Ⅰ. Summary

1. Objective of Research and Development

International Clean Energy Network Using Hydrogen Conversion (WE-NET project) aims at contribution to solving global environmental problems by means of large-scale and effective utilization of clean and renewable energies such as hydraulic, solar, and wind which are available widely on the earth. Its purpose is also to establish technologies capable of introducing an international energy network utilized in the wide fields such as hydrogen production from these energies, conversion of hydrogen as necessary, transportation, storage, generation of power, fuel for transportation, and town gas, in order to satisfy energy demands, and to develop core elementary technology as well as preparation conceptual design of the total system.

Phase I of WE-NET project scheduled for six years from FY 1993 aims at establishment of the basic research and development on fundamental technologies necessary for optimization of the energy network system. This work included a variety of hydrogen production, storage/transportation and utilization technologies such as:

・Assessment of hydrogen energy systems
・Water electrolysis using solid polymer electrolytes
・Hydrogen liquefaction technology
・Storage/transportation technology for liquid hydrogen
・Hydrogen storage technology in metal hydrides
・Hydrogen combustion turbine technology

Phase Ⅱ of WE-NET scheduled for five years from FY 1999 is now underway and focused on integrating and advancing the results of the research and development work from Phase Ⅰ. Included in this effort is the utilization of hydrogen not only from clean renewable energy but the fossil fuel to aim at short-term or mid-term realization of introducing hydrogen energy into the society. Specific project include:

・Hydrogen vehicle system component technology related to metal hydride tank systems
・Hydrogen refueling station
・Hydrogen storage materials for vehicle and stationary tank
・Hydrogen-fueled solid polymer electrolyte membrane fuel cell
・Hydrogen-fueled diesel engine

2. Items and targets of Research and Development

Research and development for Phase Ⅱ has been carried out in the following 12 tasks.

Figure 1 and Table 1 show the schematic illustration and the schedule of Phase Ⅱ in WE-NET project.

2.1 Task 1 Study of System Evaluation

The aim of surveys and studies is to study an optimal scenario for introduction of hydrogen energy and formulate a strategy for its introduction. Also a research coordination council will be organized and held to coordinate research activities under the WE-NET Project.

2.2 Task 2 Study of Safety Measures

We will conduct experiments on discharge, diffusion, ignition and explosion phenomena of hydrogen. The experiment results will be used to analyze the safety preliminarily on the latent accidents in hydrogen usage. We will establish the procedure of safety assessment and will research on safety design standards.

2.3 Task 3 Review and Investigation for International Cooperation

We will carry out activities to develop international understanding of the WE-NET and promote exchange of technical information in order to develop the WE-NET project.

2.4 Task 4 Development of Power Generation Technology

We will develop of a single-cylinder hydrogen combustion diesel engine rated 100kW for co-generation system. This engine having about 40% efficiency at terminal and more than 85% total efficiency(higher heating value basis) shall be free of any emission of environmental pollution. Implementation of the performance evaluation testing of this diesel engine to identify R & D themes for the practical application of such a diesel engine.

2.5 Task 5 Development of Hydrogen Fuel Tank System

We will develop an elementary technology for fuel system of hydrogen fuel cell vehicle by taking account of hydrogen supply from hydrogen refueling station, and further, carry out the plan ahead of schedule in order to conduct technical verification of the hydrogen vehicle driving system combined with the hydrogen refueling station in the second half of the fiscal year of 2001.

2.6 Task 6 Development of PEFC Utilizing Pure Hydrogen

We will develop of element technology for the fuel cell power generation system which meets the utilization of pure hydrogen and achieves about 45% electrical efficiency at the AC sending terminal (higher heating value basis), shall be established and a stationary type 30kW class generation system shall be demonstrated.

2.7 Task 7 Development of Hydrogen Refueling Station

We will develop and demonstrate a small scale of test system with hydrogen supply capacity of 30Nm^3/h, equivalent to about one tenth of actual scale, in order to establish the element technology and system technology for stand alone type of hydrogen refueling station for the purpose of fuel supply to hydrogen vehicles.

2.7AB Task 7AB Development of Hydrogen Refueling Station

For accelerating the introduction of hydrogen fuel cell vehicle in wide ranges, it is also necessary to develop a hydrogen refueling station using hydrogen obtained from the by-product gas in the chemical engineering process, of which a considerable amount of supply is expectable already at the moment. The object of this research and development project is to develop a hydrogen refueling station, into which hydrogen is transported from the outside the station (off-site system).

