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Views & Comments

Insurance for New and Adapted Hydrogen Processes

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Hydrogen, produced through net zero processes, has the potential to support the energy transition if new systems for production, storage, and transportation, and use can advance quickly and at scale. Innovative engineering is needed to bring about the technological advances and change we need. There are significant benefits but also inherent risks in new engineered systems and in retrofitting existing carbon intensive systems with low carbon and hydrogen alternatives. Engineering innovation cannot be viewed in isolation from its social and economic context if it is to work in a real-world setting [1,2]. This includes engaging in communication about risk and how it can be managed.

Insurance has a role to play in supporting industry in managing risk. Insurance can also be a prerequisite for a business to secure investment. The aim of this thought piece is to trigger thinking and discussion within engineering and academia about what might be needed from the insurance sector for the new hydrogen technologies we are developing. This paper adopts the position that the insurance discussion should not be limited to the financial services sector but brought within engineering, industry, and academia. The rationale is to stimulate multidisciplinary dialogue to anticipate and remove hurdles and ease new innovations successfully into the marketplace at pace.

There is widespread acknowledgement of the importance of supportive insurance in the energy transition [3–5]. However, it appears accepted within the insurance industry that insurance cover for the hydrogen economy remains in its infancy [6,7]. Industry needs to have access to suitable, readily available and affordable insurance that manages their exposure to risk and risk appetite. At this stage new hydrogen systems and innovations are increasing, and novel new ideas will soon be coming to market [5]. An immature insurance market is an issue if the financial services needed are not available at the point of market readiness.

There are specific issues to be managed with hydrogen with its high flammability, embrittlement potential, and leakage hazards, amongst others [5]. Adapting an existing high temperature process for hydrogen, for example, may bring a wider range of changing risks to be assessed than are immediately apparent. For example, this might include impacts on insurance for property damage, liability for defective components, changing risks for employees or the wider public, cyber risks with new critical systems, and personal liabilities for directors and officers (D&O cover) with a summary shown in Fig. 1. New systems bring economic as well as physical risks for businesses. The type of risk might not be particular to a new system but how it materializes, or its magnitude may differ. If critical replacement components are needed through embrittlement, for example, the supply chain may be immature and unable to supply them quickly enough leading to damaging and prolonged production downtime and business interruption. With new systems there are also risks in terms of anticipated productivity failing to meet expectations whilst systems are fine-tuned. Whilst insurance cannot deliver the component or fix performance it can be designed to offer financial buffers in time of difficulties.

As well as new or changing risk profiles, the level of risk might also change over time at different stages of development and between construction, operation, and decommissioning stages. Risk management at those stages will vary. For example, pilot and demonstration phases are critical both for product development but also come with a requirement for increased financing at a time when an understanding of risk will still be forming. A closer working relationship, bringing in risk management expertise could be beneficial. Similarly, there might be specific datasets that could be gathered at those early stages of potential interest to insurers.

Understanding the risk and distinguishing between real and perceived risks in hydrogen systems is an important issue, particularly when misinformation is rife. Without this it is difficult for the risk to be quantified and insurance priced. This is difficult as with new processes at scale there is little historical data for insurers to base decisions about the likely future of that risk. In the absence of data, a too cautious approach may be adopted, leading too few or no options for insurance cover or cover that is too time consuming to obtain or costly. In our previous work we looked at the publicly accessible grey literature and web pages for major energy insurers and reinsurers [8] to look at how hydrogen risks were articulated. In looking at those documents there is a significant difference in the sophistication of discourse. The contents range from a limited non-contextualized reference to explosion in one extreme to more detailed and advanced discussion on embrittlement, supply chains and factors specific to hydrogen [9]. In terms of bespoke products, whilst there is some dialogue around insurance for hydrogen in transport and fuel cells, there is far less on the application of insurance products around developments in net zero carbon emissions particularly for the heavy industry. With some recent exceptions (e.g., Refs. [10–12]), most

