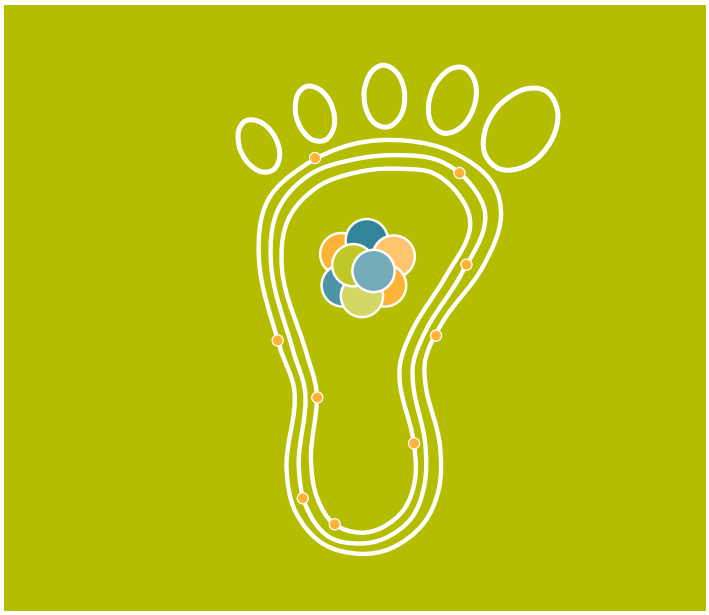
WHITE PAPER 000129

IsoFootprint

Paving the way to sustainable isotope analysis

Foreword

At Thermo Fisher Scientific™, our mission is to enable our customers to make the world healthier, cleaner and safer. The Inorganic Mass Spectrometry (IOMS) business has a long history of delivering on this mission as we continue to develop industry leading technologies that address analytical needs across a variety of segments including geosciences, environmental and food & beverage.



While our instruments are especially influential in supporting climate research, we also recognize the impact we have on the environment. If we are to improve the future trajectory of our rapidly changing climate, we must act together in creative and sustainable ways. For this reason, our team has been working on developing our own Net Zero plan. As we take this journey we want to provide the utmost transparency and accountability which is why I am pleased to share the details of our critical first step.

Chris Cascella
Sr. Director, General Manager,
Inorganic Mass Spectrometry (IOMS)

Introduction

On August 16, 2021, Inorganic Mass Spectrometry (IOMS) team at Thermo Fisher Scientific announced the IsoFootprint project, an initiative to remove all CO_2 emissions associated with the manufacture and production of all new instruments launched.

Although reduction of carbon use during instrument manufacture (through design and material improvements) and shipping is the long-term end goal for this initiative, removing carbon generated during manufacture is an important step in achieving net zero. We plan to undertake a program of carbon dioxide removal (CDR) starting this year, with the ultimate aim of permanently removing the CO_2 emissions associated with our manufacture and supply chain.

ThermoFisher SCIENTIFIC

Strategy

Setting our scope

Thermo Fisher as a corporate entity has committed to become net zero by 2050 (read more). As the Inorganic Mass Spectrometry (IOMS) team, we plan to build on this ambition through immediate action, which will encompass our Scope 3 emissions. Specifically we have decided to remove all emissions associated with our new products and their supply chain (Scope 1-3). This progressive strategy of the IOMS team is pioneering within the company and will demonstrate internally how product lifecycle emissions can be reduced and removed.

The ultimate aim of the IsoFootprint initiative is to remove the lifecycle CO_2 emissions of the entire IOMS product portfolio (Table 1). In this fiscal year, we are making the pledge to remove all CO_2 emissions associated with all new products, starting with the Thermo Scientific DELTA Q™ IRMS and the Neoma MC-ICP-MS (launched in 2020). Our target is that by 2030, 100% of the IOMS product portfolio CO_2 emissions will be included (Figure 1).

Determining our emissions

We have calculated the embodied carbon in our instrumentation using a mass scaling based on Life Cycle Assessments (LCA) of automobiles and electronic products. This technique is valid as our products share many similarities, for instance the proportion of metalwork and electronics.

The embodied carbon in a product is very closely proportional to the mass of the product (Figure 2).

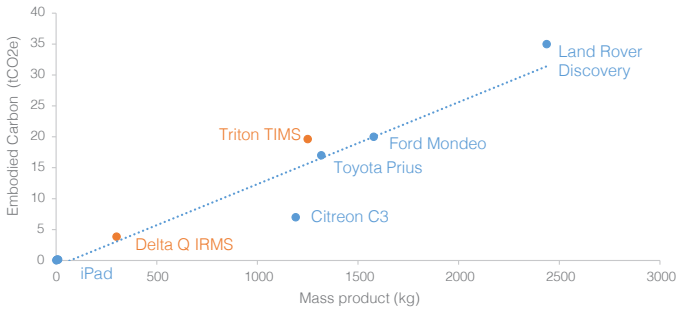


Figure 2: The embodied carbon of automobiles and electronic products as a function of product mass.[1-3] We have included an additional 25% into the embodied carbon estimates of our products (shown in orange) to account for uncertainty.

