

Project Name Spier Mob Grazing and Rewilding Project BZ00011

Project Developer: Beyond Zero Ltd

Project approval body:

UK Carbon Code of Conduct

Project Host

Spier BD Farm Registration 2008 / 254735 / 23

Table of Contents

1. Description of Project and scope

The Spier Mob Grazing and Rewilding Project, run by Angus McIntosh, is a highly innovative regenerative agriculture project on the Spier Farm near Stellenbosch. Livestock management is undertaken through ultra-high stock density, more commonly known as "mob grazing". This farm management approach was developed by Allan Savory and others during the 1980s to mimic natural cycles of migrating grazers and their interaction with grasslands (Gordon, 2011, Holmquist, 2014). The approach employs very high densities of cattle, or other grazing livestock, in small pastures for short periods. The livestock are moved numerous times a day to new grazing areas to ensure overgrazing does not occur and only the top layers of grass are consumed. Subsequently, the grassland is left for an extended period of time to ensure complete recovery and a natural seeding cycle (Chapman, 2014, Gordon, 2011, Holmquist, 2014).

The farming techniques have been associated with considerable regeneration of the groundcover on the farm and a documented increase in soil carbon. Over the past 6 years, Angus has been experimenting with the application of biochar in some areas of the pastures has resulted in an observable improvement in pasture grass regrowth. As part of the farm's transformation, all glyphosate use has been removed from the farm and the use of plastic packaging has been significantly cut. No inorganic fertilisers are applied to fields on the farm.

Douglas Wanstall from the UKCCC, the standards and approval body and Peter Wain of Beyond Zero, the project developer visited the farming business over a period of a week in February 2023 to assess the project as to its suitability to be approved under the UKCCC project development process and to expand on the work previously carried out by Credible Carbon.

This project approval report and the accompanying project development document represents an update on previous Project Idea Notes (PINs) and enables the project to be approved and certified by the UKCCC

Scope

The project boundary has been identified and includes all farming activities, the on farm processing and vineyards. The associated hotel and leisure complex has been excluded from the scope, as has the winery as although allied are separate entities. The project has created baselines for habitat classification, soil carbon stocks and total emissions from all activities within the boundary.

The UKCCC takes an alternative approach to that taken previously and instead of separating out specific interventions, the UKCCC process measures total sequestration and total emissions, taking one from the other to obtain a total net position of all activities within the project boundary. For instance the emissions reduction through the use of food waste is represented by the reduction in total emissions, rather than using a separate methodology for its use

Since 2018 Angus has been mulching vineyards on the farm with chicken feathers during the cooler months of the year. What began as an experiment is now described as a cornerstone of his vineyard management program and the farm reports observable improvements in the vines that have been

mulched with feathers¹ and improvements in soil health with increased moisture and a darker, crumbling texture associated with elevated soil organic matter levels.



Globally chicken feathers from the poultry industry represent a significant and growing environmental problem particularly when disposed at landfill. Although chicken feathers produce methane when they decompose anaerobically at landfill, peer-reviewed studies benchmarking the emissions are currently not available. Direct emissions from the chicken feathers therefore have not been included in this project approval report, rather the sequestered carbon is picked up and accounted for in the soil samples taken. Further details of the chicken mulching can be found in Section 3

Since 2010 the Spier Estate has planted tens of thousands of indigenous trees and shrubs on pockets of land across the entire 619 Ha estate. This activity, started in 2010 and up until now has not been included in the project documentation. The Spier nursery has made a significant contribution to the success of this rewilding project through the propagation of hundreds of different indigenous tree and plant species and accurate records about numbers, species and locations of planting have been kept. Carbon sequestration from this activity has been calculated and included in the project. These new plantings have been classified as additional scrub and shelterbelts. Details of this assessment is covered in Section 3

1.1 Background

According to the Fourth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC), agriculture, forestry and other land uses (AFOLU) account for approximately 30% of the total

¹ https://www.farmerangus.co.za/2019/10/16/waste-is-a-wonderful-thing-chicken-feathers-as-soil-food/

anthropogenic GHG emissions (IPCC: Agriculture in Climate change 2007). South Africa aside, where emissions are dominated by the energy sector, the AFOLU sector is responsible for the majority of emissions in Sub-Saharan Africa and is thus increasingly relevant for mitigation options. GHG emissions in the AFOLU sector are represented by the difference between carbon sequestered through photosynthetic (forests and savannas) and non-photosynthetic processes (soils and water) (sinks), and carbon released into the atmosphere as a result of agricultural practices, deforestation, fires and forest degradation (sources).