2.8 Task 8 Development of Hydrogen Production Technology

We will develop large-scale cell lamination (electrode area 2,500 cm^2) by using two hydrogen production methods (electroless plating method and hot press method). The target of current density is over 1A/cm^2 and the target of energy efficiency is over 90%. And we will develop the cells (electrode area 1,000 cm^2) for hydrogen stations. Moreover, we will develop solid high polymer electrolytes resistant to high temperatures.

2.9 Task 9 Development of Hydrogen Transportation and Storage Technology

We are going to conduct elemental tests of insulation structure and to establish the data base of thermal insulation performance. And we will develop element technologies of liquid hydrogen pump. Moreover, we will collect basic data of aerodynamic design and seal design for hydrogen compressor.

2.10 Task 10 Development of Cryogenic Materials Technology

The goals are to test material properties under liquid hydrogen environments and to develop elemental technology related to optimized welding material and welding method. Moreover, the material characteristic database will be enhanced.

2.11 Task 11 Development of Hydrogen Storage Materials

The target is to develop hydrogen absorbing alloys having the following performance.

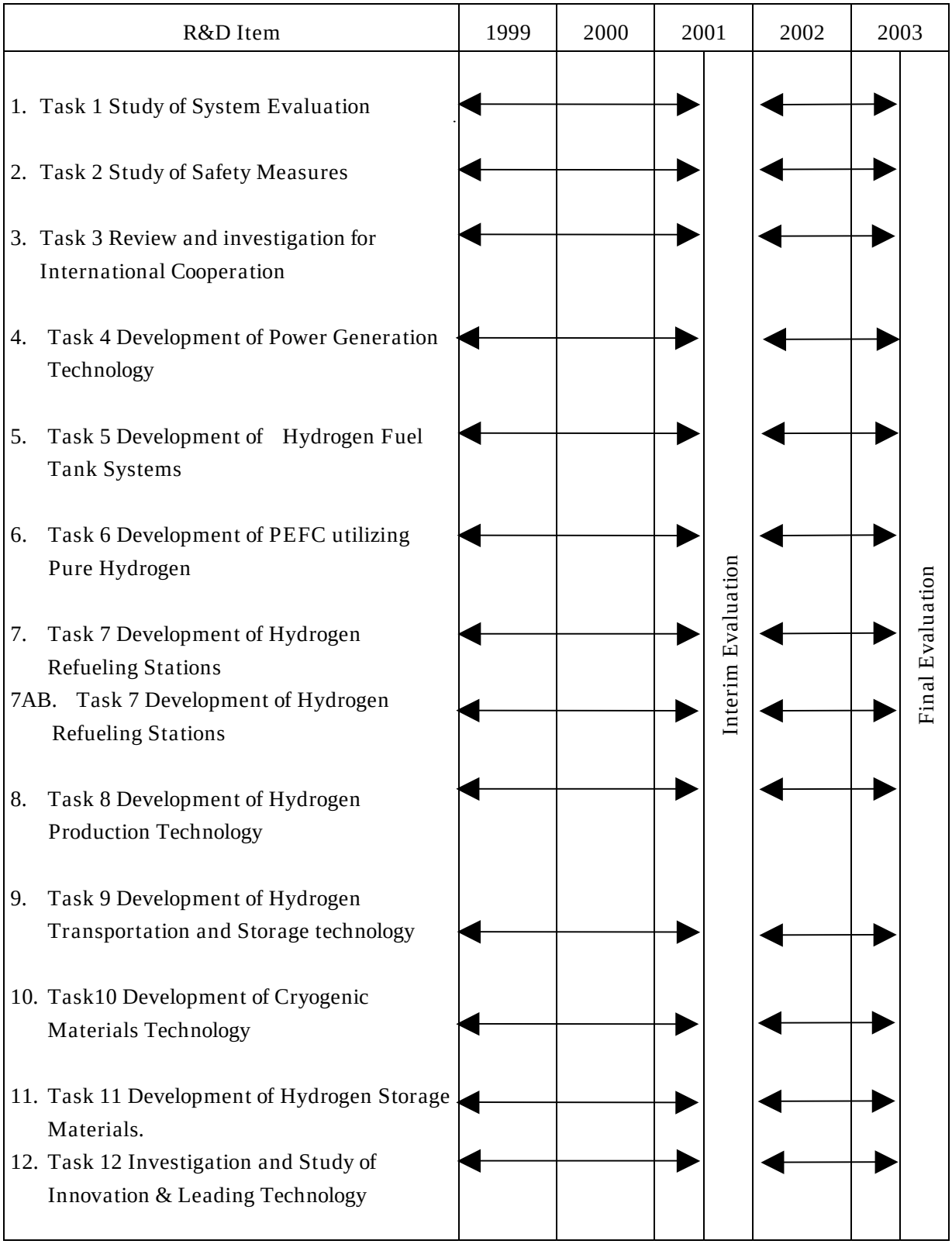
- Effective hydrogen storage capacity : more than 3mass%
- Temperature for hydrogen desorption : less than 100℃
- Durability : hydrogen storage capacity more than 90% of the initial capacity after 5,000-cycle use

we investigated hydrogen storage capacity in several carbon materials, including carbon nanotubes.

