Response from Anglo American to the Committee on Climate Change's call for evidence on building a zero-carbon economy

7th December 2018

Introducing Anglo American

1. As one of the world's leading mining companies, one of the world's largest producers of platinum and a significant producer of copper and nickel, Anglo American has an interest in low/zero emission technologies, including battery technology. However, our focus for this submission is on the future of hydrogen and fuel cell technologies (including hydrogen for mobility, heating and storage).

2. Platinum is a vital component in hydrogen and fuel cell technology that can be used in hydrogen powered vehicles (road, rail, water) and the production of green hydrogen via electrolysis, which can also be used to make hydrogen for use in energy storage. The metal acts as a catalyst as part of the chemical process that converts hydrogen into electricity, with the only by-product being water.

3. We believe in the potential of the "Hydrogen Economy", which uses hydrogen for various applications ranging from fuel cell electric vehicles (FCEVs) and storage, to heat and power. We support the development of the hydrogen and fuel cell value chains through several initiatives, including investing in start-up companies that have developed new hydrogen and fuel cell products. This is done via an Anglo American founded venture capital fund, AP Ventures[1]. We also invest directly in hydrogen and fuel cell demonstration projects globally, including co-funding the roll-out of hydrogen refuelling stations. Furthermore, we actively participate in various industry associations.

4. We are proud to be an important industry partner in the low carbon transition. Anglo American is a founding member of the global Hydrogen Council[2], launched at the World Economic Forum's Annual Meeting in Davos in 2017. The Council now consists of 54 leading companies from across the hydrogen value chain. Its vision sees hydrogen achieving roughly 20% of the required CO2 abatement in 2050, powering more than 400 million cars and building on the existing gas infrastructure to meet roughly 10% of global demand for heat[3].

Overview

1. Reaching a zero-carbon economy will require a holistic plan to decarbonise all its component sectors, with specific references to the discrete challenges within each. This plan must then work

[1] AP Ventures: https://apventuresllp.com/
[2] Hydrogen Council vision document: "How hydrogen empowers the energy transition": http://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/media/speeches/hydrogen-empowers-energy.PDF
[3] Hydrogen Council- Scaling up: http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf

backwards to identify the timeline required for investment in new technologies and infrastructure. This is a plan that must span decades, not just Parliamentary cycles.

2. The Energy Transitions Commission (ETC) – which is led by Lord Adair Turner and includes representatives from the public and private sectors – concluded in November 2018 that sectors in heavy industry (in particular cement, steel and chemicals) and heavy-duty transport, which currently account for 10Gt (30%) of total global CO2 emissions, could account for 16Gt by 2050: a growing share of remaining emissions as the rest of the economy decarbonises[4].

3. To date, the Government's overall decarbonisation plan has focused on relatively "easy wins", for example decarbonising private passenger vehicles without specific regard to heavy vehicles. While this is not wrong per se, it has been to the detriment of long-term decarbonisation targets, because it has had the unintended consequence of redirecting R&D investment away from other areas.

4. There need to be plans put in place to decarbonise heavy industry, freight and heavy transport, maritime and aviation – and this will interlink with trends in the broader economy like heating, energy storage and generation.

5. In that context, **the deployment of new technologies like hydrogen and fuel cells must start now in order to be ready in the timeframe**.

6. A study[5] conducted in partnership between the Hydrogen Council and McKinsey concluded that hydrogen could account for almost one-fifth of total final energy consumed by 2050. The Hydrogen Council sees the potential for hydrogen to power about 10 to 15 million cars and 500,000 trucks by 2030. Overall, the study predicts that the annual demand for hydrogen could increase tenfold by 2050 to almost 80 exajoules in 2050 (equalling 18% of total final energy demand in the 2050 two-degree scenario).

7. We firmly believe there is a bright and viable future for hydrogen electrolysis and believe that the CCC underestimates the opportunity available. There are several reasons we believe this:

    a. As the cost of renewable energy comes down, along with technological developments and the efficiencies that come with scale, there is significant scope for cost reductions in electrolysis.
    b. There are also respected authorities, like Emeritus Professor Dave Elliott, who believe that electrolysis has a bright future[6], and that electrolysis can become cost competitive[7].

