A STATEMENT BY SCIENTISTS ON BECCS FROM FOREST BIOMASS
(February 26, 2021)

The undersigned scientists and economists submit this letter in response to the Department of Business, Energy and Industrial Strategy and HM Treasury consultation and call for evidence on greenhouse gas removal (GGR) options. This letter focuses exclusively on the problems associated with a specific GGR technology—bioenergy with carbon capture and storage (BECCS) as applied to the burning of wood from forests.

***

Forests lead all other ecosystems in annually removing atmospheric carbon dioxide and accumulate it for centuries in the biomass of living and dead trees and in soils. Without the growth of trees in forests and other terrestrial plants, the annual increase in atmospheric carbon dioxide would be approximately 31% greater than it currently is.

Forest bioenergy is adding increasingly large amounts of carbon dioxide to the atmosphere and reducing the capacity of forests to absorb atmospheric carbon dioxide, making it more difficult to reach net zero carbon as the stated goal for limiting global temperature. Adding carbon capture and storage (CCS) technology to a bioenergy plant does not resolve this issue. Bioenergy with Carbon Capture and Storage (BECCS) has not been demonstrated at scale, and based upon existing CCS for coal, it would remove relatively little of the life cycle emissions and add substantially to the cost of electric power generation.

BIOENERGY ACCOUNTING

Utilizing incomplete accounting systems, it has been claimed that replacing fossil fuels with burning wood is carbon neutral. It is argued that replacement trees will eventually remove the carbon dioxide that was emitted at the time of burning. These claims fail to account for foregone removal of atmospheric carbon dioxide by harvested trees, the loss of carbon and nutrients from soils and soil compaction due to harvest, and the substantial fossil fuel emissions associated with harvesting and processing wood into forms suitable to burn for commercial scale heat and electricity.

Commercial scale bioenergy electric power emits more carbon dioxide per unit of electricity than does coal and more than twice as much as natural gas fueled facilities. Even if forest regrowth were to remove the previously emitted carbon dioxide from all sources, proper carbon accounting shows it cannot do so during the short climate mitigation window of one to three decades from now. In the case of whole trees and other large diameter materials, it can take anywhere from 40 years to several centuries for forest regrowth and the associated carbon accumulation just to reach emissions levels associated with fossil fuels. Forest “thinnings” in the US southeast have been shown to generate a carbon debt that lasts for over 40 years. In a power-generating scenario that uses forestry residues that would otherwise decay and release their carbon, parity with fossil fuels is reached only after a few decades.

The ongoing growth of forests (termed Proforestation) has been demonstrated to accumulate more carbon dioxide out of the atmosphere than reforestation of the harvested areas that produced the wood fuel. In fact, newly planted forests will never accumulate as much as an older forest during the multi-decadal time periods when it is needed. We do not have decades to centuries to wait.

BIOENERGY WITH CARBON CAPTURE AND STORAGE (BECCS)

Earlier in the past decade, an argument was made that burning wood and capturing the carbon dioxide to store it in appropriate geological structures would lead to negative emissions. The idea arose when climate modelers were trying to find what needed to be done to halt further increases in atmospheric carbon dioxide and were stuck with a dilemma. Any practical phasing out of carbon dioxide emitting fossil fuels left a gap between the remaining emissions and the ability of natural systems like forests, wetlands, grasslands and soils or the oceans to remove them.

Instead of simply calling attention to the gap, the modelers identified a not yet existent technology, Bioenergy with Carbon Capture and Storage. These imagined facilities would burn wood, and the emitted carbon dioxide would be captured and stored out of the atmosphere. In this oversimplified analysis these facilities would be carbon negative.

But since burning wood for energy is not carbon neutral in relevant time frames, capturing the carbon dioxide will not make it carbon negative. In addition to the stack emissions at a bioenergy plant, there are several categories of additional emissions, the harvesting, transport, and processing emissions, and the loss of carbon from soils and forest residues following harvest. Then there is the foregone removal of carbon dioxide had the harvested trees been allowed to keep growing. These emissions cannot be captured.

CARBON DIOXIDE CAPTURE AND STORAGE (CCS) TECHNOLOGY

Any analysis about the future implementation of commercial scale BECCS must examine the Carbon Dioxide Capture and Storage (CCS) technology that is in use today.

