https://consult.gov.scot/energy-and-climate-change-directorate/energy-strategy-and-just-transition-plan/consultation/

Q1: What are your views on the vision set out for 2030 and 2045? Are there any changes you think should be made?

We agree with this vision statement for 2034: "Scotland will have a flourishing, climate friendly energy system that delivers affordable, resilient and clean energy supplies for Scotland's households, communities and business." However, this requires ending reliance on burning fossil fuels and other carbon-rich fuels (such as woody biomass and mixed waste) well before 2045. Furthermore, we are deeply concerned that the draft strategy relies heavily on technologies that are either unproven or come with a high risk of worsening climate change, especially CCUS (including BECCS) and large-scale hydrogen use.

Q2: What more can be done to deliver benefits from the transition to net zero for households and businesses across Scotland?

We strongly support a Just Transition strategy; however, it needs to be one that benefits workers and communities rather than rewarding polluting companies for setting up new businesses.

Q15. Our ambition for at least 5GW of hydrogen production by 2030 and 25GW by 2045 in Scotland demonstrates the potential for this market. Given the rapid evolution of this sector, what steps should be taken to maximise delivery of this ambition?

We believe that such an ambition is incompatible with the wider vision of a climate-friendly energy system delivering affordable and clean energy. Hydrogen made from fossil gas results in even greater greenhouse gas emissions than burning fossil gas directly for energy. Blue hydrogen relies on expensive and failure-prone carbon capture technology. According to the database of the Global Carbon Capture and Storage Institute , there are only two operational commercial CCS projects involving hydrogen production worldwide: the Question project in Alberta and the Valero Port Arthur Refinery in Texas. According to a study published by *Global Justice Now* the Quest project, supposed to capture 90% of CO_2, has only captured 48% of the plant's emissions, and the equivalent of 39% of the projects' total greenhouse gas emissions. Remaining emissions from the plant are equivalent to those from 1.2 million cars running on petrol. According to a 2022 report by the Institute for Energy Economics and Financial Analysis (IEEFA), the Valero Port Arthur Refinery CCS project captured just 40% of onsite carbon emissions, a figure that does not appear to include emissions from the energy required to compress and transport the captured CO_2.

Green hydrogen production via electrolysis, based on renewable electricity, is a highly energy intensive process. According to a 2019 report by the International Renewable Energy Agency (IRENA), it requires significantly more electricity than using heat pumps for space heating or cooling or electric vehicles for road transport. Although the IRENA report suggested a case for using green hydrogen in buses and trucks, a subsequent peer-reviewed study showed that hydrogen buses are indeed significantly less efficient than battery-powered electric ones. Data obtained by the European NGO *Transport & Environment* shows that lorries run on hydrogen are also less efficient than ones running on electric batteries, although shifting transport from road to rail and using electric trolley buses are both more efficient.

There are some industrial processes, where no more efficient and low-carbon options compared to hydrogen are available. However, according to a 2021 parliamentary briefing, the transport sector remains a far greater source of carbon emissions than the industry sector , with transport and buildings (i.e. heating) jointly responsible for 64% of Scotland's greenhouse gas emissions. Until both of those sectors are 100% powered with clean, renewable energy, diverting renewable electricity to less efficient green hydrogen production will inevitably delay overall greenhouse gas reductions.

Finally, we urge the Scottish Government to rule out classifying hydrogen made from biomass electricity as 'green hydrogen'. Burning wood for energy emits no less CO_2 per MWh than burning coal. Furthermore, please see our comments under Question 17 regarding the climate impacts of biomass energy. Here we would like to highlight the fact that hydrogen from biomass electricity is one of the most inefficient forms of energy generation. Biomass electricity, together with transport biofuels, has the highest land foot prints of all types of energy generation. We are not aware of any electricity-only biomass plant with a conversion efficiency of 40% or more, and most are significantly less efficient than that. According to the UK Committee on Climate Change, a further 26% of electricity is lost during conversion to climate change.

Q16. What further government action is needed to drive the pace of renewable hydrogen development in Scotland?

See comments under Q15 above. We are deeply concerned that prioritising green hydrogen production will delay decarbonisation in the heat and transport sectors, where much more efficient uses of clean renewable electricity are possible.