The AFOLU sector in South Africa is a key socio-economic contributor and critical for ensuring local food security, employment, vibrant rural communities and forex earnings. It accounts for roughly 10% of national emissions mostly driven by livestock (75%), with fertiliser use (18%) and fuel combustion (7%) making up the numbers. This makes innovations as practised on the Spier Farm critically important. The lessons learned here should be scaled up and adopted more broadly and carbon finance is a key piece of the puzzle needed to fund the transition.

2. Project boundary

2.1 Spatial boundaries

The Mob Grazing and Rewilding Project involves parcels of land comprising 619 hectares under the ownership of Spier BD Farm Registration 2008 / 254735 / 23, which is also the recognised legal owner of any carbon credits generated by the project. Spier BD Farm has entered into a contract with the project developer.

The project is based a few miles inland from Cape Town, near Stellenbosch, in the heart of one of the most important wine producing and tourist areas of the country.

The whole project area has been visited by the project development and approval teams.

A full habitat classification has been undertaken with the various land parcels mapped and available to view on the project dashboard <u>Carbon Balance | Spier (arcgis.com)</u>



Figure 1: Figure 1: Location of the Spier Mob Grazing Project, Stellenbosch, South Africa

Add diagram showing project boundary and habitats

The approval report documents the project activities in 2022 and supersedes any documentation created before that time.

The next full audit will be carried out in mid 2027 and so the approval document covers the 5 years period between 2022 and 2027 with interim annual reports to be completed in the first half of each year.

The project accounting period for the mob grazing project is as follows:

- Start date: 1 January 2011 and has been audited four times subsequently by Credible Carbon
- End date: The project will run for 25 years and sequestrated carbon is expected to remain in the soil for 30 years at least. The project's baseline is reassessed ahead of each audit and is based on the lates soil carbon test results and an updated habitat map showing any changes in biomass growth

The project has sold 15,885tCO2 up to an including end-May 2020. These ARE CREDIBLE CARBON FIGURES

3. Methodologies

The Spier Mob Grazing Project has undergone the UKCCC project development and approval process to make its claims of emissions reductions and carbon dioxide removal and the ensuing net zero position.

3.1 The UKCCC standard V1.2

The various innovations introduced on the 619 hectare site farmed by Angus McIntosh has led to significant improvements in soil carbon.

The ultra-high stock densities result in large depositions of manure and urine, along with extensive trampling of the field. This trampling spreads the manure over the field, disrupts the soil surface and tramples vegetative organic matter into the soil surface. Together these factors promote increased soil carbon levels, beneficial microbial activity and grass root health (Chapman, 2014, Gordon, 2011, Holmquist, 2014, Page, 2015). Mob grazing therefore has the potential to sequester atmospheric carbon dioxide, particularly in previously degraded lands (Rush, 2008, University of Nebraska-Lincoln, 2017).

Grazing of rangelands can result in the increase or decrease of soil carbon levels, depending on the local climate, grazing history, livestock management and type of inputs provided to the fields (IPCC, 2003b, IFAD, 2009). The default values presented within the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry indicate that soil carbon stocks typically remain constant or decrease within grasslands under normal grazing practices. Soil carbon levels only increase when the land is well managed and receives an external input, such as irrigation, fertiliser or seeding of the fields (IPCC, 2003b). The management of fields according to the mob grazing principle is therefore expected to result in carbon sequestration that would otherwise not occur with typical livestock farming practices.

The Spier Mob Grazing Project includes the production of cattle, chickens and, most recently, pigs. Cattle herds are moved four times per day as per the mob grazing philosophy, while the chickens housed in their "Eggmobiles"² are moved daily. The pigs are moved to a new area every third day, although their shelter is moved daily to ensure even trampling of the area.

The pastures are irrigated and seeded with various perennial plants, including legumes to ensure



Image 1: The chickens are truly free-range.

effective nitrogen fixation, but do not receive any fertilisers or other chemicals. Farmer Angus has recently started experimenting with biochar which he has applied to various patches on the pastures.