Assumptions regarding the carbon capture potential of CCS for coal and natural gas fired electric power stations proved to be overestimated in practice because of incomplete life cycle accounting, underestimating the additional electricity needed to capture the CO_2, and the inefficiencies of the capture process itself. A major facility operating CCS at scale in the United States, Petra Nova in Texas, reported a 92.4% carbon capture before shutting down in summer of 2020, but another analysis finds it only captured 55.4% of CO_2 at the stack from coal combustion. Electricity for carbon capture requires an additional 0.5 kWh per kWh of electricity produced by the plant. The electricity was supplied by a natural gas generator, and the gas combustion emissions were released to the atmosphere. This reduced overall emissions removal to just 33.9% of total CO_2 emissions. Over a full life cycle including upstream emissions, Petra Nova's carbon capture reduced emissions by only 10.8% over 20 years. The Petra Nova facility did not include a storage component because the captured CO_2 was utilized for enhanced oil recovery, so those gas transportation and storage emissions would need to be added for a BECCS facility. Petra Nova CCS ceased operations in the summer of 2020 due to a loss of market for the recovered CO_2.

The realities of existing CCS technology demonstrate that contrary to assumptions, BECCS is unlikely to remove very much CO_2 from the lifecycle of a wood burning facility, and will forego the proforestation potential for carbon accumulation out of the atmosphere when it is most needed.

THE ECONOMICS OF BECCS

Electricity from burning wood is more expensive than most other technologies other than nuclear power and emits greenhouse gases and air pollutants, whereas less expensive zero emission alternatives like wind or solar emit none. Capturing carbon dioxide from bioenergy will utilize CCS developed for coal plants.

The Petra Nova coal plant processed just 31% of the stack emissions from a 654 MW boiler. The cost of the extra carbon capture equipment was $1 billion. Overall, the cost of the capture technology added 74% ($4200/kW) to the cost of the plant ($5700/kW). The costs would be even higher for a BECCS plant that must account for the cost of the CO_2 storage process.

In the U.K., billions of pounds have already been spent to make expensive wood burning to produce electricity feasible. Far superior alternatives to coal include zero carbon sources like the U.K.'s highly successful off-shore wind, to which battery and mechanical storage can be added at far less cost than BECCS with far greater reduction in greenhouse gas emissions.

IMPLICATIONS OF BECCS FOR UK CLIMATE POLICY

The UK Committee on Climate Change (CCC) has been clear that **before** bioenergy can play a role in decarbonization, the UK must undertake a host of reforms to its biomass accounting rules and sourcing safeguards on the supply chain side: "There are a *number of gaps* in the framework which *must be addressed* (in particular around accounting for changes in carbon stocks in existing forests in the sustainability criteria)." (*See page 17, emphasis added)*.

The modest CO_2 removal, biomass carbon loss, elevated air pollution levels, and high cost must be recognized. Clear evidence points to the fact that a large proportion of the biomass imported into the UK energy market is coming from roundwood (whole trees) that is degrading forests and their associated biodiversity. Claims of sustainable forestry for this fuel source even if true will not reduce the growth of atmospheric CO_2 stocks. This does not move the UK towards its goal of becoming zero net carbon by 2050.

Even in the scenarios depicting the most aggressive reliance on domestic UK sources, imports will continue to play a major role. The main CCC scenario still requires importing 21% of UK biomass, and one of the other scenarios presented has imports accounting for as much as 42% of total biomass supply by 2050. At the scale of demand being contemplated, bioenergy will continue to increase pressure on land and forests, along with adverse consequences for water, and biodiversity.

As the UK government considers how GGR technology will play into its commitments to achieve net zero emissions by 2050, we urge you to reject policies aimed at promoting commercial scale implementation of forest bioenergy and forest Bioenergy with Carbon Capture and Storage (BECCS).

