Technologies and Challenges about Engineering Geology for Renewable Energy

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Renewable energy is closely related to various topographical and geological conditions, which form the ground conditions for various facilities[1)]. The sources of renewable energy include solar, wind, hydro, geothermal, solar thermal, atmospheric heat, other naturally occurring thermal energy, and biomass. Utilization forms include power generation and thermal utilization. This presentation will outline the technologies and future challenges in the field of applied geology for the utilization of renewable energy.
In geothermal power surveys, integrated assessment approaches combining various survey methods are being implemented to identify deep underground geothermal reservoirs. Furthermore, since promising sites are often located within national parks or volcanic zones, considerations for facility aesthetics, coordination with natural parks, and coexistence with hot spring areas are also crucial.
For solar power installation sites, it is necessary to confirm the presence of soft ground on flat terrain, landslide-prone area on slopes, and instability in embankments or cut slopes. Addressing the impact of disasters caused by slope failures occurring in the surrounding area and countermeasures against strong wind damage are also critical.
Onshore wind power facilities in Japan are often installed on coastal reclaimed land, sand dunes, hilly terrain, mountain ridges. Key challenges include selecting sites with favorable wind conditions, determining the necessity and methods for ground improvement (soft ground countermeasures, landslide stability measures), and identifying bearing layers while considering seismic resistance.Offshore wind power generation in coastal waters generally involves sand and clay deposits, necessitating foundation ground verification and measures for soft ground.
There are various types of power generation technologies utilizing ocean energy (wave power, tidal range, tidal currents, ocean currents, temperature differences). France's Rance Tidal Power Station, which began generating electricity in 1967. Many of these technologies are still in the research or demonstration phase.
Small-scale hydropower generation methods include reservoir-type and run-of-river types. Understanding the local topography is crucial for assessing the energy potential (flow rate, head).
Biomass includes waste-derived, underutilized (thinning wood, etc.), and productive resources (vegetable oils, etc.). It is used to produce fuel for power generation, thermal utilization, and transportation fuel. Power plant locations are often reclaimed land near coastal areas when using imported resources, or plain land areas when using domestic resources. Countermeasures for soft ground are critical.
Geothermal heat utilization is a method that employs the constant temperature underground to perform heat exchange. It is necessary to measure the distribution of strata and thermal conductivity. Applications for hot spring heat utilization include agriculture (greenhouse cultivation, etc.), aquaculture (fish, etc.),etc. Key considerations include understanding the hot spring's temperature, water quality, and flow rate; the spatial relationship between the hot spring source and the utilization facility; coexistence with geothermal resource development. Additionally, facilities utilizing geothermal or hot spring heat face geological challenges related to chemical reactions between hot water and rock. These include measures against

clogging caused by mineral deposits (such as hot spring scum) and ground weakening due to alteration in volcanic areas (a factor contributing to landslides).
Renewable energy sources generate electricity in unstable quantities and at irregular times, making the storage and control of electricity a key challenge. As a method for electricity storage, technology is being explored that involves storing compressed air underground and using it to generate electricity when needed. Additionally, as a technology related to renewable energy, CO^2 underground storage exists, and investigations are being conducted on storage reservoirs and barrier layers.
As we have seen, understanding the local topography and geological conditions is crucial for the installation of renewable energy facilities, depending on the type of energy source and the specific facility.
References
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