Q17. Do you think there are any actions required from Scottish Government to support or steer the appropriate development of bioenergy?

Bioenergy is not carbon neutral and commonly no less emissive of CO_2 than fossil fuels. The reason why CO_2 emissions from bioenergy are not accounted for in the energy and transport sectors is that they are supposed to be accounted for in the land use and forestry sector of the countries from where biomass is procured, although current UNFCCC accounting rules for that sector are far from robust. IPCC guidelines on national greenhouse gas accounting state: "*The IPCC approach of not including bioenergy emissions in the Energy Sector total should not be interpreted as a conclusion about the sustainability or carbon neutrality of bioenergy*."

It would be wrong for the Scottish Government to seek to reduce CO_2 emissions from energy generation on paper by taking advantage of what scientists have long called a "climate accounting error", ignoring the very real and widely proven climate impacts on bioenergy.

Energy from wood:
In early 2021, 500 scientists signed an open letter about the use of forests for bioenergy. They stated: "*The result of this additional wood harvest is a large initial increase in carbon emissions, creating a 'carbon debt', which increases over time as more trees are harvested for continuing bioenergy use. Regrowing trees and displacement of fossil fuels may eventually pay off this carbon debt, but regrowth takes time the world does not have to solve climate change. As numerous studies have shown, this burning of wood will increase warming for decades to centuries. That is true even when the wood replaces coal, oil or natural gas*."

A 2018 study showed that even the use of genuine logging residues for energy is incompatible with the goal of limiting global warming to 1.5 degrees.

Sawmill residues and waste wood, on the other hand, are only available in very limited quantities and entirely insufficient for meeting the current demand for wood bioenergy. The UK is dependent to more than 80% on net imports of wood and wood products. Furthermore, 65% of waste wood across the UK is burned for energy. This contradicts the principles of a circular economy since the vast majority of waste wood can be used to make wood products. By comparison, Italy uses 85% of all waste wood to make wood products. Diverting sawmill residues and waste wood from the wood products industries, especially the wood panel industry, in order to burn it for energy indirectly leads to more logging of forests, most of it overseas (given the UK's dependence on net imports), which harms biodiversity and the climate.

Liquid biofuels
The vast majority of biofuels worldwide are made from purpose-grown crops, such as rapeseed oil, palm oil, maize or sugar cane. Of the biofuels used in the UK, around 68% of ethanol is made from cereals (corn and wheat, i.e., it competes directly with cereal production for land. In 2022, 12 UK NGOs wrote to the Department for Transport, demanding on the Secretary of State to "i*mmediately halt the use of food and feed crop based feedstocks in UK biofuels. This means urgently revising the Renewable Transport Fuel Obligation to ensure no biofuels from any food crops are incentivised for as long as the global and UK food price crisis continues*". Although the 2022 spike in food prices worldwide was driven by Russia's invasion of Ukraine and extreme weather events in key cereal growing regions caused by climate change, global wheat and corn prices had already risen dramatically in 2021, worsening food insecurity amongst hundreds of millions of people. The Scottish government must not lend its support to using land to grow crops for biofuels, or for that matter biogas/biomethane at a time of growing food insecurity and hunger, especially in the global South and worsening food poverty in Scotland. Nor should biofuels and biogas/biomethane production be allowed to compete with the need to protect and restore our natural ecosystems and protect our wildlife.

According to Defra statistics, used cooking oil (UCO) accounts for 79.8% of biodiesel feedstock, almost all of it imported. While local UCO collections for biodiesel make sense, those can only meet a small fraction of current biofuel demand. Long-distance import of UCO is problematic for two reasons: Firstly, it makes no sense to ship a waste fuel across thousands of miles, generally from countries that themselves use virgin vegetable, including crude palm oil, for their own biofuel use. Secondly, UCO imports lack transparency and there have long been serious concerns over fraud in this sector, i.e. about virgin palm oil being fraudulently classified as UCO. For example, Malaysia collects 70 million litres of UCO every year but the UK and Ireland imported a total of 151 of feedstock from Malaysia that was declared to be UCO.

Biofuel production from lignocellulosic feedstock such as straw and wood has not been successful at scale anywhere in the world, and neither has biofuel production from algae.