² Full descriptions, plans and pictures can be found from the links at http://www.farmerangus.co.za/about/

All meat and eggs are sold to local retailers and restaurants. In addition to the pasturelands, a number of vineyards are located on the farm. Cattle are allowed to graze in these fields in the off-season in line with the farm management approach.

This potential for carbon sequestration associated with these practices has allowed the project to be approved by the UKCCC and issue carbon credits onto the UKCCC registry from which it trades certified carbon credits that deliver multiple UN sustainable development goals.

Feathers from a nearby chicken farm (not the laying facility on Spier) are diverted from landfill and used as a soil mulch on the vineyards. The benefits of this mulch result from the addition of carbon and calcium directly to the soil and mediating the temperature of the soil to promote microbial activity.

Subsequent carbon sequestration will be confirmed by soil analysis, but the need to take emissions from the animals into account is expected to reduce the total savings in the coming years despite the continued livestock activity, feathers and good rains.

It was originally anticipated that 2,000tCO2 would be sequestrated every 12 months between 11 August 2020 and 10 August 2023. This has proven to be a conservative figure and the actual net sequestration after all emissions is circa 5000 tonnes per year. Due to the soil sampling methodology not being completed to the full UKCCC specification, a buffer of 40% shall be applied until the next sampling phase when the UKCCC methodology will be used.



Image 2: Aerial view of the farm in 2007 before commencement of the project and again in 2017.

Can we add a more recent aerial photo?



Image 3: Organic food waste which would normally go to landfill and produce methane emissions, supplements the pig feed.

Chicken Feathers

The poultry industry is an important and fast-growing component of global food production systems. In South Africa, the industry is the largest single contributor to the agricultural sector, and provides direct and indirect employment to over 110 000 people (SA Poultry Assoc., 2020). Unfortunately the industry is also a significant contributor to global greenhouse gas emissions.

Globally increasing quantities of biomass waste from the poultry industry are recycled, including feathers which are produced in vast quantities. Chicken feathers have a high nitrogen content and as they break down will release an amount that will be taken up by the grapevines. The remaining matter will significantly contribute to soil organic matter, although some will be lost in the form of methane and the net effect will be captured by continual soil organic matter tests.

In South Africa, although there is increasing regulatory pressure to find alternative solutions, most feathers still end up in landfill. In the Western Cape, the poultry industry is concentrated in an area around Stellenbosch and Paarl and, despite the many possible routes for beneficiation, the standard disposal of landfilling causes leachate production that pollutes groundwaters and leads to carbon dioxide and methane production for long periods after deposition.

In 2018 Angus McIntosh at Spier Farm started experimenting with chicken feathers as mulch for the vineyards. What began as an experiment is now described as a cornerstone of his vineyard management program. The farm reports observable improvements in the vines that have been mulched with feathers and other vineyards have started to adopt the practice.³

The farm takes delivery of feathers on a daily basis during the cooler months of the year from April to November. In total, 350 tonnes of feathers are delivered to the farm per annum and applied around the base of the vines in the vineyards as an organic mulch.



³ https://www.farmerangus.co.za/2019/10/16/waste-is-a-wonderful-thing-chicken-feathers-as-soil-food/

The project has been planting indigenous trees and shrubs spread out in pockets over the entire Spier estate since 2010. Most of the trees and shrubs have been propagated at the Spier nursery from seeds collected on the farm and from local reserves in the Helderberg area. The result is a flourishing indigenous nursery.

The total area of the farm planted with trees and shrubs is roughly 25 hectares. The Spier Farm team is encouraging further rewilding on historically overgrazed pastures where Indigenous renosterveld vegetation is being allowed to reestablish from the existing seed bank.

These areas have been included in the carbon sequestration calculations but do pose a risk of future burning in

periods of severe drought and so careful management is advised and the project Host should take note of the UKCCC risk of loss policy to ensure mitigation strategies are in place.