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[4] Energy Transitions Council "Mission Possible": http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_FullReport.pdf
[5] Hydrogen Council report: Hydrogen, Scaling up, November 2017: http://hydrogencouncil.com/hydrogen-scaling-up-new-roadmap-launches-at-cop-23/
[6] Physics World "Hydrogen: the word from the UK's Committee on Climate Change" https://physicsworld.com/a/hydrogen-the-word-from-the-uks-committee-on-climate-change/
[7] Physics World "All power to gas" https://physicsworld.com/a/all-power-to-gas/

c. Not only this, but electrolysis plants can take advantage of electricity at times of high supply and low demand (reducing the cost of hydrogen production), they can help avoid the need for constraint payments[8], and they can provide rapid response grid balancing. These services improve the economics of the overall system.

8. **We believe there should be a fuller analysis of the viability of electrolysis, to ensure opportunities aren't missed in the planning for a net zero UK**.

Question 6 (Hard-to-reduce sectors): Previous CCC analysis has identified aviation, agriculture and industry as sectors where it will be particularly hard to reduce emissions to close to zero, potentially alongside some hard-to-treat buildings. Through both low-carbon technologies and behaviour change, how can emissions be reduced to close to zero in these sectors? What risks are there that broader technological developments or social trends act to increase emissions that are hard to eliminate?

9. While we believe hydrogen will be used across the energy spectrum, from transport and electricity generation to heating and energy storage, it's worth highlighting that hydrogen has particular utility in areas that are hardest to decarbonise with batteries – for example heating, logistics, freight, industry, shipping and even planes. Supporting batteries in these areas will only limit our future ability to decarbonise them.

10. In November 2018, the ETC concluded that it will be technically possible to achieve net-zero CO2 emissions in the harder-to-abate sectors by mid-century, and that hydrogen is "highly likely to play a major, cost-effective role in the decarbonisation of several of the harder-to-abate sectors." The ETC says that achieving a net-zero-CO2-emissions economy will require an increase in global hydrogen production from 60 Mt per annum today to something like 425-650 Mt by mid-century. The ETC also highlights "enormous potential" for the cost reduction of electrolysis through economies of scale and learning curve effects, based on 50% of future hydrogen demand being met this way[9].

11. Hydrogen offers many advantages as an energy carrier. It can be made at periods of low demand and stored for long periods of time, and it can then be burned like natural gas or converted to electricity in a fuel cell. It is also light. This means it is scalable for aviation, trains, boats and heavy transport. As a gas it can be used for low-carbon heating.

12. **On aviation**, Singapore-based HES Energy Systems[10] is designing a hydrogen fuel cell electric plan, with a range between 500km to 5,000km, by taking advantage of the lightness of hydrogen, with a first flying prototype before 2025. HY4[11] is another example of this. Developed primarily by Germany's DLR Institute of Engineering Thermodynamics, it made its first flight in 2016 and has a

[8] The Telegraph "Wind farms paid £100m to switch power off" https://www.telegraph.co.uk/news/2018/01/08/wind-farms-paid-100m-switch-power/
[9] Energy Transitions Council "Mission Possible": http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_FullReport.pdf
[10] Green Car Congress, "Singapore's HES unveils plans for regional hydrogen-electric passenger aircraft: Element One": http://www.greencarcongress.com/2018/10/20181002-hes.html
[11] HY4: http://hy4.org/

range of between 750 and 1500km. Airbus has also recently joined the Hydrogen Council as a steering member, underscoring the importance of hydrogen in aviation.

13. **On industry,** hydrogen is uniquely well placed to help heavy industry decarbonise industrial processes, in a way that is simply not possible with battery electrification. For example, voestalpine in Austria[12] and HYBRIT[13] (comprised of SSAB, LKAB and Vattenfall) are currently looking at making this a reality for steel production. Cadent's £900 million HyNet project, operational by the mid-2020s, would create hydrogen and deliver it to 10 UK industrial sites.