Given the strict limits to genuine waste and residue feedstock for biofuels, competition with for land with food and with the need to conserve and restore natural ecosystems is inevitable.

Bioenergy from short rotation coppicing:
If short-rotation coppicing was adopted on a larger scale, it would compete with land needed to grow food and with the need to restore and conserve natural ecosystems, in the same way as growing energy crops for biofuels or anaerobic digestion does.

However, uptake of SRC remains extremely low, not only in Scotland but worldwide, except for short-rotation eucalyptus plantations in tropical countries, especially Brazil. According to a peer-reviewed study looking at SRC in the UK: "*Planting SRP [short-rotation plantations] is currently unappealing to the majority of farmers. It is traditionally viewed as a high risk, long-term commitment with high capital costs, poor cash flow and marginal returns. Under existing economic conditions, most farmers don't recoup the investment incurred during the establishment of the crop until seven years after planting and don't make any profit until they have sold their crop in year 10...Hence, the current situation is one of too much risk and too little reward for growers.* "

Real-world yields appear to fall far below those predicted from experiments under ideal conditions. Based on figures obtained from Vattenfall, their short-rotation willow plantations have a yield of only 5.13 odt per hectare. The lower the yields, the larger the land area required per MWh of energy. And the larger the land area required, the worse the climate impacts become once direct ad indirect climate change emissions are considered. The authors of a US study about energy from short-rotation coppicing concluded:

"*Savings from [short rotation] coppice wood at 10 tDM/ha/y for combined industrial heat and power would be zero when replacing natural gas, and 35% when replacing coal. Even at yields of 14 tDM/ha/y, these savings would rise to 25% (gas) and 70% (coal). If land would otherwise regrow forest, cellulosic ethanol even at 17 tDM/ha/y would produce no gain and would reach only 69% even if the only alternative were re-growing grass. Even in unusual cases with optimistic assumptions, bioenergy from dedicated use of land cannot be part of a sound climate stabilization strategy.*"

As set out in a World Resources Institute paper, solar PV can provide up to 100 times the amount of energy per hectare of bioenergy from energy crops.

Anaerobic digestion:
All of the adverse impacts of energy crops described above also apply to those used for biogas and biomethane production, including silage grass. The use of manure for anaerobic digestion can link energy production to factory farming, which is the cause of serious environmental harm (water pollution, dependence on imported animal feed including soya from South America where it is a key driver of deforestation), public health threats (avian influenza) and of course harm to animal welfare.

We agree with the findings set out in a report by *Feedback Global* that anaerobic digestion has a strictly limited role to play, one which should be by and large limited to the use of food waste, provided this does not harm efforts to reduce the overall volume of food waste.

We would also point out that biogas and especially biomethane production can result in high methane emissions. Such emissions can be minimised; however, they are currently entirely unregulated so there is no incentive on biogas and biomethane producers to install the best possible mitigation and control systems. According to the authors of a UK study, "*the average emission rate [from biogas production] was 15.9 kg* CH_4 *hr*$^{-1}$*, and the average loss was 3.7%*".

The authors of another recent peer-reviewed study found: "CH_4 *loss rates in biomethane and biogas supply chain exceed those in oil and natural gas...Methane emissions could be more than two times of greater than previously estimated, with the digestate handling stage responsible for the majority of methane released. To ensure the climate benefits of biomethane and biogas production, effective methane-mitigation strategies must be designed and deployed at each supply chain stage*".

Such methane leaks are a particular concern when feedstock, such as energy crops or straw, is used that would not otherwise decompose to methane.

Q18. What are the key areas for consideration that the Scottish Government should take into account in the development of a Bioenergy Action Plan?

We believe that the use of bioenergy in Scotland must be reduced, not increased. Scotland currently produces around 7% of renewable electricity and 86% of renewable heat from biomass. Biofuel use is determined by UK-wide policy, namely the Renewable Transport Fuel Obligation, however, we are deeply concerned that the Scottish Government has advocated for greater biofuel use.

The large majority of biomass burned for energy comes from burning wood which, as we have argued above, results in carbon emissions that are commonly on a par with those from burning coal. In the heat sector, biomass competes directly with heat pumps which, if powered with clean renewable electricity, result in significant greenhouse gas reductions.