The Spier nursery records the number of trees planting since 2010 which totals more that 36,000. A yearly breakdown of trees planted is show in Table 3. In addition to trees, the project has planted a wide variety of endemic shrub species from the Fynbos biome. Before the start of the project, areas now planted with trees were overgrazed pastures. Other areas planted include riparian zones along the banks of the Eerste River which had become increasingly infested with alien invasive trees and thus at risk of continued cycles of fire and landscape degradation with subsequent loss of soil carbon. There has also been extensive planting of trees and shrubs around the hotel, and public parking areas, these have been excluded from the carbon removal calculations.

An innovative approach in keeping with the ethos of Spier, is the establishment of 'nature strips' along the small roads on the farm. The

nature strips which vary in size from 4 - 16m wide, run for well over 1000m along verges which were formally barren sandy areas and are now thriving with small indigenous trees and shrubs. The rewilding of large parts of the Spier estate has resulted in increased numbers of indigenous birds and small

Image 4: The nursery on the farm propagates a wide variety of indigenous trees and shrubs from seed.

Year	No. of trees
2010	856
2011	1540
2012	1670
2013	2139
2014	1933
2015	1883
2016	3987
2017	2216
2018	6104
2019	8370
2020	2584
2021	2802

Table 1: Trees planted by year on the estate.



11

mammals that endemic to the fynbos biome. The result is an effective carbon sink comprised of a wide variety of endemic trees and shrubs.



Image 5: Nature strips along the side of a single track road in the estate with shrubs and small indigenous trees.

Methodological Approach

4. Poverty alleviation impacts:

It is clear that Angus has a strong relationship with the farm and estates team, each morning before work they all assemble for some light exercise and fun to help set the scene for the days work ahead. Spier Estate employs roughly 300 people, many from previously disadvantaged areas such as Khayalitsha. Before COVID this figure was higher but the estate was forced to retrench due to the economic downturn. Historically 50% of the carbon revenue paid to the project, has been paid out directly to the employees on the farm and this is set to continue into the future. This delivers significant positive social outcomes in accordance with SDG 1 to eliminate poverty.

Murewa's story: https://www.news24.com/citypress/business/cattle-herder-buys-his-first-house-with-carbon-credits-windfall-20201211

https://www.engineeringnews.co.za/article/farm-workers-earn-through-carbon-credit-programme-2016-12-13 https://www.spier.co.za/blog/spier-shares-cash-spoils-of-carbon-trade-with-workers

5. Emissions and sequestration Data

Internal Carbon Accounting

Internal carbon accounting refers to the practice of measuring and managing the carbon emissions of an organisation's operations and activities. It involves quantifying the amount of greenhouse gases, specifically carbon dioxide (CO2) and other carbon equivalents reported as CO2e emissions, that are produced as a result of the organisation's energy consumption, transportation, waste management, and other business processes.

Internal carbon accounting provides organisations with a comprehensive understanding of their carbon footprint and allows them to track and monitor their emissions over time. By collecting and analysing data on emissions, organizations can identify areas of high emissions and implement strategies to reduce their carbon footprint.

The process of internal carbon accounting typically involves data collection, measurement, and calculation of emissions. This includes calculating energy consumption, fuel usage, greenhouse gas emissions from transportation, and other relevant factors. The data is converted into CO2 equivalent emissions, which allows for easier comparison and aggregation of different greenhouse gases.

Internal carbon accounting not only helps organisations meet their environmental sustainability goals but also enables them to identify cost-saving opportunities. By understanding their emissions profile, organizations can implement energy efficiency measures and adopt renewable energy sources, reducing their energy consumption and associated costs.

The UK Carbon Code of Conduct recommend that corporations use an internal CO2e value of £50 per tonne, although not yet a cash cost, this should help companies to formulate investment policies, always ensuring that the carbon cost of any decision is considered alongside any financial decision.

When analysing asset purchases, it will be the case that some assets will have a high carbon Return on Investment but low financial return and others the reverse.

Moreover, internal carbon accounting can support organisations in complying with regulatory requirements related to emissions reporting. It also contributes to building a positive brand image by demonstrating a commitment to sustainability and environmental responsibility.

A UK Carbon code of conduct certified Net Zero journey must be based on emissions reductions and internal carbon sequestration (insetting). The aim of this project is to achieve Net Zero status through internal management and process change.

