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A study of Energy Oriented Urban Development Model for Industrial Complex plan

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Summary

o Korea consumed total 198.5 million TOE and the portion of crude oil n was 100.4 million TOE in 2002 which marked the 10th largest energy consuming country and ranks the 4th crude oil consumer in the world.

o Industries consumed 51.5% of the total energy and 93% of industrial energy was used at the manufacturing industries such as steel, textile, chemical, food and beverage, pulp and paper, and timber industries, which lead to energy intensive industries numbered 110,000.

o Also Korea ranks the 10th greenhouse gas emission countries of the world (134.9 million TC) which may cause Korean industries to suffer severely during the implementation of United Nations Framework Convention on Climate Change (UNFCCC).

o Therefore, the target of the study is to develop a model for the analysis and design of industrial complex by integration of the energy usage and environmental problems.

o The research work contents are as followings:

- Analysis of Korea energy consumption
- Concept of the integration of energy and environment problems
- Basic concept of industrial complex planning
- Structural model of industrial complex
- Case study (1)
- Recommendation and conclusion

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1. Analysis of Korea Energy Consumption

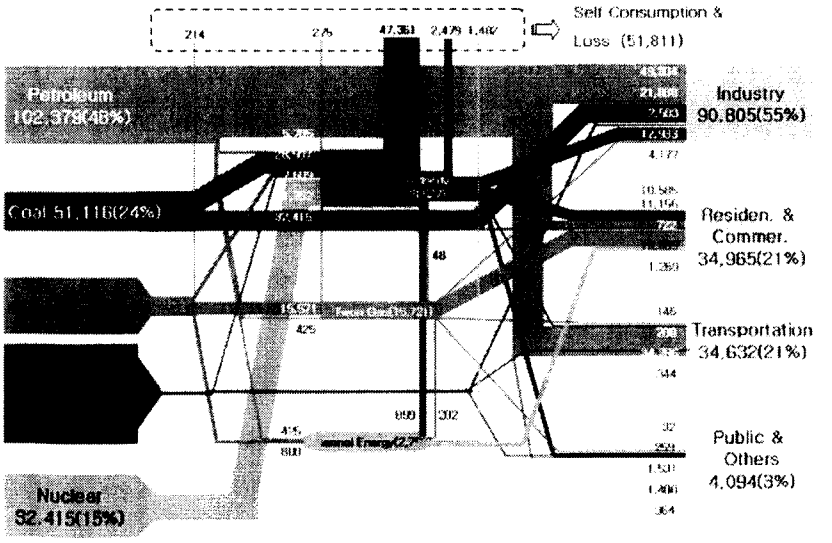
o The 97 % of total end-use energy is imported from overseas, which is equivalent to 143.194 million TOE with 4.5% of annual increase rate.

o In terms of the energy sources the oil portion was 62.2%, hydraulic power 14.9%, coal 11.6%, liquefied natural gas (LNG) 8.8%, and others was 2.6%. In terms of the energy usage, the industrial sector was 56.2%, transportation sector 22.8%, the commercial and public sectors 6.9% and the residential sector was 14.1 % of total energy.

o 93% of industrial energy is consumed at the manufacturing industry with 2.0% increase rate of energy consumption.

o From the <Figure 1-1>, energy consumption flow diagram, the energy loss was 26%.

