# §10. Synergistic Effect for Hydrogen Fuel Production in LHD-type Power Reactor

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Figure 1 gives power flow diagram from fusion output to power generation and electrolysis. The four different styles of plant outputs are investigated: (A) pressurized hydrogen of 637 tons per day, (B) liquid hydrogen of 596 tons per day, (C) 1 GW of power generation, and (D) 0.832 GW of electricity production plus 100 tons per day of liquid hydrogen. Case (A) and case (B) are dedicated hydrogen production and these cases are desirable as the infrastructure for the future fuel cell society. Case (C) is suitable for a largely constant level of power demand as well as a nuclear fission power plant. Case (D) has the flexibility in plant operation. Electrical power to the grid can be modulated if the excess electricity were used for the hydrogen production, at the constant power generation. This fraction rate of case (D) is also appropriate for the levelization between on-peak and off-peak demand [1].

The efficiency from electrical energy to hydrogen combustion energy, $\eta$, is defined following equation.

$$\eta = \frac{E_{H2}}{E_{WS} + E_{PACK}} \times 100 \qquad (1)$$

Where, $E_{H2}$ is convustion energy of hydrogen, $E_{WS}$ and $E_{PACK}$ are input energy of electrolyzer and packaging energy of compression or liquefaction process. Calculation results are summarized in Table 1. As shown in Eq. (1) , energy required for electrolysis is given by the sum of the electrical input energy and thermal energy change of before and behind water split. Since waste heat of more than 200 MW is inputted for stem production, high efficient energy conversion can be obtained in this method.

Figure 2 gives schematic diagram of co-generation of electricity and hydrogen in the FFHR power reactor showing bi-production of oxygen and fuels of fusion reactor. About 100 kg of deuterium, which is the fuel which is sufficient mass for a fusion reactor, will be contained in the produce hydrogen of 700 tons. In the steam production process for steam electrolysis, concentration and evaporation of seawater lead to high efficient separation of lithium resource which is the materials for breeder blanket and/or coolant of primary cooling circuit. Since 150 ppb of lithium is contained in the seawater, 6350 tons of seawater include of about 1 kg of lithium. It was confirmed that the hydrogen production was one of the effective operation styles for a LHD-type fusion power plant [2].

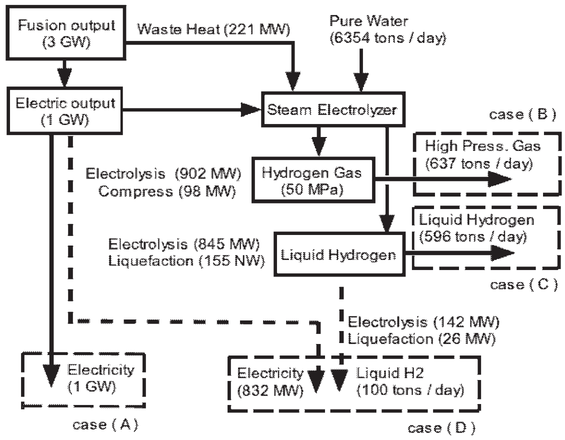


Fig. 1 Power flow from fusion output to power generation and electrolysis

Table 1 Energy conversion efficiencies to $H_2$ combustion energy.

| Output style | Output Power | efficiency |
|---|---|---|
| Dedicated $H_2$ production (Compression to 50 MPa) | 651 tons/day | 104.5 % |
| Dedicated $H_2$ production (Liquefaction) | 651 tons/day | 97.8 % |
| Off-Peak time $H_2$ production | 651 tons/day + 824 MW | 97.8 % |


1) S. Yamada et al.: Fusion Eng. and Design, **82** (2007) 2817.
2) S. Yamada et al.: Fusion Eng. and Design, **84** (2009) 1997.


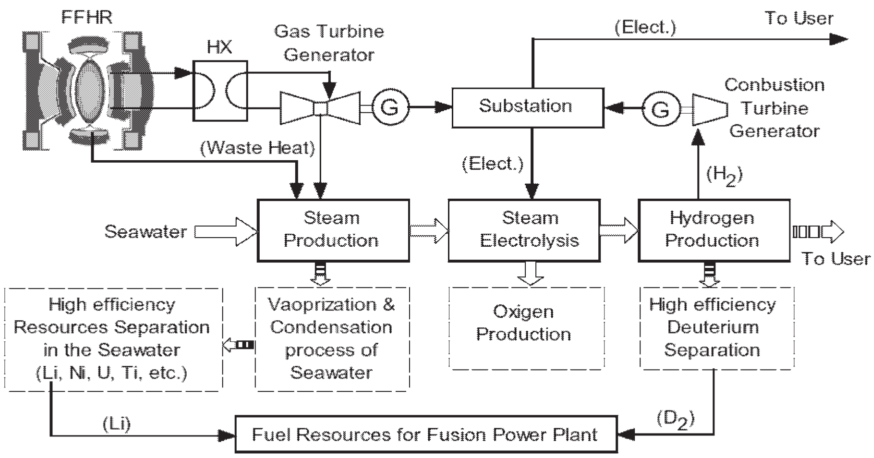


Fig. 2 Schematic diagram of hydrogen production, power generators and fuel resource production.