public data bases available in Slovenia were reviewed in order to supplement the data on energy supply which are used for the energy balances of Slovenia, with more specific data on energy use. Detailed data bases on energy use by the industrial sector are maintained by the Statistical Office of Slovenia. The content of data bases on the industrial consumption was evaluated and access to synthetic data was secured. For the planned analysis of energy consumption patterns, the relevant population and building census were identified and acquired. Results of the household consumption survey were evaluated for modelling energy use by the household sector.

Model. Conceptually, the model consists of the following parts: households, industry (i.e. manufacturing), local energy supply and large scale energy supply. Other energy uses (services and transport) are at the present not modelled but data will be used from standard energy planning studies. A schematic presentation is given in Figure 1. This presentation does not reflect the actual state of the model but is only illustrative.

Analysis. The full analysis of the problem includes:

- Calculation of the economic optimum for each scenario and strategy, namely:

  - total cost, including cost structure;
  - cash flow;
  - energy flows and energy balances;
  - emissions of main pollutants;
  - resource consumption;
  - employment.

- Sensitivity analyses to variations of the main influencing parameters and constraints.

Table 1

Industry - Scenario table for three strategies related to three different intensive energy efficiency programs

	Scenarios	"MINUS"			"PLUS"		
	Real income	2.2 % p.a.			5.5 % p.a.		
	Average increase of industrial VA: *(1995-2000)* *(2001-2020)*	 2.4 % p.a. 1.9 % p.a.			 5.2 % p.a. 3.8 % p.a.		
GROUP OF MEASURES	*Strategies*	"0"	MODERATE improvement of energy efficiency	INTENSIVE	"0"	MODERATE improvement of energy efficiency	INTENSIVE
a	*Information and promotion programs*	base case	yes	yes	base case	yes	yes
b	*Technical regulation, standards and agreements*	base case	yes	yes	base case	yes	yes
c	*Management regulations, standards and incentive programs*	-	yes	yes	-	yes	yes
d	*Financial incentives for energy efficient investment*	-	moderate	intensive	-	moderate	intensive
e	*CHP and energy networks*	-	moderate	intensive	-	moderate	intensive
f	*Employ all technical options for efficient use of energy, domestic energy and renewable energy*	-	moderate	intensive	-	moderate	intensive
g	*Steel industry arc furnaces*	base case	moderate	intensive	base case	moderate	intensive
h	*Paper industry*	base case	moderate	intensive	base case	moderate	intensive
i	*Energy pricing, measurement and tariffs*	-	yes	yes	-	yes	yes
j	*Emission tax of x SIT*	no	no	yes	no	no	yes
k	*Energy tax of y SIT*	no	no	yes	no	no	yes