William R. Moomaw, PhD
Professor Emeritus Tufts University
Distinguished Visiting Scientist Woodwell Climate Research Center
Fellow American Association for the Advancement of Science

Additional Signatories:

Henry W. Art, PhD
Robert F. Rosenburg Professor of Biology & Environmental Studies, Emeritus
Williams College
Williamstown, Massachusetts, USA

Andrew Balmford, Professor
University of Cambridge
Cambridge, UK

James Baxter, PhD Student
Imperial College London
London, UK

Andrew Bladon, Dr.
Research Associate
University of Cambridge
Cambridge, UK

Elizabeth Boakes, Dr.
Postdoctoral Research Associate
University College London
London, UK

Walter Bock, Professor
Columbia University
New York City, New York, USA

Mary S. Booth, Director
Policy for Policy Integrity
Pelham, Massachusetts, USA

Amy Boyd, Professor
Warren Wilson College
Asheville, North Carolina, USA

Duncan Brack, Associate Fellow
Chatham House
Royal Institute of International Affairs
London, UK

Richard B. Bradbury, Head of People
Conservation Science
RSPB Centre for Conservation Science
Honorary Research Fellow
University of Cambridge
Cambridge, UK

Tom Bradfer-Lawrence, Dr.
University of Stirling
Stirling, Scotland, UK

Robert D. Brown, Dr.
Dean (Retired) College of Natural Resources
North Carolina State University
Cary, North Carolina, USA

Cerabolini Bruno Enrico Leone, Full Professor
University of Insubria
Varese, Italy

Steve Carver, Dr.
University of Leeds
Director, Wildland Research Institute

Tiziano Gallo Cassarino, PhD
Senior Research Fellow
University College London
London, UK

Alessandro Chiarucci, Professor
Alma Mater Studiorum – University of Bologna
Bologna, Italy

Donato Chiatante, Emeritus Professor
University of Insubria
Past President, Italian Society for Forest Restoration
Italy

Eric Chivian, M.D.
Founder & Former Director
Center for Health and the Global Environment
Harvard Medical School
Shared 1985 Nobel Peace Prize for Co-Founding International Physicians for the Prevention of Nuclear War

Norman L. Christensen, Professor
Dean Emeritus
Nicholas School of the Environment
Duke University
Chapel Hill, North Carolina, USA

Kevin Cianfaglione, Dr.
PhD, EU pl.
Adjunct Professor
Université de Lorraine
Nancy, France

Ian Convery, Professor
University of Cumbria
Ambleside, Cumbria, UK

Alan Cottey, Dr.
Fellow
University of East Anglia
Norwich, UK

Gillian Davies, Senior Ecologist
BSC Group, Inc.
Visiting Scholar, Global Development & Environment Institute
Tufts University
Acton, Massachusetts, USA

John M. DeCicco, Research Professor Emeritus
University of Michigan
Ann Arbor, Michigan, USA

Alfredo Di Filippo, PhD
Associate Professor
Università della Tuscia
Viterbo, Italy

Adam Eagle
CEO
Lifescape Project
London, UK

Peter Emmrich, PhD
John Innes Foundation Fellow in Sustainable Development and Agriculture
University of East Anglia
Norwich, UK

Karlheinz Erb, Dr.
Associate Professor
Institute of Social Ecology
University of Natural Resources and Life Sciences
Vienna, Austria

Goffredo Filibeck, Dr.
Assistant Professor
Department of Agricultural and Forest Sciences
University of Tuscia
Viterbo, Italy

Jennifer Francis, Dr.
Senior Scientist
Woodwell Climate Research Center
Falmouth, Massachusetts, USA

Charlie Gardner, Dr.
Lecturer, Conservation Science
Durrell Institute of Conservation and Ecology University of Kent
Canterbury, UK

Gianluca Gianluca Piovesan, Professor
University of Tuscia
Viterbo, Italy

Jonathan Green, Dr.
Researcher
University of York
York, UK

Helmut Haberl, Dr.
a.o. Univ.-Professor
Institute of Social Ecology
University of Natural Resources and Life Sciences
Vienna, Austria

Chad T. Hanson, PhD
Ecologist
John Muir Project of Earth Island Institute
Big Bear City, California, USA

Mark E. Harmon, Professor Emeritus
Oregon State University
Corvallis, Oregon, USA

Sally Ann Hawkins, PhD
Researcher
University of Cumbria
Ambleside, UK

Sarah Hobbie, Distinguished McKnight University Professor
University of Minnesota
St. Paul, Minnesota, USA

Jan (Jeňýk) Hofmeister, PhD
Assistant
Faculty of Forestry and Wood Sciences
Czech University of Life Sciences
Prague, Czech Republic

Patricia Howard, Professor Emeritus
Wageningen University
Honorary Professor, University of Kent
Ashford, Kent, UK

Robert Howarth, Professor
Cornell University
Member, New York State Climate Action Council
Ithaca, New York, USA