<Figure 1> Korea Energy Flow Diagram



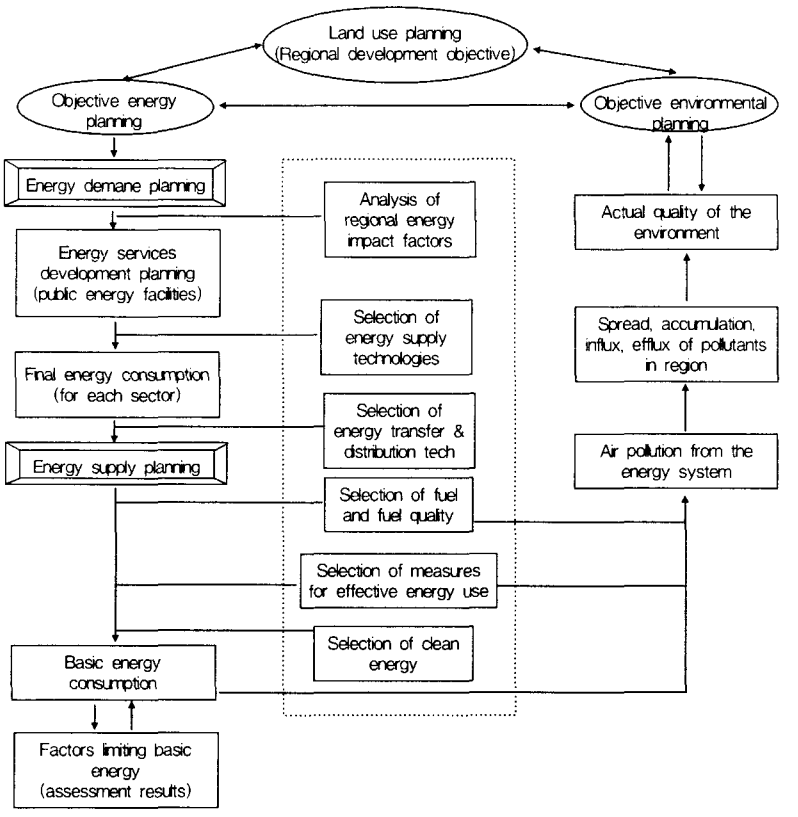
2. Concept of Integration of Energy and Environmental Problems

Until now there has been no study of integrated energy and environmental plan for the regional

development plan from the point of individual industrial complex and there has been no study the urban or regional planning from the point of integrated energy and environment.

Using the WISE model, a model of integrated energy and environmental plan is developed, which systematically combines energy and environmental problems with the existing land utilization plan (see <Figure 2>).

<Figure 2> Flow diagram of integrated energy and environmental plan



o Planning of industrial complexes needs the followings;

1) Energy demand forecasting;

2) Influence factors of the regional energy supply;

3) Identification of technologies for generation, transferring, and usage of energy;

4) Regional environmental conditions;

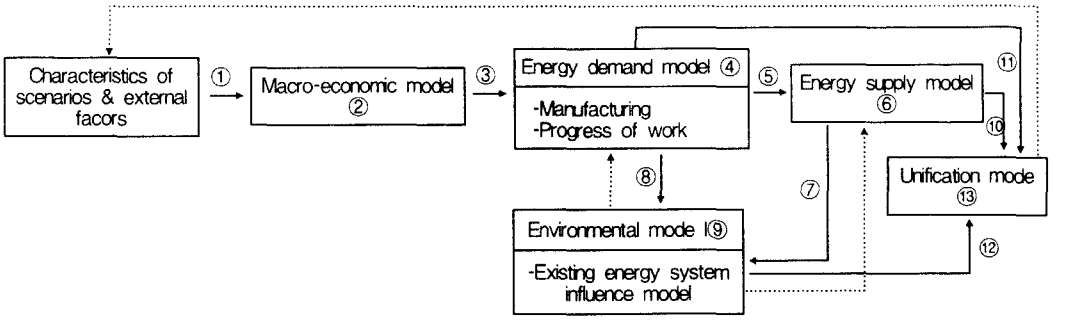
5) Identification methods for waste energy usage.

The industrial sector of 51.5% (49.0 million TOE) consumption of total national energy is classified into 1) Agricultural and fishery industry, 2) Mining industry, 3) Manufacturing industry, and 5) Construction industry in accordance with the Standard Industrial Classification (SIC) established in 1992. Moreover, this concept limits the work scope to the planning of manufacturing-based industrial complexes, which is about 86% of the energy consumption of industrial sector, as identified in the SIC 3.

3. Basic Concept of Industrial Complex Planning

<Figure 3> shows the basic concept of industrial complex planning, which was derived from the model of the regional energy and environmental planning.