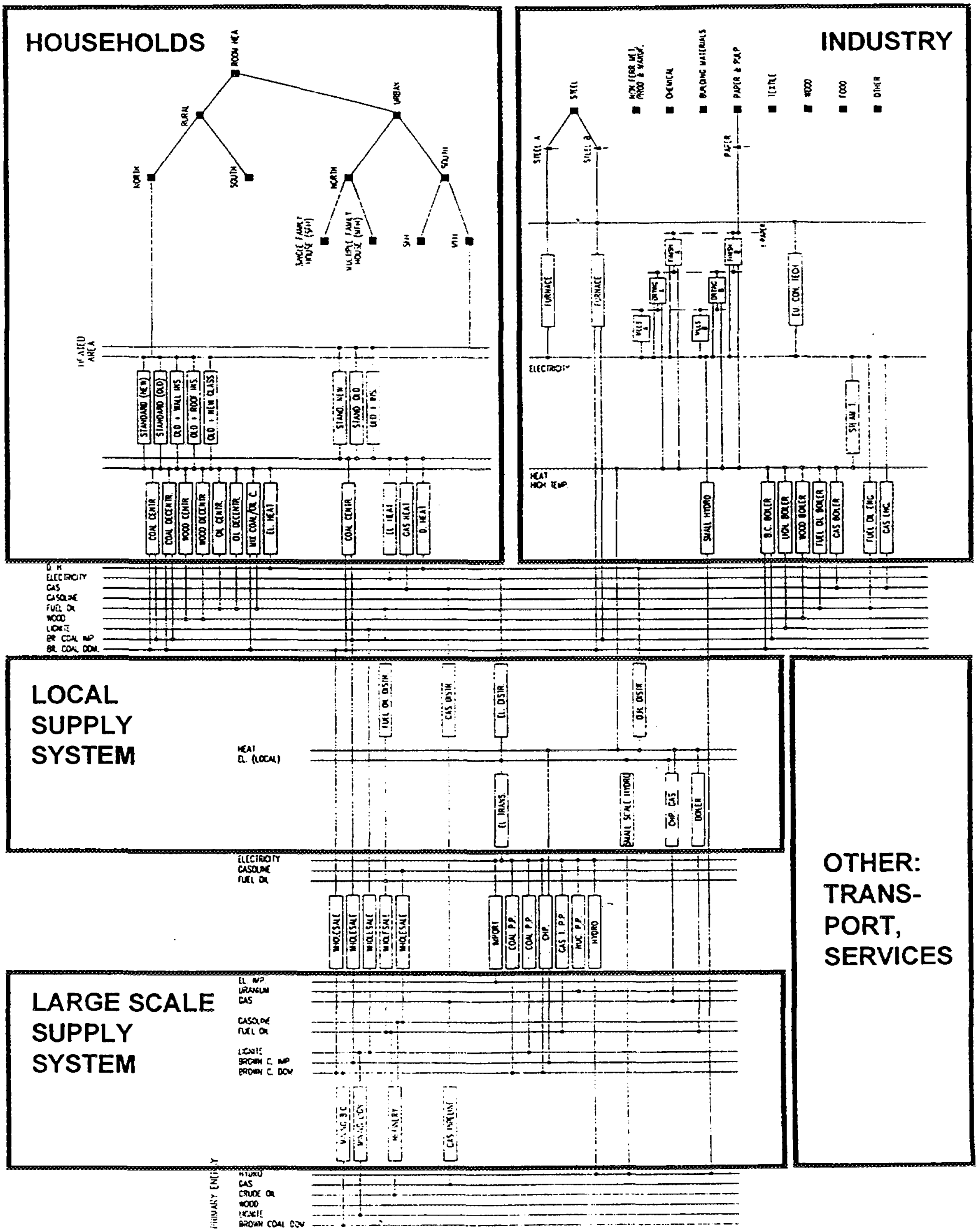

Figure 1. Reference Energy System and Subsystem

Policy recommendations. At an early stage of the project, policy recommendations will be drafted on the basis of the problem analysis and development of the Scenario Table. The recommendations will be reviewed at each of the three phases of the project. For policy recommendations, robust and multicriterial conclusions based on the Scenario Table analysis will be proposed.

Implementation and Monitoring Program. Following the policy decisions, the project should be extended to the policy implementation phase. The project extension should include monitoring of the results achieved by the chosen strategies.

3. MODELLING FRAMEWORK

In the procedure of integrated resource planning, supply and demand should be analyzed in an integrated approach. For demand side, the screening simulation model called PLANET is envisaged. WASP will be used for the optimization of the generation expansion plan (see Figure 2).