14. **On transport and agriculture**, given approximately 36 per cent of transport-related greenhouse gas emissions come from trains, heavy goods vehicles, light vans, buses and coaches[14] (market segments that are also well supported by FCEV technology), it is clear that FCEV technology has a big role to play in decarbonising heavy transport, like the type used in agriculture. FCEVs are already being deployed in heavy transport, for example: Hyundai has agreed to supply 1,000 hydrogen fuel cell lorries to the Swiss commercial vehicle market over a five-year period, starting in 2019[15] and Nikola Motor Company' is introducing a hydrogen fuel cell-powered articulated truck unit designed specifically for the European market as soon as 2022[16]. There are already hydrogen fuel cell buses carrying passengers on the roads of cities like London and Aberdeen today.

15. However, the technology must be allowed to grow and develop. The UK currently risks its competitive advantage in hydrogen and fuel cell technologies if it makes a political decision to throw its weight exclusively behind battery technology. Looking at Government funding, £200m has been made available for battery electric vehicle (BEV) charging infrastructure (from which hydrogen refuelling is explicitly excluded), alongside a £246m Faraday Challenge for battery technology. There is only around £43m available for hydrogen technology and refuelling infrastructure.

Question 8 (Technology and Innovation): How will global deployment of low-carbon technologies drive innovation and cost reduction? Could a tighter long-term emissions target for the UK, supported by targeted innovation policies, drive significantly increased innovation in technologies to reduce or remove emissions?

16. The UK has world-leading expertise in hydrogen, through companies like ITM Power, Riversimple, Element Energy, ULEMCo, Johnson Matthey and Arcola Energy, and academic institutions like the University of Birmingham Fuel Cells Group and Manchester Fuel Cell Innovation Centre.

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[12] H2 Future Project: https://www.h2future-project.eu/
[13] HYBRIT: https://www.ssab.com/company/sustainability/sustainable-operations/hybrit
[14] DfT, Greenhouse gas emissions (ENV02), 23 November 2017: https://www.gov.uk/government/statistical-data-sets/env02-greenhouse-gas-emissions
[15] The Telegraph "Hyundai to supply 1,000 hydrogen fuel cell lorries in Switzerland": https://www.telegraph.co.uk/cars/news/hyundai-supply-1000-hydrogen-fuel-cell-lorries-switzerland/
[16] Nikola Motors: "Nikola Launches Stunning Truck for European Market": https://nikolamotor.com/press_releases/nikola-launches-stunning-truck-for-european-market-53

17. The hydrogen fuel cell is a British invention. It was first created by William Robert Grove in Swansea, in 1842. The UK still maintains world-leading expertise in the technology, but countries like Germany, China and Japan, and in the US, California, are currently looking at deploying and further developing the technology the most seriously.

18. Clearly international investment and co-operation will play an important role in advancing the technology, but the UK must not just play a "waiting game"; being proactive will put the UK in a strong position to lead the high-skilled value-added jobs that this growing industry will create.

19. Long term emissions targets are not passive. Government must recognise that investment, and in turn technological advancement, are influenced by its policy and the signals that sends to markets. Future Government policy must be oriented about long-term planning, which includes supporting cost reductions and advancements in hydrogen technology. This approach has proven successful in offshore wind, where the decline in costs would not have been possible without Government policy.

20. Other countries are ahead of the UK on this:

    a. **Germany**: The country is home to the world's largest electrolysis facility, which is converting surplus wind energy into hydrogen in Mainz. Once complete, REFYHNE, at Shell's Rhineland Refinery, will take the mantle as the world's largest electrolysis plant. The technology for this comes from the British company ITM Power[17]. Germany is also home to the world's first hydrogen fuel cell train, made by Alstom, and now carrying passengers in Lower Saxony.
    b. **Japan:** President Abe has set his sights on turning Japan into a "hydrogen-based energy society"[18], setting itself the target of having 40,000 FCEVs on the road by 2020[19] and 800,000 by 2030, alongside 80 hydrogen refuelling stations by 2022 and 900 by 2030[20].
    c. **California:** On 26th January 2018, California increased its commitment to 200 total hydrogen stations by the end of 2025[21], with USD$92m in investment[22]. The latest funding was an USD$8 million grant in November 2018[23].
    d. **China:** The Chinese government predicts that there will be one million FCEVs on its roads by 2030[24], and it will put in place 300 hydrogen refuelling stations by 2025 and 1,000 by