We have used the instrument mass and the established relationship (Figure 2) to estimate of the embodied carbon of our instrumentation. An additional 25% has been incorporated into the estimated embodied carbon of each product (Table 1). We are currently in the process of developing a more complete LCA for our product portfolio. Updated embodied carbon estimates will be included in future whitepapers.

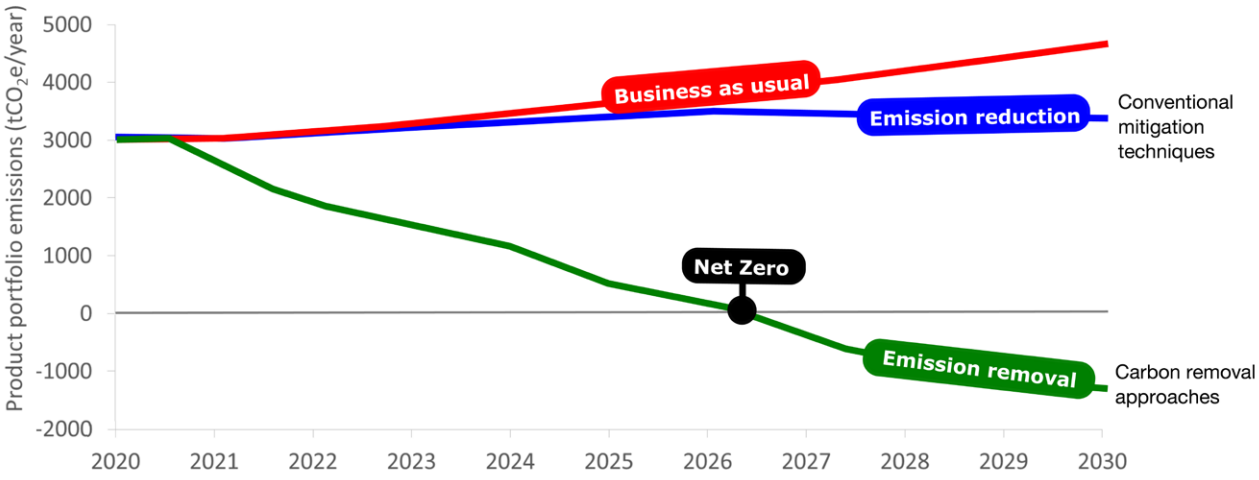


Figure 1: Pathway to net zero across the IOMS product portfolio. Conventional mitigation techniques to reduce the carbon footprint of our instruments (e.g. the choice of energy supplier, or efficiency improvements in the design of our instruments) will not be fast enough to reach net zero by 2030. Therefore, we will additionally remove the CO_2 emissions associated our product portfolio and supply chain.

Product	Instrument mass (kg)	Embodied CO_2 + 25% (tCO_2/unit)
Thermo Scientific™ Argus VI™ SVMS	700	10.5
Thermo Scientific™ DELTA Q™ IRMS	300	3.8
Thermo Scientific™ DFS™ GC-HRMS	900	13.8
Thermo Scientific™ Element GD™ GD-MS	723	10.9
Thermo Scientific™ Element™ Series HR-ICP-MS	723	10.9
Thermo Scientific™ Helix MC Plus™ MC-NG-MS	1500	23.8
Thermo Scientific™ Helix SFT™ SVMS	1300	20.5
Thermo Scientific™ Neoma™ MC-ICP-MS	1250	19.6
Thermo Scientific™ Neptune™ MC-ICP-MS	1250	19.6
Thermo Scientific™ Triton™ TIMS	1250	19.6
Thermo Scientific™ Ultra™ HR-IRMS	1800	28.8
Thermo Scientific™ 253 Plus™ 10kV IRMS	680	10.2
Thermo Scientific™ 271 Ultra™ HR-IRMS	1800	28.8

Table 1: The embodied carbon of the IOMS product portfolio.

Our intention is to remove the CO_2 emitted to the atmosphere over the product's lifecycle (from cradle-to-gate). For 2021, this would equate to removal of 500 tCO_2e covering the DELTA Q IRMS and the Neoma MC-ICP-MS but will reach 4600 tCO_2e/year by 2030 as we scale-up across the entire product portfolio.