<Figure 3> Basic concept of industrial complex planning



The concept of the model for the planning of manufacturing industry complexes is continuously improved through the works of 1) development and testing of the model, 2) formation and decision of energy policies, 3) feedback to the basic concept as well as the flexibility.

The structure of this model, which is practically identical to the WISE model, consists of ②

socio-economic model, ④energy demand model of various industries, ⑤energy conversion and supply model, ⑨environmental impact model, and ⑬unification model. Each model is used to analyze the specific problems of the particular elements of the energy system.

o The information of input variable ③ for energy model ④ is come from external factors ①, such as policy issues, potential future conditions or assumptions, as well as natural conditions like the climate and topography of the area to be developed; and model ②, which deals with the socio-economic activities of the relevant area.

o Using input variable ③ as the basic data, the energy demand model of the related manufacturing processes, facilities, and technologies (such as heating, cooling and lighting technologies), is established based on the energy intensity of all economic activities within each manufacturing industry. Here, the end-use energy demand is calculated by the total unit energy input (energy intensity) per each product (or VA), fuel mix, and product mix based on the amount of goods produced or the value added (VA) of goods. However, in the cases where industrial complex development planners do not know the detailed information (such as production volume) about the manufacturing industries which are scheduled to install in the area in question, the end-use energy demand can introduce a concept of energy intensity per unit area, for individual manufacturing industries that is similar to the one employed in the development of residential areas. The end-use energy demand is displayed as the annual energy demand for each type of fuel. As the energy demand model developed in this study is fully dependent on external data (including the data of economic activities of Korea's trading partners), the properly assessing correlation between the anticipated future activities of each manufacturing industry and energy consumption patterns is enhanced.

o The output calculated using the energy demand model is then used as the input variable of the ⑤ energy transfer and supply model in order to calculate the cost of the energy supply system, including the primary energy demand as well as transportation, conversion and distribution of energy. As for ⑥ the energy supply model, two approaches can be used either

simultaneously or individually. The energy demand and supply balance approach, which is used to calculate the primary energy sources to meet the end-use energy demand, takes into consideration of the transportation, refining, conversion, distribution and loss of energy, which includes the calculation of thermal efficiency of electrical demand and of space heating per area of residential sectors. In accordance with the results of study on urban or regional planning carried out by advanced countries, the amount of energy to be supplied is usually set at the same level as the energy demand, while still being based on energy demand, or takes into consideration of the potential limiting factors included within the basic framework of their respective scenarios.

o The energy flows found within the energy supply system and the end-use energy consumption are used as input variables ⑦ and ⑧ in the ⑨environmental impact model. The environmental impact model is determined by the environmental limitations found in the scenario, which was set up to deal with air and water pollution, and other environmental factors that impact human health and safety that are associated with the various energy systems. The Reference Energy System Impact Model (RESIM) was designed to assess environmental impact factors related to the energy supply, what is known as energy supply networks, from the extraction of the primary energy to the end-use energy consumption. The calculation of environmental impact does not need to take into account of specific factors or supply networks at the regional level but can be calculated using solely by the total amount of energy in a given area. The definition of impact factor found in the scientific literature, and which is used in this model, is one that is closely related to that of energy units. Those impact factors which can be quantitatively analyzed include the impact factors of land use and air and water pollution on human health, and exposure to unexpected accidents or hazardous pollutants.

o The preference model ⑬, which is based on a utility theory that contains various attributes and uses the outputs from the above-mentioned model as input variables (⑩, ⑪, ⑫), was developed to help policymakers assess alternative energy/environmental strategies. This model takes into account of the ambiguity of the related strategies, the various objective characteristics