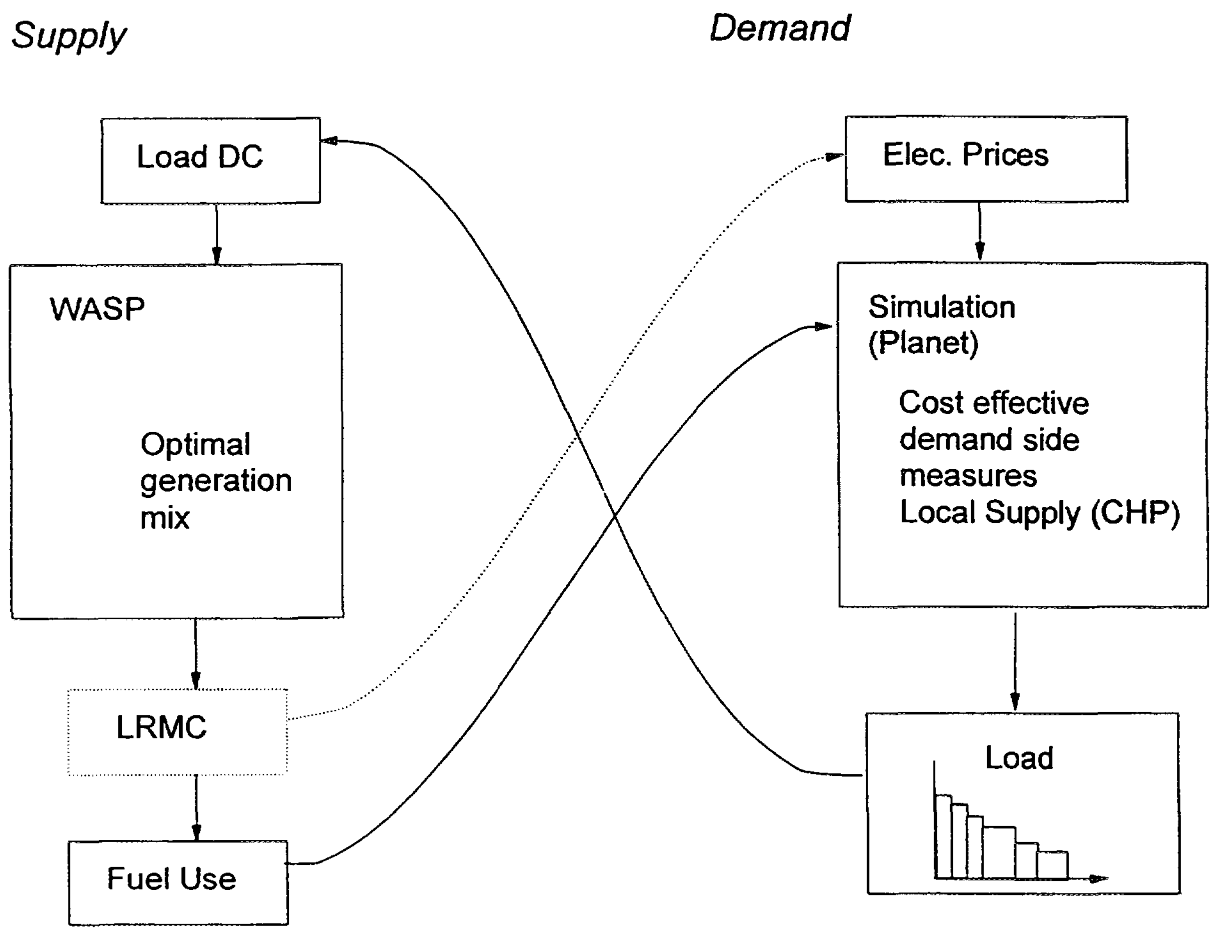

Figure 2. Interlinks between WASP and the demand simulation model

The three interlinks between the demand and supply models are at the following levels: (a) load diagram modelling, (b) long run marginal costs of electricity, and (c) local supply systems.

The two models (PLANET, WASP) will be connected by exchanging inputs and outputs as follows: in the demand model, the electricity demand will be represented with six different load steps representing different tariff periods, plus peak load.

This tariff structure has been in use in Slovenia for electricity sales from qualified producers since September 1995. In addition, three seasons are introduced for the household sector and other groups.

A study of the impact of demand side measures on the load diagram is described in [Renar 93], the expansion planning being analyzed by the ELBIVIM model. Qualified, existing and potential producers will be modelled inside the demand model as long as they are not dispatchable (a capacity ceiling of 220 MWe for district heating purposes is planned). Long run marginal costs can be applied as input in the demand model for assessment of the cost effectiveness of measures. In addition, fuel consumption data is required as an input for integrated balance model.

Results of the demand and supply analyses will require an additional estimation of the financial, environmental and social impacts of the options.

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