Carbon Dioxide Removal Projects

Atmospheric CO_2 is conventionally removed by several methods[4-7]. We propose to invest in a combination of carbon dioxide removal projects in order to ensure long-term removal of CO_2 from the atmosphere, which is done in an ethical and sustainable manner. We have used the following principles to guide our choice of CDR projects:

1. Supporting true net zero carbon removal projects: we aim to support projects in which carbon is removed from the atmosphere permanently.

2. Supporting carbon removal projects that are additional: the CDR projects that we support can clearly demonstrate that they are removing CO_2 from the atmosphere that would otherwise not have been removed.

3. Supporting globally sustainable carbon removal projects: managing our emissions is a global challenge requiring international contribution. As a multi-national corporation, we do not want to jeopardize the ability of a developing country to achieve its targets by supporting cheaper CDR projects in those countries. Therefore, we supported CDR projects that were, in general, higher cost and based in developed countries.

4. Supporting new CDR technologies that will scale: we aim to support CDR projects with the greatest opportunity to scale. This means not necessarily supporting the cheapest projects, but instead providing capital to fund projects that will benefit from early investment to grow and drive down the future costs of carbon removal.

Carbon Dioxide Removal Portfolio

We constructed our CDR portfolio from a number of different CDR projects with ranging permanence of CO_2 removal:

- Short-term: natural solutions in which CO_2 is removed from the atmosphere for up to 100 years
- Medium-term: engineering solutions in which CO_2 is removed from the atmosphere for 100-1000 years
- Long-term: engineered solutions in which CO_2 is removed from the atmosphere for more than 10,000 years.

For our initial year of CO_2 procurement, 78% was from short-term natural solutions, 15% was from medium-term solutions and 7% was from long-term solutions. This balance was chosen to provide a carbon price of $80/$tCO_2e$.

Short-term CDR projects

1. Timber construction: TEWO
   Tewo is a timber company based in Norway who develop timber construction elements. They use locally-sourced Programme for the Endorsement of Forest Certification (PEFC) certified lumber to make pre-fabricated, insulated wall elements. One ton of wood absorbs 1.8 tons of CO_2 during the growth period, but the CO_2 will be released back into the atmosphere if the tree decomposes or is used for paper or energy. However, in the case of wooden building elements, carbon is stored in the building long-term, disrupting the normal carbon cycle and creating a net-negative process because sustainable forestry ensures that trees are re-planted. In Europe, buildings are regulated to have a minimum lifetime of 50 years, but in reality, the CO_2 storage is likely to be much longer.

2. Timber construction: ARE
   ARE is Norwegian company producing a wooden building elements from sustainably managed local forests. All emissions from the harvesting of the timber, transport to the production facility, through to

the production and packaging of the products were accounted for in the life cycle assessment (LCA) that Accend performed in accordance with ISO 14067 standards. The LCA has been independently audited.

3. Cellulose insulation: Ekovilla
   Ekovilla is a Finnish company developing carbon net-negative cellulose fiber insulation used in both new construction and renovation projects. The cellulose fiber insulation is made from recycled newspapers. Once installed, CO_2 is stored in durable building structures for a minimum of 50 years. Ekovilla's cellulose fiber carbon removal project has been reviewed by Carbon Plan following ISO 14044 and ISO 14064 standard, and independently audited.

Medium-term CDR projects

1. Biochar: Nordgau
   Nordgau, based in south-east Germany, produces biochar to sell to the farming industry as a soil additive. Biochar is produced from locally-sourced wood chips from PEFC certified forests. As well as locking away 2.8 tons of CO_2 for every ton of biochar buried, it greatly increases the water and nutrient retention in the soil, reducing the need for fertilizers, which are energy intensive to produce. Nordgau hold the European certificate of sustainably produced biochar (EBC). Nordgau has been issued with CORC's by the Puro marketplace in accordance with the strict Puro methodology for biochar production. The certifications have been third party verified.

Long-term CDR projects

1. Direct air capture: Carbon Engineering
   Carbon Engineering is a Canada-based Direct Air Capture (DAC) company. DAC works by pulling in atmospheric air and capturing the CO_2 through a series of chemical reactions. The pure, compressed CO_2 is safely and securely stored underground in appropriate geological reservoirs, locking the CO_2 away from the atmosphere for > 10,000 years. Carbon Engineering are in the process of engineering the first plant capable of capturing 1 megaton CO_2/year, which is expected to begin operation in 2024. To support Carbon Engineering in the deployment of large-scale DAC facilities, we are investing only a small proportion of our total product portfolio emissions (3%) in this technology to show the market interest in this exciting new technology.

2. Bio-oil: Charm Industrial
   Charm Industrial are a US-based company producing bio-oil, a liquid by-product of the same pyrolysis process that produces biochar. Bio-oil is injected underground into Class I industrial disposal wells or Class V salt caverns, locking away the CO_2 on geological timescales. Charm Industrial have demonstrated the scalability of the project and are currently operating to meet immediate demand within a 6-month timeframe.