[17] ITM Power "World's Largest Hydrogen Electrolysis in Shell's Rhineland Refinery" http://www.itm-power.com/news-item/worlds-largest-hydrogen-electrolysis-in-shells-rhineland-refinery
[18] Financial Times "Join Japan and act now to save our planet" https://www.ft.com/content/c97b1458-ba5e-11e8-8dfd-2f1cbc7ee27c
[19] Financial Times "Japan is betting future cars will use hydrogen fuel cells" https://www.ft.com/content/98080634-a1d6-11e7-8d56-98a09be71849
[20] Reuters "Japan venture aims to build 80 hydrogen fuelling stations by 2022" https://www.reuters.com/article/us-japan-hydrogen/japan-venture-aims-to-build-80-hydrogen-fuelling-stations-by-2022-idUSKBN1GH072
[21] California Fuel Cell Partnership https://cafcp.org/blog/february-2018-hydrogen-station-update-webinar-questions-answers
[22] California Energy Commission (PDF download) https://efiling.energy.ca.gov/getdocument.aspx?tn=223453
[23] California Energy Commission https://www.energy.ca.gov/releases/2018_releases/2018-11-07_hydrogen_station_nr.html
[24] China Daily "Hydrogen on track to drive China's development" http://www.chinadaily.com.cn/a/201806/05/WS5b15ddf4a31001b82571e211_2.html

2030. This infrastructure will support 50,000 fuel cell electric cars by 2025, expanding to one million by 2030. Wuhan's city development plan also states its intention to build itself into a "hydrogen city".

21. **The UK Government must set ambitious goals for decarbonisation, but it must do so alongside a clear plan for how this is achieved across the economy, including the deployment of hydrogen.**

Question 10 (Policy): Including the role for government policy, how can the required changes be delivered to meet a net-zero target (or tightened 2050 targets) in the UK?

22. If the UK wants to become a net zero economy then it needs to adopt a long term, strategic approach. This must focus on the entire economy, including the hardest to decarbonise sectors of it, and explore how to support new technologies and industries.

23. Hydrogen will be essential for decarbonising the economy, which makes investment (both Government and private sector) in hydrogen electrolysis technology imperative.

24. **We recommend that the CCC and Government work with industry to produce an analysis of the potential cost reductions for hydrogen electrolysis.**

25. In the next few years, we will start to see a greater deployment of FCEVs, especially in heavy vehicles, but the current shortage of infrastructure will hinder their uptake. This is a "chicken and egg" situation given refuelling infrastructure will initially be lossmaking, but the lack of infrastructure will hinder demand. This means Government will initially need to play a leadership role.

26. **We recommend that the CCC and Government make the buildout of hydrogen refuelling infrastructure a priority, equal to that of BEV charging infrastructure.** This should include both match funding mechanisms for infrastructure and vehicle subsidy. In Germany this has been done through the establishment of a public private partnership (H2 Mobility[25]) to invest in hydrogen refuelling infrastructure, a model the UK should consider. It has helped overcome the "Catch 22" of supply versus demand by starting with the build out of refuelling stations.

27. **We further recommend that the CCC and Government establish a roadmap for the deployment of hydrogen vehicles and hydrogen refuelling infrastructure**. The simple act of providing industry with a trajectory and targets for hydrogen vehicle deployment will help spur infrastructure investment at little or no cost to Government.

28. Hydrogen is especially well placed to support with decarbonising heating, with a number of trials and studies currently ongoing. However, it will take time to deploy the required transmission and generation infrastructure.

[25] H2 Mobility: https://h2.live/en/h2mobility

29. **Given tight timescales, Government must be prepared to rollout hydrogen in heating in anticipation that the trials could prove successful. We recommend that the CCC and Government set out plans for phasing in hydrogen in heating, starting from the early to mid-2020s.**

30. Private sector investors are ready to play their role, but the Government needs to ensure it does not inadvertently redirect private sector funding away from hydrogen technology. **The CCC must ensure the Government has a technology neutral policy framework, not only in name but also in implementation.**