Carbon balance - Spier vineyard and farm

In the year to 31 March 2023 Spier vineyard and farm emitted 1416 tCO2e and sequestered -6492 tCO2e. This gives a net carbon balance of -5076 tCO2e which equates to -12.24 tCO2e per hectare. See Figure 1 and Carbon Balance | Spier (arcgis.com)



Figure 1: Overall carbon balance

Emissions and sequestration by section

Figure 2 shows Spier's 2023 emissions and sequestration by section. See more detail of key sections below.

The key emitters are the livestock (48.8%) of total emissions and fuels which represented 33.6% - see Figures 4 and 5 for more detail. The inventory (capital items from the past 10 year) and crops represented just 1.4% and 2% of the emissions respectively.

Figure 2 also shows current sequestration of the above ground habitats and biomass and the below ground (soils). It is worth noting that -5968 tCO2e sequestered by the soil represents 92% of all sequestration resulting in total sequestration dwarfing total emissions.

Figure 2: Emissions and sequestration by section



Emissions – 2023 baseline (Year to 31 Mar 2023)

Headline emissions by scope and greenhouse gas

It is interesting to note (see Figure 3) that 50% of emissions are Scope 1 and by greenhouse gas almost 75% are carbon dioxide gas (CO2). Scope 3 emissions represent 22% of emissions. These are the indirect emissions that occur upstream and downstream in the value chain and include, for example, purchased goods, transport and distribution and waste generated in operations.

	Emissions by Scope				By GHGs			
Emissions (tCO2e)	Scope 1	Scope 2	Scope 3	Outside of Scope	CO2	СН4	N2O	Total
Fuels	321.6	54.8	100.0	0.0	476.3	0.0	0.0	476.3
Materials	0.0	0.0	200.4	0.0	200.4	0.0	0.0	200.4
Inventory	0.0	0.0	19.2	0.0	19.2	0.0	0.0	19.2
Crops	29.0	0.0	0.0	0.0	21.3	0.0	7.7	29.0
Livestock	355.0	0.0	0.0	336.1	336.1	322.1	32.9	691.1
Total	705.5	54.8	319.5	336.1	1053.3	322.1	40.6	1416.0

Figure 3: Emissions by scope and greenhouse gas

Emissions by section

As shown in Figures 2 and 3 the sections with most opportunity for potential emission reduction are livestock and fuel.

Livestock

Livestock represents just under half of total emissions and Figure 4 shows that over 90% of the emissions are from the beef cattle (44.4%) and the poultry (31.8%) and pig (16.5%) purchased feed. An opportunity exists to work with suppliers to reduce these emissions. A 10% reduction in emissions from feed would reduce emissions by around 33 tCO2e.

Figure 4: Emissions from livestock



Fuel

Fuel represents 34% of total emissions and Figure 5 shows that over 80% of the emissions from fuel are from road diesel (386.4 tCO2e) and an additional 16% from electricity (74.1 tCO2e). A 10% reduction in emissions from each of road diesel and electricity would reduce emissions by around 46 tCO2e.

Figure 5: Emissions from fuel



Materials

Materials used, in the year to 31 Mar 2023, represented 14% of total emissions and Figure 6 shows that 92% of these emissions (184.8 t CO2e) are from the concreate used in repairing roads and tracks. The remainder were from a range of materials from water to a laptop as illustrated in Figure 6.

Figure 6: Emissions from materials



Sequestration – 2023 baseline (Year to 31 Mar 2023)

Understanding the opportunities to sequester more carbon starts with a baseline habitat map to identify and quantify the areas of habitat and land use but also to understand location relative to other habitats and the core vineyard. The detail and location is shown at <u>Habitat Map | Spier (arcgis.com)</u>

As shown in Figure 7 over 90% (-5968 tCO2e) of current sequestration is derived from the soil. The woodland and hedges/field margins provide an additional 322 tCO2e or 5% of the total.



Figure 7: Sequestration by habitat

Recycling waste (Figure 8) will either create zero emissions or provide offsets against emissions. In the year to 31 Mar 2023 waste recycling amounted to -15.7 tCO2e of which -14.3 tCO2e was 4 tonne of scrap metal.