Tara Hudiburg, Associate Professor
University of Idaho
Moscow, Idaho, USA

Alistair S. Jump, Professor
Global Change Ecologist
University of Stirling
Stirling, UK

Heather Keith, Dr.
Griffith University
Canberra, Australia

Xavier Lambin, Professor
University of Aberdeen
Fellowship of the Royal Society of Edinburgh
Aberdeen, UK

Beverly E. Law, Emeritus Professor
Oregon State University
American Geophysical Union Fellow
Corvallis, Oregon, USA
David Lindenmayer, Professor
The Australian National University
Canberra, Australia

James A. Lutz, Associate Professor
Utah State University
Director, Western Forest Initiative
Logan, Utah, USA

Brendan Mackey, Professor
Griffith University
Director, Griffith Climate Action Beacon
Southport, Queensland, Australia

Paul S Manos, Professor
Duke University
Durham, North Carolina, USA

David Martin, Professor
Davidson College
Davidson, North Carolina, USA

Juan F. Masello, Dr.
Principal Investigator
Justus Liebig University Giessen
Giessen, Germany

Christoph Meyer, Dr.
Lecturer in Global Ecology and Conservation
University of Salford
Manchester, UK

Antonio Montagnoli, Dr.
Researcher
University of Insubria
Varese, Italy

Robert K. Musil, Ph.D., M.P.H.
President & CEO
Rachel Carson Council
Bethesda, Maryland, USA

Howard S. Neufeld, Professor
Appalachian State University
Boone, North Carolina, USA

Eva Novotny, Dr.
Retired
University of Cambridge
Cambridge, UK

James Palmer, Dr.
Lecturer in Environmental Governance
University of Bristol
Bristol, UK

Kirsty Park, Professor
University of Stirling
Stirling, Scotland, UK

Robert K. Peet, Research Professor
University of North Carolina
Chapel Hill, North Carolina, USA

James E Perry, Emeritus Professor of Marine Science

Virginia Institute Marine Science
College of William and Mary
Past President Society Wetland Scientist
Gloucester Point, Virginia, USA

Stuart Pimm, Doris Duke Chair of Conservation
Duke University
Durham, North Carolina, USA

Sir Ghillean Prance, Professor
Former Director (Retired)
Royal Botanic Gardens, Kew
Lyme Regis, Dorset, UK

Fakhar Qureshi, Dr.
Teacher of Science
Desborough College
Maidenhead, UK

James W. Raich, Professor
Iowa State University
Ames, Iowa, USA

Peter H. Raven, President Emeritus
Missouri Botanical Garden
George Engelmann Professor of Botany Emeritus, Washington University
St. Louis, Missouri, USA

Curtis J. Richardson, John O. Blackburn Distinguished Professor
Chairman, Environmental Science and Policy Division
Director, Duke University Wetland Center
Nicholas School of the Environment
Duke University
Durham, North Carolina, USA

Brendan Rogers, Associate Scientist
Woodwell Climate Research Center
Falmouth, Massachusetts, USA

Juliette N. Rooney-Varga, Professor
Director, Climate Change Initiative
University of Massachusetts Lowell
Lowell, Massachusetts, USA

William Schlesinger, President Emeritus
Cary Institute of Ecosystem Studies
Millbrook, New York, USA

Lori S. Siegel, Senior Modeler
Climate Interactive
Hanover, New Hampshire, USA

Alison Smith, Senior Research Associate
University of Oxford
Oxford, UK

Mark Stanback, Professor of Biology
Davidson College
Davidson, North Carolina, USA

John Sterman, Jay W. Forrester Professor of Management
Massachusetts Institute of Technology
Cambridge, Massachusetts, USA

Jens-Arne Subke, Dr.
University of Stirling
Stirling, UK

Miroslav Svoboda, Professor
Czech University of Life Sciences
Prague, Czech Republic

John B. Taggart, Associate Professor Emeritus
Department of Environmental Sciences
University of North Carolina Wilmington
Wilmington, North Carolina, USA

Wayne Walker, Associate Scientist
Director, Carbon Program
Woodwell Climate Research Center
Falmouth, Massachusetts, USA

Daniel Welch, Dr.
Sustainable Consumption Institute
University of Manchester
Manchester, UK

David A. White, Professor Emeritus in
Conservation Biology
Loyola University New Orleans
New Orleans, Louisiana, USA

Philip Andrew Wookey, Professor
University of Stirling
Stirling, UK