CAMBRIDGE ZERO

Hard to Decarbonise Technologies
Special Interest Group

Nuclear power: Challenges and opportunities in hard to decarbonise applications
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Panel

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Challenges

- Provision of heat, representing half of global final energy demand, with low carbon sources across wide range of delivery temperatures.
- Replacement of fossil fuels in high energy density applications such as long haul flight and cargo shipping.
- Supply of low carbon feedstocks to industrial processes, such as metal reduction and fertiliser production.
- Stimulating private investment in nuclear.

Discussion Points

- Low temperature space heating currently provided by natural gas can be displaced by heat pumps, hydrogen combustion, or district heating.
- Nuclear has a potential role in all options, either as grid power, in hydrogen production or in direct heating. There are international precedents for district heating networks using waste heat from nuclear power plants, or dedicated district heating reactors e.g. one recently commissioned in China.
- Economics of nuclear are such that direct heat provision is relatively economical. Constant load is always preferable. Best suited to high capex industrial processes that must also run at full load to be economical.
- Processes requiring heat at temperatures above around 55°C can not be easily addressed with single stage heat pumps and require less efficient resistive heating methods. Above 1,300°C any electric heating method is difficult and combustion is probably necessary.
- Nuclear technologies can currently provide heat at 300°C and advanced high temperature systems are expected to reach around 900°C. Above 1,300 °C requires combustion feedstock production combined with pre-heating.
- Shipping can be directly addressed with civil nuclear propulsion, which has been demonstrated, but regulatory barriers are considerable. Alternative fuels such as ammonia may be more easily achievable, albeit at a much reduced overall energy efficiency.
- Synthetic fuel production for high energy density cases (shipping and aviation) and direct air capture of carbon dioxide are all strong use cases of combined heat and power nuclear 'energy parks'.
- Scale and complexity of nuclear projects are not the barriers to investment they are assumed to be and are comparable with those of upstream oil and gas. Novelty and idiosyncratic risks in addition to these factors does lead to a barrier.
- Government needs to share risk until technology is mature enough, as demonstrated with offshore wind. RAB financing structure used with Tideway Tunnel may suit nuclear more than the contracts-for-difference used with offshore wind.
- Energy security is a hard-to-monetise public good leading to a market failure and a need for Government intervention.

Opportunities

- Adaptation of current systems and design of entirely new ones to utilise nuclear as a versatile heat source rather than simply an electricity generator.
- Integration with other engineering systems: heat distribution, H_2 and synthetic fuel production, direct air carbon capture.
- Design of financing structures which optimally share risk and reward between public and private entities.

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