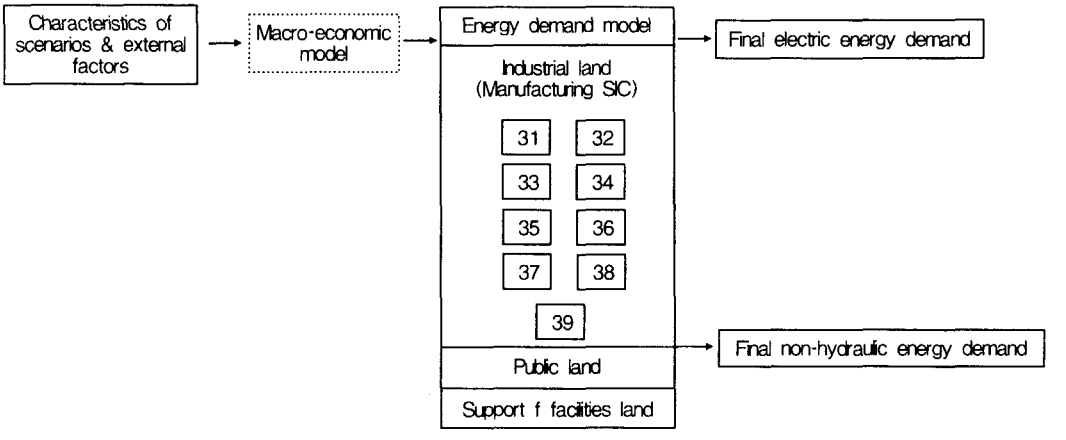
of energy/ environmental problems, and the individual structural factors which influence the decision makers. Finally, as mentioned above, the dotted lines indicate the flow of additional information between the main factors, and the conducting of the feedback process, which is based on the model of user subjective judgment and not formulized mathematical equations.

4. Structural Model of Industrial Complex

o The study to develop an energy model for a domestic manufacturing industry complex was done by investigating and analyzing the present state and structure of energy consumption of the manufacturing industry and of energy technologies based on energy intensity and useful energy demand in order to calculate actual energy demand.

o As shown in <Figure 4>, the general energy demand models which can be applied to an industrial complex is characterized by the socio-economic variables as external factors, and by the individual production technologies. Moreover, their outputs appear in the electricity and thermal energy types.

<Figure 4> Structure of the energy demand model for an industrial complex



31: Food and beverage, cigarette manufacturing industries

32: Textile, clothes, and leather industries

33: Wood and wooden products industries

34: Paper, paper products, and publishing industries

35: Chemical, petroleum, coal, and plastic products industries

36: Non-metallic mineral products industries

37: Basic metal industries

38: Metal assembly products, machinery and equipment manufacturing

39: Other manufacturing industries

o In addition, the decision to feedback the results of the end-use energy consumption identified by the energy demand model into the socio-economic model is decided by the model user and not based on formal mathematical equations.

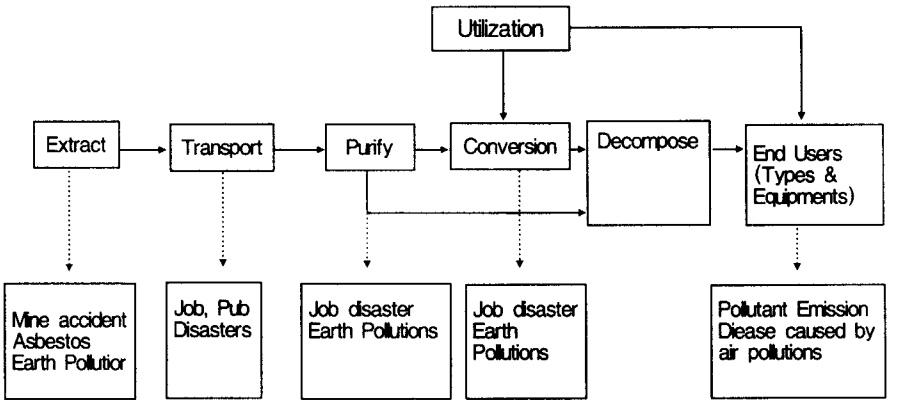
5. Energy/Environment Model for Industrial Complex

To evaluate the parameters and effects of the energy consumptions at industrial complex the energy/environmental model is defined as a system of land, air, water, structural building and human life.