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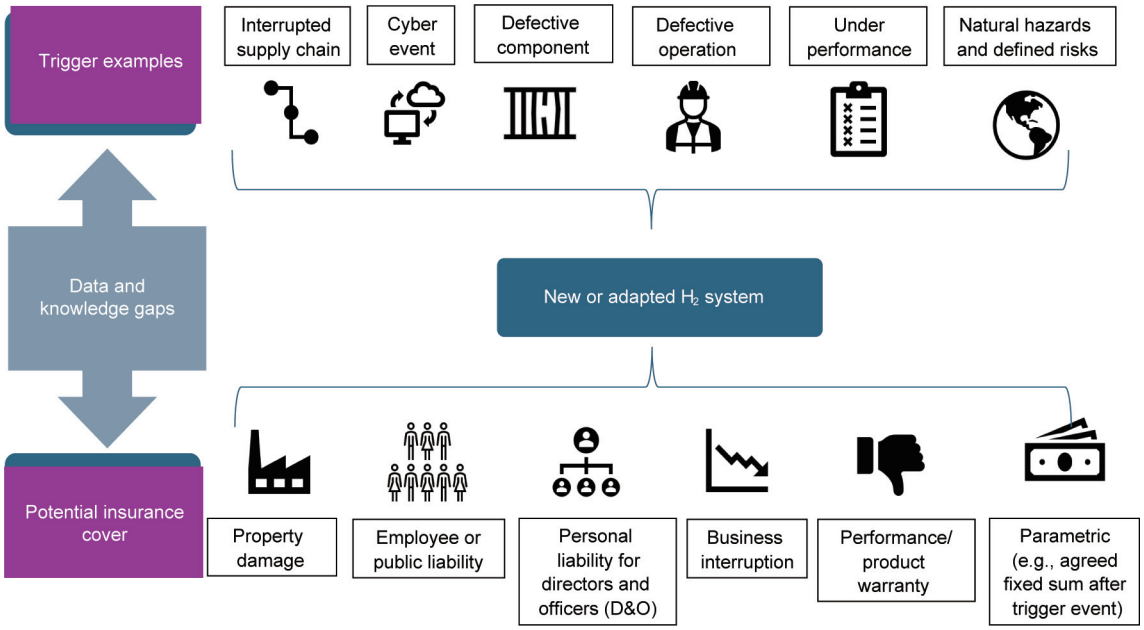

Fig. 1. Trigger and cover examples.

institutions reviewed did not have bespoke hydrogen offerings in this respect. Two did not mention hydrogen at all. It may be that there are products that are neither publicly advertised nor contained in the public facing documents identified, but overall, the documents support the view of an immature albeit evolving market [6].

The position with hydrogen might be contrasted with the more developed insurance market around more mature technologies such as solar and wind (e.g., discourse in Ref. [13]). Wind and solar insurance products have moved on and advanced from the early stages of the technical development of renewable energy as the risks became better understood, characterized, standardized, and mitigated. To put this into context, over the last decade the renewable energy insurance market has grown to 18.77 billion USD with growth expected to continue [14] and at the same time premiums have generally reduced and stabilized [13]. Utility scale solar currently represents around 32% of the renewable energy market in comparison with negligible figures for hydrogen [14,15]. The range of insurance products for wind and solar projects has become more sophisticated moving from property damage into parametric insurance (discussed below), supply chain risks, and natural catastrophes [14,16]. Better risk management practices as a result of insurance requirements have also been highlighted, for example, reducing premiums if there is a good inventory of spare parts for key component failures [13] or in the design and implementation of standards and best practice across the sector [16]. The increasing sophistication of the market does not mean there are fewer opportunities for academia, in fact the insurance sector can be one of the first to see problem areas materialize. There are still gaps in knowledge that engineering can work to fill with hot topics including characterizing the rise in solar manufacturing defects [16], securing granular data on battery energy and storage system (BESS) failures [14], insights on corrosion and fatigue in wind farms particularly as they grow in size and complexity [17], climate risks, and real-time data to address sub-sea cable failures in off shore wind [14], amongst others. It is reasonable to assume hydrogen insurance might develop along a similar pattern with basic property level coverage gradually maturing to more sophisticated and bespoke offerings powered by data and insights on new products and performance. If the insurance evolution is taking place within other sectors, hydrogen insurance may go the same way, but over what time scale? How can this process be responsibly speeded up?