Supplier	Location	Type	Description	Certification	Contracted durability	Contracted volume
TEWO	Norway	Timber construction	Growing sustainable forests in Norway for timber construction of durable buildings	Puro.earth independently verified by DNV GL.	50+ years	88 tCO_2e
ARE	Norway	Timber construction	Growing sustainable forests in Norway for timber construction of durable buildings	Puro.earth independently verified by DNV GL.	50+ years	150 tCO_2e
Ekovilla	Finland	Cellulose fibre insulation	Production of cellulose fibre for insulation in durable buildings	Puro.earth independently verified by DNV GL.	50+ years	144 tCO_2e
Nordgau	Germany	Biochar	Producing high-quality biochar from sustainable feedstock for use as soil additive	Puro.earth independently verified by bio. inspecta	1000 + years	75 tCO_2e
Carbon Engineering	Canada	Direct Air Capture	Removing CO_2 from air and storing it underground	Pending	10,000 years +	20 tCO_2e
Charm Industrial	US	Bio-oil	Storing carbon dioxide in deep geologic storage as carbon-containing fluid produced from biomass	Pending	10,000 years +	15 tCO_2e

Table 2: A summary of IOMS group 2021 CDR investment.

thermo scientific

Looking ahead

Beyond 2021 our aim is to explore and invest in more long-term CDR technologies (Figure 3). This clearly has to be balanced with the economics and risks associated with different CDR projects. For instance, by 2025, it is likely that there will be several operational megaton DAC facilities, making DAC a more viable option for CDR.

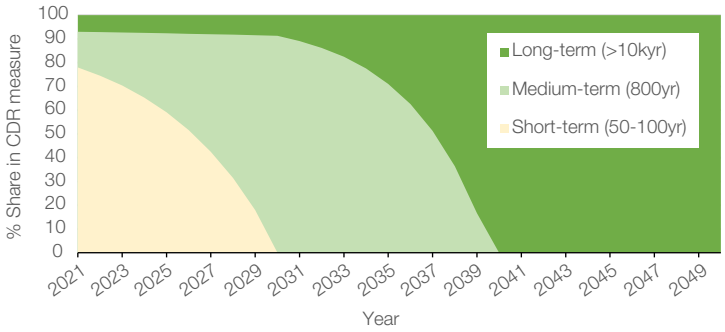


Figure 3: Projections of our investment in different CDR projects (grouped on sequestration permanence).

By 2030, we aspire to only be investing in medium and long-term CDR projects and by 2040, 100% of our carbon removal investment will be in long-term (10,000 year +) CDR projects, meaning that our instruments meet the criteria for true net zero. The carbon removal industry is a young and rapidly changing, with exciting new technologies developing quickly[8-9]. We will conduct annual reviews of the CDR market and assess our targets based on the state of the market. This will go hand-in-hand with conducting investigations into the ways to reduce the carbon footprint of each product, such that we can reduce the reliance on CDR in the future.

References

1. How bad are bananas, Mike Berners-Lee, 2010.
2. Paul Teehan and Milind Kandlikar, Comparing Embodied Greenhouse Gas Emissions of Modern Computing and Electronics Products, Environmental Science & Technology, 2013 47 (9), 3997-4003
3. http://brusselsblog.co.uk/PDF/CarFootprintM.pdf
4. David W. Keith, Geoffrey Holmes, David St. Angelo, Kenton Heidel, A Process for Capturing CO_2 from the Atmosphere, Joule, 2018, 2 (8), 1573-1594
5. Schmidt, H-P, Anca-Couce, A, Hagemann, N, et al. Pyrogenic carbon capture and storage. GCB Bioenergy. 2019; 11: 573– 591.
6. Suzette P. Galinato, Jonathan K. Yoder, David Granatstein, The economic value of biochar in crop production and carbon sequestration, Energy Policy, 2011, 38 (10), 6344-6350.
7. Institute for Carbon Removal law and policy, Why Talk About Carbon Removal? Carbon Removal Briefing Paper No. 1, 2018
8. Sahag Voskian and T. Alan Hatton, Faradaic electro-swing reactive adsorption for CO_2 capture, Energy Environ. Sci., 2019,12, 3530-3547
9. R. Sharifian, R. M. Wagterveld, I. A. Digdaya, C. Xiang and D. A. Vermaas, Electrochemical carbon dioxide capture to close the carbon cycle, Energy Environ. Sci., 2021, 14, 781-814

Find out more at **thermofisher.com/IsoFootprint**

ThermoFisher SCIENTIFIC