



**CARBON DIOXIDE
REMOVAL**
MISSION

Technical Track on Biomass Carbon Removal and Storage (BiCRS)

Mapping bioresources, phase 1

Consistency check comparing Mission Innovation's Data Visualization Tool for Bioresources and the Clean Energy Ministerial Biofuture Initiative Global Biomass data accessible via the US Department of Energy's Bioenergy Knowledge Discovery Framework (KDF).

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Summary and Conclusion

The Mission Innovation (MI) Carbon Dioxide Removal (CDR) Mission, Technical Track on Biomass Carbon Dioxide Removal and Storage (BiCRS), has produced a biomass resource database for its members. In parallel, Oak Ridge National Laboratory (ORNL) developed the [International Feedstock Reporting](#) data portal—herein referred to as the CEM Biofuture-KDF data—on behalf of the Clean Energy Ministerial Biofuture Initiative (CEM Biofuture), as a specific task under Biofuture’s 2024–25 Action Plan. This work was conducted at the request of CEM Biofuture and funded by the U.S. Department of Energy in support of that initiative, and it is hosted within DOE’s [Knowledge Discovery Framework \(KDF\)](#).

The parties agreed in November 2024 to do a consistency check of the two data sets.

In both datasets, only two countries, UK and USA, were represented with sufficient data to perform a detailed comparison. For these two sets of data the conclusions are:

The CEM Biofuture-KDF and BiCRS bioresources databases are not directly comparable:

- CEM Biofuture-KDF is compiled to present a global data set from reports received to date from contributing countries based on the most recent (ranging from 2000 to 2024), citable sources for current biomass production potentials, as well as potential additional future production for nations where projected supplies are reported.
- The MI BiCRS data set is tailor-made with the objective of producing unified information on biomass resources amongst the eight member countries, based on the most recently available national data, to meet an outcome of MI CDR. This was necessary to secure a consistent data set.
- Different definitions of sub-categories in the two data sets were found for both the UK and USA.
- Uncertainty about what the data represent in the CEM Biofuture-KDF, as this depends on the source reports which sometimes identify a maximum estimated biomass volume, whereas other sources report available biomass under a set of defined technical, economic and environmental constraints.
- The CEM Biofuture-KDF data collection process continues, with updates and additions as new reports are submitted for inclusion in the data set. Some reports such as those for the UK, were based on earlier studies and included “projections to 2020” which represented estimates of what could have been available if biomass market demand had developed. This is distinct from the Mi BiCRS data set which requested each nation to report in a consistent manner on the actual biomass data for that year.

The first three points are believed to be generally valid when comparing and/or using different databases for estimation of biomass available for bioenergy and/or Carbon Dioxide Removal (CDR). Data assessment for bioresources will often be adapted to national and international reporting requirements and guidelines, as well as to the applications.

With these reflections in mind, it is likely that the two data sets will complement each other:

- CEM Biofuture-KDF gives a first order estimate of available resources in several countries
- The BiCRS approach will give consistent and comparable estimates between countries and clarity with respect to biomass resources that are available for carbon dioxide removal and/or GHG emissions reductions.

1. Background

1.1. Purpose of this note

The purpose of this note is to report a consistency check and the possibility for supplementary use of two data sets on biomass resources:

- The [International Feedstock Reporting](#) data portal for biomass resources, a part of the US Department of Energy's bioenergy [Knowledge Discovery Framework \(KDF\)](#), hereafter CEM Biofuture-KDF, developed by [Oak Ridge National Laboratory \(ORNL\)](#), on behalf of the [Clean Energy Ministerial Biofuture Platform Initiative \(CEM BF\)](#) and the [MI Integrated Biorefineries Mission \(MI IB\)](#). This is a global data set that is designed to be hosted online and serve as a living dataset with continual updates when new data becomes available and processed.
- A biomass visualization tool for biomass resources, developed by the [Mission Innovation \(MI\) Carbon Dioxide Removal \(CDR\) Mission](#), Technical Track on Biomass Carbon Dioxide Removal and Storage (BiCRS). This is data base with biomass resources for the MI BiCRS limited to members, and is hereafter called BiCRS VT.

The following sections will give the background for the consistency check, brief descriptions of the data sets, and the results.

Unfortunately, only two countries are available with sufficient data for a meaningful comparison, the United Kingdom (UK) and the United States of America (USA).

The lack of adequate and comparable information was a major finding that is detailed in the report generated by the [CEM Biofuture-Department of Energy KDF analysis](#). When seeking to compare estimates of currently available biomass and future production potentials of biomass resources under economic and sustainability constraints, researchers are faced with distinct and often incompatible or unclear definitions, classifications, units, sustainability criteria and other biomass resource assessment assumptions. Some of these incongruencies can be addressed through conversions, such as in the case of comparable units. However, other incongruencies require interventions of the authors of the biomass resource assessments, such as clarifying underlying assumptions about accessibility and cost of biomass removals, sustainability criteria, and specifics about reported values, such as whether metric tons are reported in green tons (full moisture) or oven dry metric tons (0% moisture), or something else.

