Executive Summary: WhiskHy: Green Distillery Project

Supercritical
Beam Suntory
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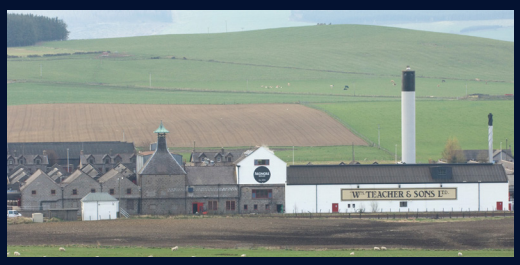
May 2021



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WhiskHy: Green Distillery Project

Rising greenhouse gas (GHG) emissions and global warming represent the biggest challenge that the world has ever faced. To counteract the risks that climate change poses, emissions must be reduced to zero and, by some estimations, turn negative. The UK government has set a target of Net Zero by 2050 and the Scottish government aims to exceed that by achieving Net Zero by 2045. Meeting these targets will require the transformation of the whisky industry, which currently accounts for approximately 1.3% of Scotland's territorial GHG emissions.

The Scotch Whisky Association has set itself the ambitious goal of Net Zero Operations for the sector by 2040, to which Beam Suntory is aligned. Cost effective solutions to deliver against these targets are required.

Challenge

Distilleries in Scotland are often located in remote areas, away from gas and electricity grids and so are reliant on delivered fossil fuel as an energy source. The use of LPG at Ardmore as a fuel source has achieved around 25% decarbonisation compared to more traditional heavy fuel oil but will never offer a zero GHG solution. Scotland, benefitting from abundant renewable resources (wave, tidal, offshore wind and onshore wind), could lead in the deployment of decentralised on-site green hydrogen production using water electrolysers. The use of hydrogen fuel as a replacement for LPG is an attractive option for decarbonising the distillery sector. However, due to electrolyser costs and efficiencies, the near-term cost difference of fuels remains a major barrier to fuel switching.

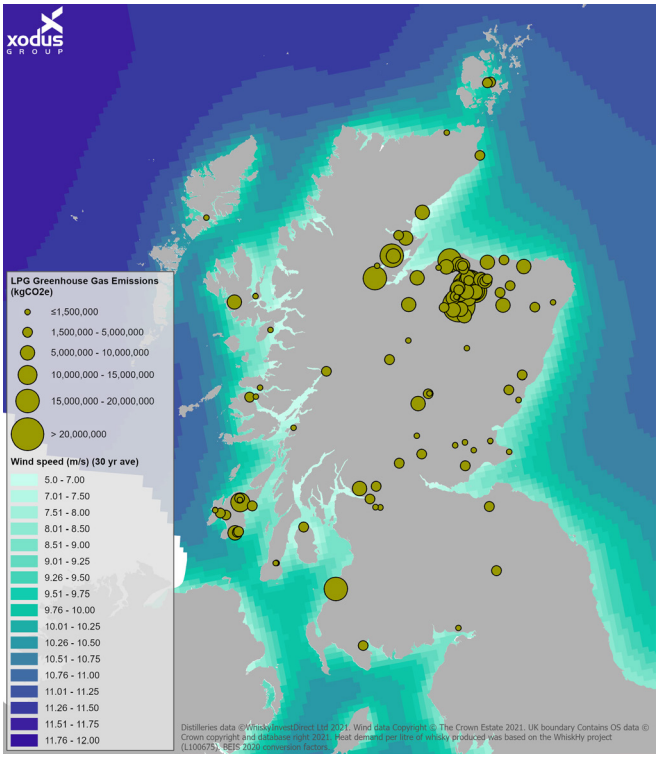

Figure 1: CO_2e footprint from LPG across the Scottish whisky distillery sector and average wind speed (m/s)

WhiskHy Solution

Project WhiskHy will demonstrate the use of low-cost green hydrogen to decarbonise the 19th largest distillery in Scotland, Ardmore. The deployment of Supercritical's UK developed electrolyser technology will be a world first. It will utilise wastewater from Ardmore Distillery and in the full solution, locally sourced renewable power. Hydrogen will be generated on-site and this will augment the distillery's existing LPG boiler via a dedicated hydrogen line.