A question arises as to why the insurance sector should be interested in shouldering this uncertainty. There are no easy answers to complex problems, but two broad themes emerge to answer this question. The first is climate change risk and adaptation. The insurance claims expected as a result of the climate crisis are set to increase to astronomical levels [18] and will impact on sustainability and profitability [19]. A joined-up approach and investment in carbon neutrality in the energy side of an insurer's business must be beneficial to the disaster and climate risk book of business [20], but a joined-up approach is not always achieved [21]. As insurance departments specialize, siloes can occur and an energy sector project could be considered in isolation to an insurer's exposure to wider climate risks [14]. The potential benefits of a renewable energy project as part of a portfolio or strategy in the drive against climate change might be disregarded. There are data gaps and insights that academia can help to fill.

The second theme is that hydrogen systems represent a new market for the insurance sector, and it appears there are opportunities that can still be filled in terms of interest and expertise [3]. In this respect, the insurance sector appears slow in some areas in getting to grips with hydrogen needs, with a few exceptions leading the field. This suggests missing connections between innovators needs and insurance could be fruitfully explored.

There is scope for innovation in insurance products to meet the needs of a new system, not all of it radical. Parametric insurance exists already and could be adapted or made more widely available for example [3]. Parametric insurance can provide pre-defined fixed sum pay-outs should a defined risk or event materialize (more details refer to Ref. [22]). This fixed sum is agreed in advance and may not reflect the actual cost of a physical loss but could provide a degree of certainty for both parties. It can equate to a more measurable risk for insurers and provide a fixed, prompt payment for insureds when they need it [3].

Other options are being explored, for example, around performance guarantees [23], for cover where perhaps a new system underperforms relative to an agreed standard over a defined period or product. This has value in new renewable energy systems, for example, where there is variability in performance [24–26]. For

performance and parametric insurance to be viable, there must be data to understand the risk, and academia is well-placed to develop models to support that assessment [22,23].

More radically, there are norms in insurance practice that might be ripe for change. Annual insurance cover, for example, is the norm. Should it be? Could longer term insurance offerings support both insurers and policyholders? Could this stimulate a better working relationship with mutual longer-term interests? Are there investment opportunities for insurers that could reduce climate risks—how might this trigger a re-think over how risk is viewed and shared between industry, government, and insurers? How can investments to mitigate climate change be better linked to energy related insurance? What governance hurdles might need to be resolved for this to work? These are questions and solutions that may be difficult to work through in a sector known for its cautious approach.

Overall, there is a need for more joined-up thinking and networks, not just within insurance companies but externally. There is a role for research and academia here, particularly those working on early technical readiness level (TRL) innovations. The *valley of death* concept describes the chasm that can exist between innovation and market readiness. It is argued that insurance can help bridge that chasm as insurance can manage risk, it provides security for investors, it can reduce the cost of financing and increase funding opportunities [27]. There are roles for academic researchers in the developing of academic–industry partnerships to address these issues. A summary of challenges and aims covering some of the issues explored is included in Fig. 2. A practical example which could be replicated is that initiated by the University of Edinburgh with AXA insurance in addressing insurance and artificial intelligence (AI) risks [28]. Universities also offer opportunities for Living Labs for innovation to be tested, and new ideas explored [29]. Other opportunities are bespoke courses for the energy insurance sector on future energy systems, invitations for insurer input on project advisory boards, placements and knowledge sharing activities, among others. These all sit alongside the high-quality research that academia can offer.