1.2. Background for consistency check

CEM BF, MI IB and MI BiCRS share a need to know the availability of sustainable biomass for various applications. Thus, an exchange of information on performed, ongoing and planned work, as well as on possibilities to join efforts and resources, is mutually beneficial.

Therefore, MI BiCRS and the CEM BF teams met in November 2024 to review the purpose, structure and content of each data set. Present were members of CEM BF, MI IB and MI BiCRS, along with representatives from ORNL. An outcome of the meeting was that a consistency checks and the possibilities for supplementary use of the two data sets would be useful.

1.3. Mission Innovation Bioresources Mapping and Visualization Tool

The [Action Plan 2022 – 2026 of the Mission Innovation Carbon Dioxide Removal \(MI CDR\) Mission](#) has as its Outcome # 1: “Enhanced understanding of local and global CDR potential.”

To this end, the MI BiCRS co-lead Norway initiated a mapping process. Together with MI BiCRS member Canada a spreadsheet was developed asking the eight members BiCRS (Australia, Canada, European Union, India, Japan, Norway, UK and USA) for information on annual “production” of biomass in four main categories (agriculture, forest, aquatic and waste), each with two or more sub-categories. Data should be actual data for 2020 or a very close by year, with projections for 2050 if available. Results for five member countries were received (Canada, Japan, Norway, UK and USA).

The BiCRS VT gives biomass at three levels:

- Column D: Gross annual biomass growth/production, less natural losses
- Column E: Quantity of biomass that is inaccessible or unavailable due to conventional or competing uses excluding bioenergy
- Column F: Quantity of biomass that is inaccessible or unavailable due to other constraints and sustainability issues
- Column G: Potential for increased biomass supply- which reflect estimates of the biomass and its carbon content available for CDR, CO₂ emission reductions and other applications are then found column G = columns (D-E-F).

The results of this exercise were launched in the autumn of 2024, as a data portal with bioresources data for five of the eight member countries, that is available at [Mission Innovation Carbon Dioxide Removal Mission](#)¹ (MI CDR) web site. This exercise and launch

¹ Scroll down to Latest Missions News and then to [DATA VISUALIZATION ON BIORESOURCES FOR CDR](#)

occurred in parallel with the independent launch of the CEM Biofuture Initiative-Department of Energy KDF data portal launch, discussed below.

1.4. US Department of Energy's bioenergy Knowledge Discovery Framework (KDF)

At the Clean Energy Ministerial meetings in October of 2024, the [International Feedstock Reporting](#) data portal (CEM Biofuture-KDF) was launched as part of the US Department of Energy's [Bioenergy Knowledge Discovery Framework \(KDF\)](#) in support of the CEM/MI goals, alongside the development of the Global Biomass Resource Assessment and the report [Mapping and Synthesis of International Feedstock Supplies](#).

The intention of the KDF is to share research results in support of a data-driven bioeconomy, by ensuring access to high-quality data that supports growth of a resilient bioeconomy, including market analyses associated with a series of reports on U.S. biomass supplies, known as the Billion-Ton Reports. These data can be used to chart a course for larger investments or in support of strategically targeted scientific research.

In the [International Feedstocks data portal](#) section of the KDF, data from 62 countries were compiled into consistent classes based on the most recent reports received during a data collection period in 2024. The reports received and analyzed ranged in publication date from 2000 to 2024. These reports offer citable references for specific biomass volumes which was processed and standardized by ORNL. The reports included estimates of future potential biomass supplies for 42 of those 62 countries. The Global Biomass Resource Assessment database and the International Feedstocks data portal are designed for regular updates, with quarterly revisions planned to incorporate newly acquired data, as well as improvements and corrections to existing content in both the database and the portal.

The assessment and data processing were conducted by researchers at [the U.S. Department of Energy](#) (DOE) [Oak Ridge National Laboratory](#) (ORNL), with funding provided by both the U.S. Department of State and DOE's Bioenergy Technologies Office (BETO), and managed through BETO, on behalf of the CEM Biofuture Initiative and Mission Innovation Integrated Biorefineries Mission.

2. Results

2.1. UK

2.1.1. CEM BIOFUTURE-KDF data for the UK

Data were reported based on the European project [S2Biom](#) project, which was active 2013 – 2016 and supported the sustainable delivery of non-food biomass feedstock at local, regional, national and pan-European levels for EU28 (UK was part of EU at that time), the Western Balkans, Ukraine, Moldova and Turkey. Amongst the deliverables was the biomass potential that can be accessed via a “computerized and easy to use” toolset and respective databases.

The objectives were addressed by making use of data up to 2016 with volumes reported for 2012 and projections for 2020 and 2030.

2.1.2. BiCRS data for the UK

The UK data in the BiCRS data set are from [UK and Global Bioenergy Resource Model 2024](#). The 2020 results reflect the actual quantity of the resources used for bioenergy in the UK in 2020. For 2025 – 2050, the results reflect the potential quantity of the resources that could be available to the UK, based on the scenario the user has configured.