2.12 Task 12 Investigation and Study of Innovation and Leading Technology

It is aimed at giving valuable suggestions and proposals to the direction of the WE-NET project and contributing to the research and development through feasibility study, as well as further research if necessary, of such innovative, leading and conventional technologies.

Table 1 Schedule of R&D for WE-NET, Phase Ⅱ



International Clean Energy Network Using Hydrogen Conversion (WE-NET) Phase Ⅱ Program

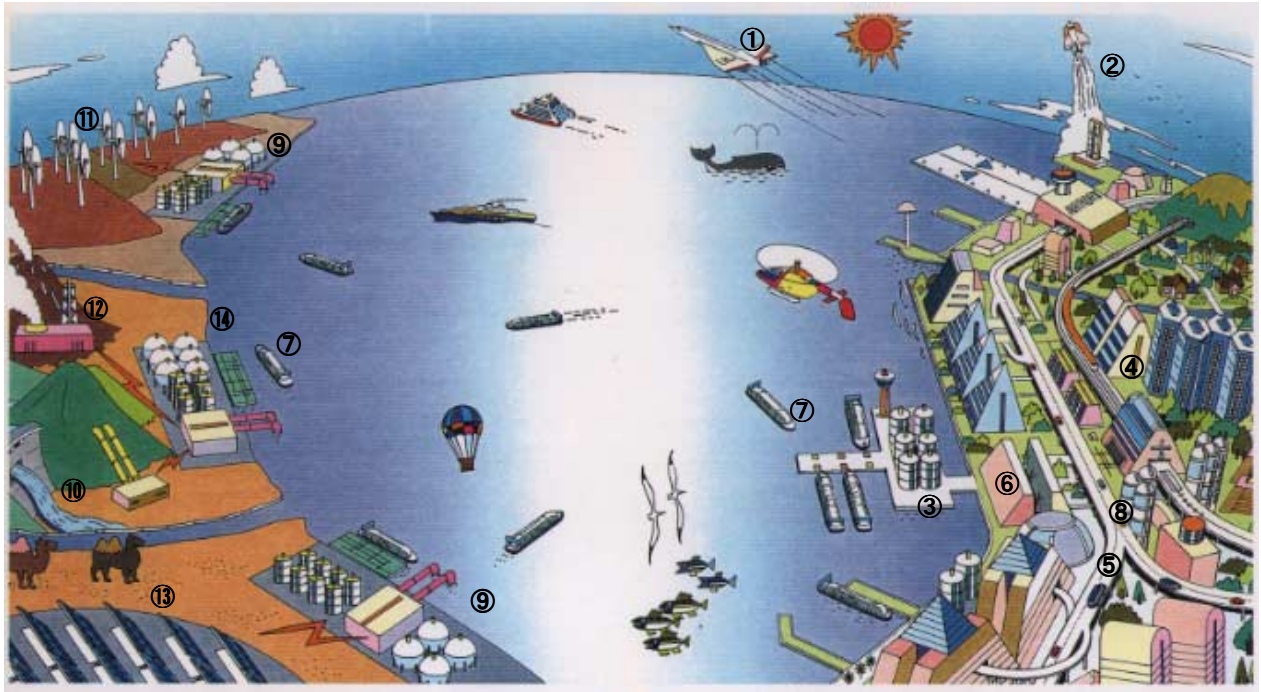


Fig1　Conceptual Diagram of WE-NET

①Hydrogen Aircraft　②Hydrogen Rocket　③Hydrogen Storage Tank ④Energy Consumption Site　⑤Hydrogen Bus　⑥Hydrogen-Combustion Power Generation
⑦Hydrogen Tanker　⑧Hydrogen Vehicle　⑨Hydrogen Production Plant ⑩Hydropower Station　⑪Windmill Power Station
⑫Geothermal Power Station ⑬Photovoltaic Power Station　⑭A Country Rich in Renewable Energy

①Hydrogen Aircraft　②Hydrogen Rocket　③Hydrogen Storage Tank ④Energy Consumption Site　⑤Hydrogen Bus　⑥Hydrogen-Combustion Power Generation
⑦Hydrogen Tanker　⑧Hydrogen Vehicle　⑨Hydrogen Production Plant ⑩Hydropower Station　⑪Windmill Power Station
⑫Geothermal Power Station ⑬Photovoltaic Power Station　⑭A Country Rich in Renewable Energy