Reaching out and engaging with insurers could help understand how risks are perceived and calculated within the insurance sector, and explore ways of engaging and working, to assess and reduce them; insurers are experts at risk identification and quantification and have data insights that could be shared. This could support the development of the product and its market readiness. To what extent do projects consider data gathering for insurance at early TRL stages of a project for example? Could data be gathered on how a component performs over several cycles during its development; could that go some way to filling performance data gaps for insurance even as in interim measure? Insurers are grappling with an array of fast evolving technologies, could stronger and more established relationships with the academics working in these spaces help them navigate this space to support new green technologies? Further work could focus on joint interests in terms of standardization and certification of hydrogen systems [5], not only to reduce risk but so insurers can quantify, compartmentalize risks and adapt existing products for streamlined services. Academia can work alongside industry innovators, and insurers as a bridge for exchanging knowledge, building trust, and identifying and filling data gaps.

As stated, this thought leadership piece is aimed at triggering dialogue in this space and the role academics, innovators, and insurers can play in addressing the innovations needed in the climate crisis. A shared understanding, language, and routes for engagement need to be stimulated to maximize the innovation and drive the net zero transition at pace. It is hoped this is the start of further discourse.

CRediT authorship contribution statement

Elisabeth Shrimpton: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Nazmiye Balta-Ozkan:** Writing – review & editing, Resources, Project administration, Funding acquisition, Conceptualization.

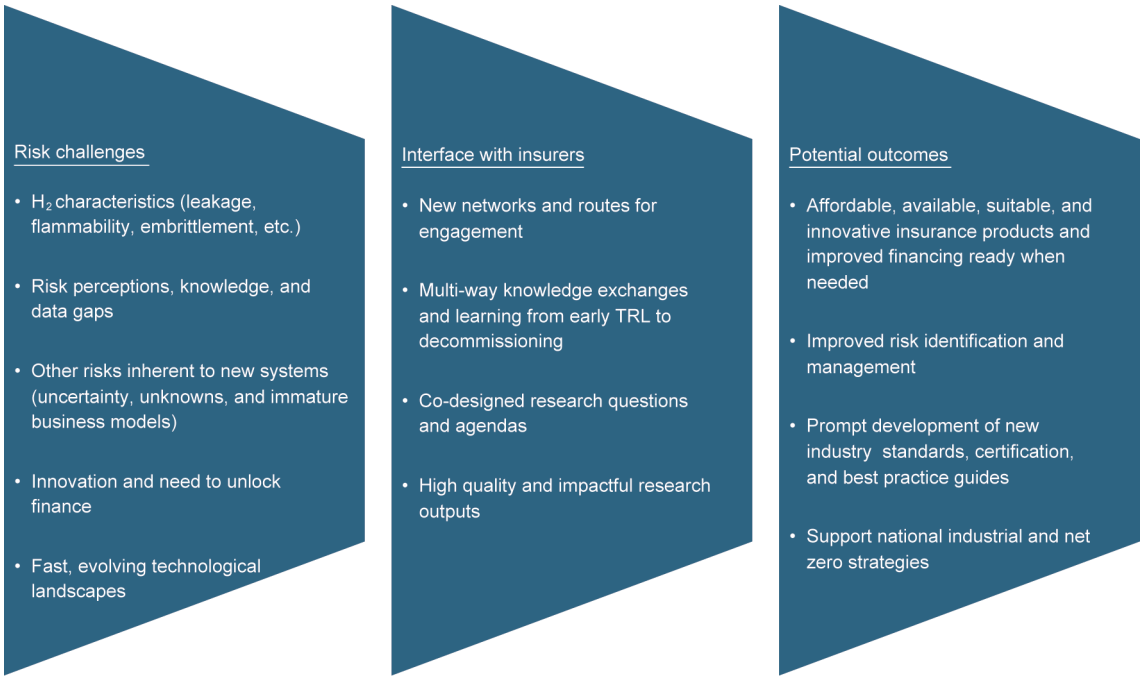

Fig. 2. Risk challenges through to potential outcomes with improved engagement with insurers.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data statement

No new data were created or analysed during this study. Data sharing is not applicable to this article.

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