In the course of over whole energy supply the harmony of different energy sources being needed for the planned industrial complexes is emphasized for optimum environment friendly energy chains, where the energy chain consists of energy extraction, transportation, purification, conversion and utilization at end consumers and is expressed as the reference energy system at energy supply side.

<Figure 5-1> shows the stream of pollutant emissions, transportation, and exposition to human health in the course of the energy chain.

<Figure 5> Major effects in the course of energy (fuel) chain

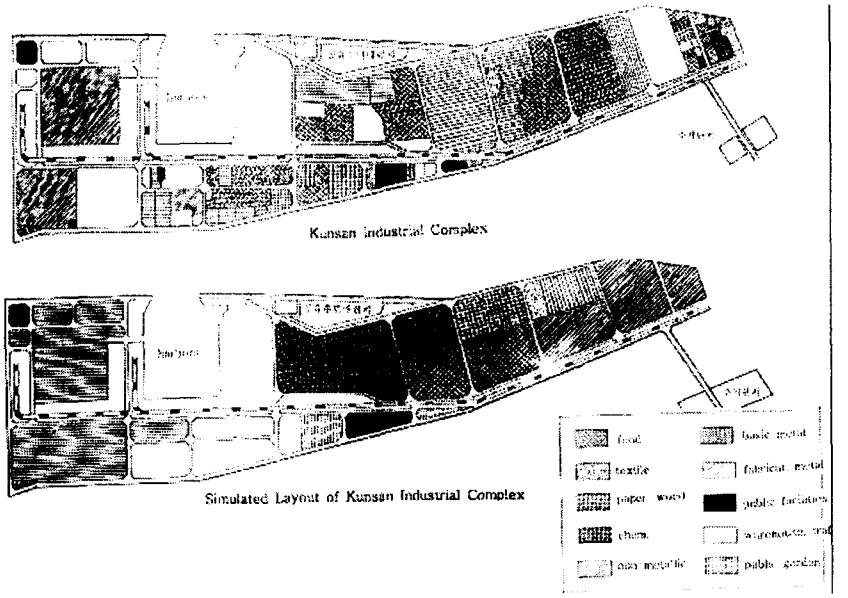


As the environmental problems at the industrial complexes occur at the end users of energy the emission of pollutants should be minimized. The most effective measures to solve industrial pollution are the utilization of industrial wastes as energy source and forming of the green parks adaptive to industrial pollutants.

6. Case Study (1)

Subject of the case study
Kunsan National Industrial Complex
(Food and beverage, textile, pulp, timber, chemical, non-metallic, basic metal, metal assembly)

Classification	Present status	Simulation of the application of the model
Disposition of industries based on their specialization	Do not take into consideration energy/ environmental problems	Grouping of the industries that operate at high temperatures together and the arrangement of the remaining industries in a layered fashion so as to make use of waste heat
Combined Heat and Power Plant (CHP)	Not yet introduced. Usage of individual boiler systems	The introduction of a central energy supply system could contribute to an annual 20% reduction in energy usage
Calculation of prospected energy demand	Not carried out	* Calculation of the heating load and electricity demand * Calculation of useful energy * Calculation of energy source units
Waste	Reclaiming disposal	* Usage of the heat from incinerated waste
Efficiency	-	* Annual 30% reduction in costs * Minimization of environmental problems * 10% improvement in productivity



7. Recommendation and Conclusion

The Korean government has implemented the national energy and environmental plans, while local governments have established and implemented the five-year local energy plans using this model.

In order to extend the concept of regional development planning this study introduced a more reasonable industrial complex model. This study is based on the basic concept of the industrial model from an energy and environment and takes into consideration of the factors (parameters) related to artificial conditions, such as the natural conditions and the energy system prevailing within a given industrial complex.

By applying this integrated energy and environmental model to local government plans for the construction of industrial complexes designed to bolster local industrial activities, the energy consumption can be reduced and the environment can be improved.

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