2.1.3. UK - comparison between CEM Biofuture-KDF and BiCRS VT

Several factors make the direct comparison between the two data sets difficult:

1. Projections in CEM Biofuture-KDF vs. actual values in BiCRS. We can use willow and miscanthus as examples, as these crops are clearly and equally defined in both data sets. From Table 1 it seems that projections made in 2017 for the year 2020 were optimistic. We believe that this helps to illustrate the difference between what biomass volumes could be grown and supplied under certain market assumptions, versus what actually occurred in the UK, 2016-2020.
2. At the time of this review, it was not obvious what the numbers from CEM Biofuture-KDF represent. This is a useful and relevant critique of the CEM Biofuture-KDF data, and one that has been identified as a priority for continued improvement. It is important to clarify what any reported biomass volume represents, using consistent terms and definitions. For example, in S2Biom, biomass is reported in terms of “technical potential”, “base potential”, and different categories of “user defined potential”. Technical potential is the absolute maximum of available biomass and with minimum technical and competing use constraints.

The CEM Biofuture-KDF reports volumes based on “base potential” and this should in essence be what is available after sustainability restrictions/considerations, whereas user defined potential may also include some other limitations. Base case should correspond to columns (D-F) in BiCRS VT. Table 1 illustrates the discrepancies identified in this comparison.

3. Different use of sub-categories. Some examples are:
 - a. Forest residues classified in hardwood, softwood and mixed wood in the CEM Biofuture-KDF, just tops and branches in BiCRS VT
 - b. BiCRS VT separate between straws, agricultural residues and a range of energy crops. CEM Biofuture-KDF operates with cereals and sunflower straw, and some categories one would expect to fall under agricultural residues, like maize stover, rice residues and sugar beet leaves, but has also an undefined category for general agriculture residue.

This again is a valid and useful critique of the CEM Biofuture-KDF data, which merely reports volumes based on the descriptions provided in source reports. The need for more consistent reporting and classification systems (such as the template that was applied by BiCRS VT), is a key issue discussed in the CEM Biofuture-KDF Report.

Table 1. Numbers for willow and miscanthus from different sources in kt , UK

	CEM Biofuture-KDF 2020*	S2Biom TECH 2020	S2Biom BASE 2020	S2Biom UD01 2020	BiCRS Vis. Tool 2020 (actual)*	BiCRS Vis. Tool 2050
Willow	1073,4	1233,8	1183,3	1108,4	16	1006
Miscanthus	471,9	545,1	520,2	497,2	83,3	1126

*This number will be corrected in the next release of CEM Biofuture-KDF 2020 to be the same as S2Biom BASE 2020

NOTE: UK is divided into 173 regional units. Most biomass categories in CEM Biofuture-KDF have 173 entries but some have multiples of this, meaning that the regional units are entered twice or more, sometimes with different numbers. This makes comparison of the databases impossible, as is the case for forest/logging residues. The same can be seen for other European countries in CEM Biofuture-KDF e.g. Denmark, Finland and Sweden. This data input error will be corrected in a future update to the CEM Biofuture-KDF data.

2.2. USA

2.2.1. KDF/CEM BIOFUTURE-KDF data for the USA

Summary data for the USA as a whole are found at the CEM Biofuture-KDF, and are based on [The 2023 Billion-Ton Report \(BT23\)](#) and are as Table ES-2 in the report, converted from short tons to metric tonnes; see also [KDF](#).

2.2.2. BiCRS VT Data for the USA

The main source of data is the [2023 Billion-Ton Report \(BT23\)](#) and its associated data portal. This source was supplemented by data provided by the United States Department of Agriculture (USDA) Forest Service, Forest Inventory and Analysis National Program, derived from the [EVALIDator web-application](#) and the [2020 Resources Planning Act \(RPA\) Assessment](#).

2.2.3. USA - comparison between KDF and BiCRS

There are several differences in definitions/uses of some sub-categories between CEM Biofuture-KDF and direct comparison will not give meaningful results (differences supplied by Anelia Milbrandt, NREL):

- The BiCRS dataset includes post-consumer wood waste, which corresponds to Municipal Solid Waste (MSW) wood in BT23, and wet organic waste (sludge and other) as in BT23. However, the BiCRS dataset does not include most of the solid waste resources derived from biomass such as paper, cardboard, etc.
- Logging residues in BT23 are considered as Tops and Branches in BiCRS.
- “Forest processing waste” in BT23 corresponds to “Processing residues (sawmills, pulp & paper)” in the BiCRS database.
- Deadwood is not included in BT23.
- BT23 includes currently used biomass resources to generate heat, power, transportation fuels, as “Agricultural”.
- The CEM Biofuture-KDF provides data on the available resource quantity under specified market conditions. This is similar to column G in the BiCRS dataset. However, these qualifications are not easily understood by someone focusing on the global data set itself.
- “Other forest waste” in CEM Biofuture-KDF= other removals and residues – unutilized wood volume from cut or otherwise killed growing stock, silvicultural operations such as precommercial thinning, or timberland clearing for other uses (i.e., cropland, pastureland, roads, urban settlement). This definition is based on the source reporting agency (U.S. Forest Service) definition and classification system.

We hope that the collaborations between researchers working on the Biofuture-KDF and the BiCRS databases will continue to provide mutual benefits and improved understanding.