Figure 8: Emissions and Offsets from Waste



6. Monitoring plan

An Annual monitoring plan is to be created for the Spier project, with full verification at year 5 where all baselines will be re tested for verification purposes and to form the baseline for the next verification cycle with the following items required for monitoring:

- 1 Any updates to Soil organic carbon determined by laboratory soil analysis
- 2 Any significant changes in likely emissions data to include scope 1,2&3.
- 3
- 4 Any changes to the numbers of livestock.
- 5 The use of aerial photographs and documented records with land owners to establish the extent of land that would have been tilled, burned and subjected to fuel wood harvesting.
- 6 Any changes to habitats through land use change or loss events

Notes:

- Any changes to activities are to be notified to the project development team
- Any loss events due to fire or other circumstances out of the project hosts control must be notified to the project team

1. References:

von Blottnitz, H., Chitaka, T. and Rodseth, C. (2018) 'South Africa beats Europe at plastics recycling, but also is a top 20 ocean polluter. Really?' Cape Town, South Africa.

DEA&DP (2017) Western Cape Integrated Waste Management Plan 2017-2022. Department of Environmental Affairs (2018) South Africa State of Waste. A report on the state of the environment. Draft report. Pretoria: Department of Environmental Affairs. Available at: www.environment.gov.za.

Macleod, M. et al. (2013) Greenhouse gas emissions from pig and chicken supply chains - A global life cycle assessment, Food and Agriculture Organization of the United Nations (FAO). Available at: http://www.fao.org/3/a-i3460e.pdf.

Rodseth, C., Notten, P. and Von Blottnitz, H. (2020) 'A revised approach for estimating informally disposed domestic waste in rural versus urban South Africa and implications for waste management', *South African Journal of Science*. Academy of Science of South Africa, 116(1–2), pp. 1–6.

Kebede, B., & Soromessa, T. (2018, February). *Allometric equations for aboveground biomass estimation of Olea europaea L. subsp. cuspidata in Mana Angetu Forest.* Retrieved from tandfonline.com: https://doi.org/10.1080/20964129.2018.1433951

CDM Executive Board . (2011, November 25). *Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities*. Retrieved from cdm.unfccc.int: https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-17-v1.pdf

SA Poultry Assoc. (2020). 2020 Industry Profile. Retrieved from https://www.sapoultry.co.za/: https://www.sapoultry.co.za/wp-content/uploads/2022/03/SAPA-INDUSTRY-PROFILE-2020.pdf

Atkins, P., & Cartwright, A. (2021, match 15). *Grootbos carbon Project*. Retrieved from Credible Carbon: https://www.crediblecarbon.com/offset-projects/grootbos/

2. Appendix A Registration agreement

3. Appendix C: Tree species planted on the farm

Acacia karoo Aloe arborescens Aloe perfoliata aloe speciosa Apodytes dimidiate – White Pear Brabejum stellatifolia - Wild Almond Buddleja saligna – False Olive Buddleja saviifolia - sagewood Calodendrum capense - Cape chestnut, Celtis Africana - White Stinkwood Cunonia capensis - red alder cypress sp-Eleadendron Croceum - saffron wood Ekebergia capensis – Cape Chestnut Ficus burtt-davyi - veld fig Grewia ocidentalis - Crossberry Gymnosporia buxiflora - Pendoring Halleria lucida – Tree Fuscia Harpephyllum caffrum – Wild plum Heeria argentea - Kliphout, melkboom, rock ash, rockwood, wild apricot Heteromopha trifoliata - Parsley Tree Ilex mitis - African holly, Cape holly Kiggelaria Africana – Wild Peach Leucadendron argenteum – Silver Tree Myrsine Africana - Cape myrtle Noltea Africana - Soap Dogwood Nuxia floribunda – Forest elder Nylandtia bispinosa Olea europaea subsp. Africana – Wild Olive Olinia Ventosa – Hard Pear Pittosporum viridiflorum - Cheesewood Podocarpus elongatus - Breede River yellowwood Podocarpus falcatus - Outenigua yellowwood Prunus Africana – Red Stinkwood Rapanea melanophloeos - Cape Beech Scotia afra - Karoo boer-bean Searsia chirindensis – Red current Searsia pendulina Searsia lancealata Searsia pallens Searsia pallens Searsia rehmanniana Sideroxylon inerme - Milkwood Syzygium cordatum – Water Berry Tarchonanthus comphoratus - Camphor bush Vipris lanceoalata - White ironwood Virgilia oroboides - Keurboom