Whisky production is an energy intensive, often remote, 24/7 operation which is heavily dependent on regular truck deliveries of non-renewable fossil fuel for combustion to produce heat. Switching from Liquified Petroleum Gas (LPG) to hydrogen would significantly reduce CO_2e at Ardmore.

Producing, storing and consuming hydrogen on-site has the potential to be cost neutral with LPG by the end of the decade and cost neutral with natural gas in the UK by 2040, both possibly earlier if carbon taxes are increased above current plans. Producing the hydrogen on-site (or in close proximity) has the benefit of removing the challenging step of transporting the light gas to the distilleries, providing greater independence and lower costs of consumed fuel.

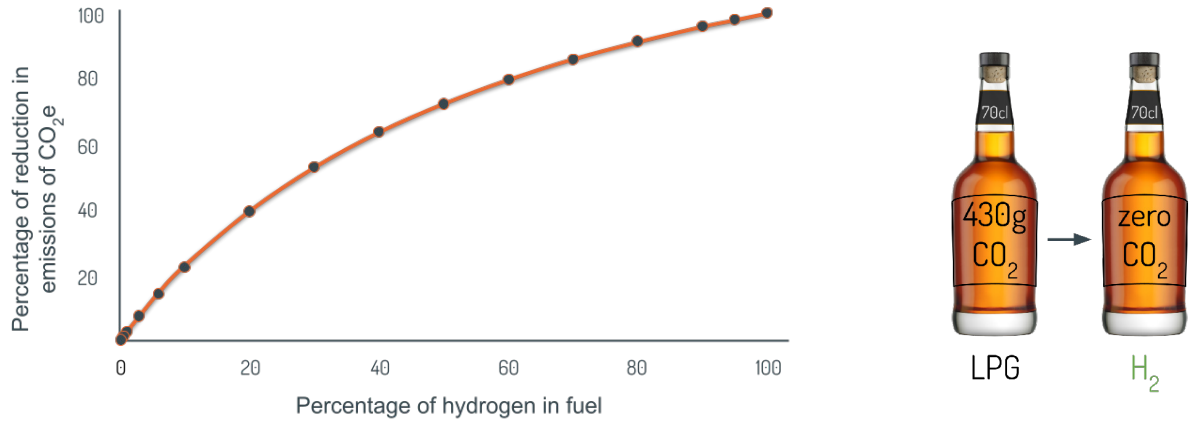

Figure 2a): Percentage reduction in CO_2e with an increase in percentage of hydrogen in the fuel mix (based on mass). b) CO_2e from a bottle of whisky using LPG and 100% green H2.

The technology advancement and pilot deployment of the world's first supercritical electrolyser at a 50 kW system at Ardmore distillery is predicted to cost a total of circa £3.6M over 3 years. The investment will accelerate this UK based low-cost hydrogen production technology to Technology Readiness Level (TRL) 5 accelerating affordable decarbonisation in response to the government's policy to achieve Net Zero by 2050, in line with the Prime Minister's Ten Point Plan.

Electrolysers require at least 9 litres of water for every kg of hydrogen produced. However, through the feasibility study, Supercritical believes that it will be possible to use the distillery wastewater as a feedstock for the electrolyser requiring no addition to the freshwater withdrawals.

With directly connected local renewable energy and on-site hydrogen production, Supercritical addresses the intermittent nature of renewable energy to ensure supply to the 24/7 distillery demand. Supercritical supplies 200 bar hydrogen and stores it in high pressure storage tanks, which inturn feed the boiler, without any need for a hydrogen compressor. Cost and safety considerations regarding hydrogen storage are site dependent but could be a deciding factor in technology choice.

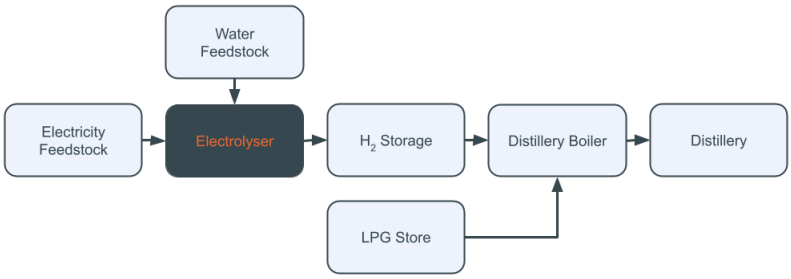

Figure 3: Diagram illustrating the basic process for the Phase 2 demonstrator.

Conclusions

Progression of WhiskHy to Phase 2 deployment is under consideration, with the project potentially kicking off in summer 2021. Here are our top take-aways:

- Switching to zero emission hydrogen as a fuel from LPG would reduce CO_2e by 615 g per litre of whisky and save on truck fuel deliveries. The proposed pilot would produce 164,100 bottles of zero CO_2 whisky per year (70 cl).
- The use of distillery wastewater as the electrolyser feedstock will be tested and prioritised if feasible, meaning valuable freshwater is not depleted for the on-site production of hydrogen.
- Producing, storing and consuming hydrogen on-site has the potential to be cost neutral with LPG by the end of the decade and cost neutral with natural gas in the UK by 2040.
- Zero emission hydrogen direct firing offers a unique opportunity to revive age-old practices that were once so core to the perceived quality of Scotland's world-renowned spirit.
- For the reference distillery, there were no technical barriers identified for the combustion of hydrogen in the existing fossil gas combustion boiler, with the existing boiler able to accommodate between 0 - 100% hydrogen with minimal modifications. This dual fuel approach minimises distillery modification costs and enables a gradual transition to hydrogen with a proportional CO_2e reduction to zero.
- Findings for hydrogen use in steam boilers are likely to transfer to multiple industries, enabled by low cost hydrogen produced via Supercritical's methodology.
- Renewable generation from wind augmented with solar, complement each other well and mitigate some of the intermittency challenges. Social concerns around increased renewable energy installations will need to be addressed.

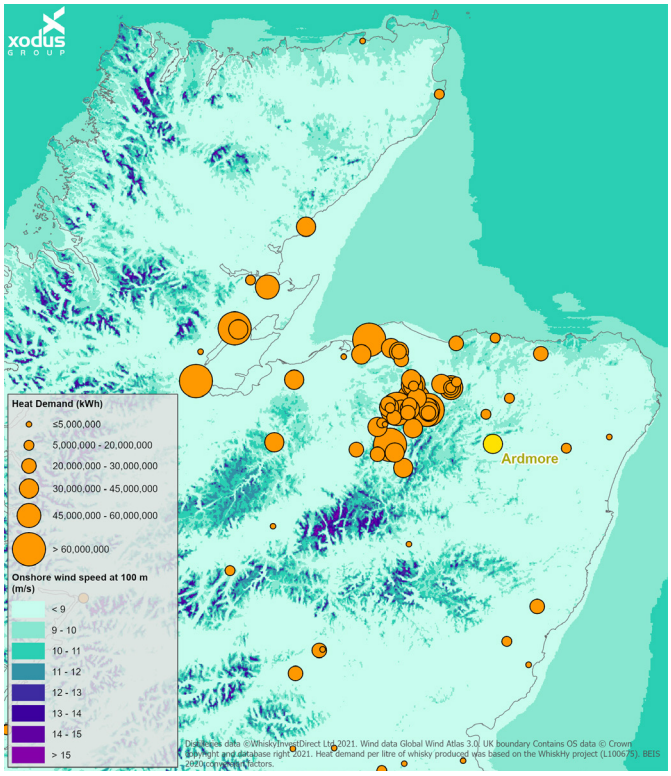

Figure 4: Northeast Scotland (inc. Ardmore) - Heat demand (kWh) and average onshore wind speed (m/s)

- Storage of hydrogen on-site, topping up with curtailed renewables is cost effective but with limits of the total amount stored due to the size and cost of pressurised hydrogen containers.
- The alkaline purge water from the electrolyser can potentially be utilised in the on-site organic wastewater treatment plant to neutralise the input water to the membrane bioreactor.
- Zero emission whisky could promote the distillery sector not only within the UK but also abroad, acting as a flagship product of the green hydrogen technology decarbonising a 'hard-to-abate' sector.

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