Carbon Accounting in Ornamental Crop Production

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Overview of carbon accounting

Why:

- To ensure sustainability of the industry against the carbon metric.
- To adhere to the requirements of assurance schemes and retailers.
- To understand the impact of different elements of the production system and supply chain on carbon emissions (and removals).
- To encourage resource use efficiency and waste reduction, where possible.
- To identify where adaptations could be appropriate.

Overview of carbon accounting

How:

- Decide whether the whole operation or only part of the operation is being included in the calculations.
- Measure & monitor at appropriate levels of granularity to allow for accurate modelling of crop production, associated supply chains and inputs.
- Select carbon auditing methodology and use year-after-year to monitor change.
- Identify areas where emissions originate and take steps to reduce before offsetting the remainder (if aiming for neutrality).

Overview of carbon accounting

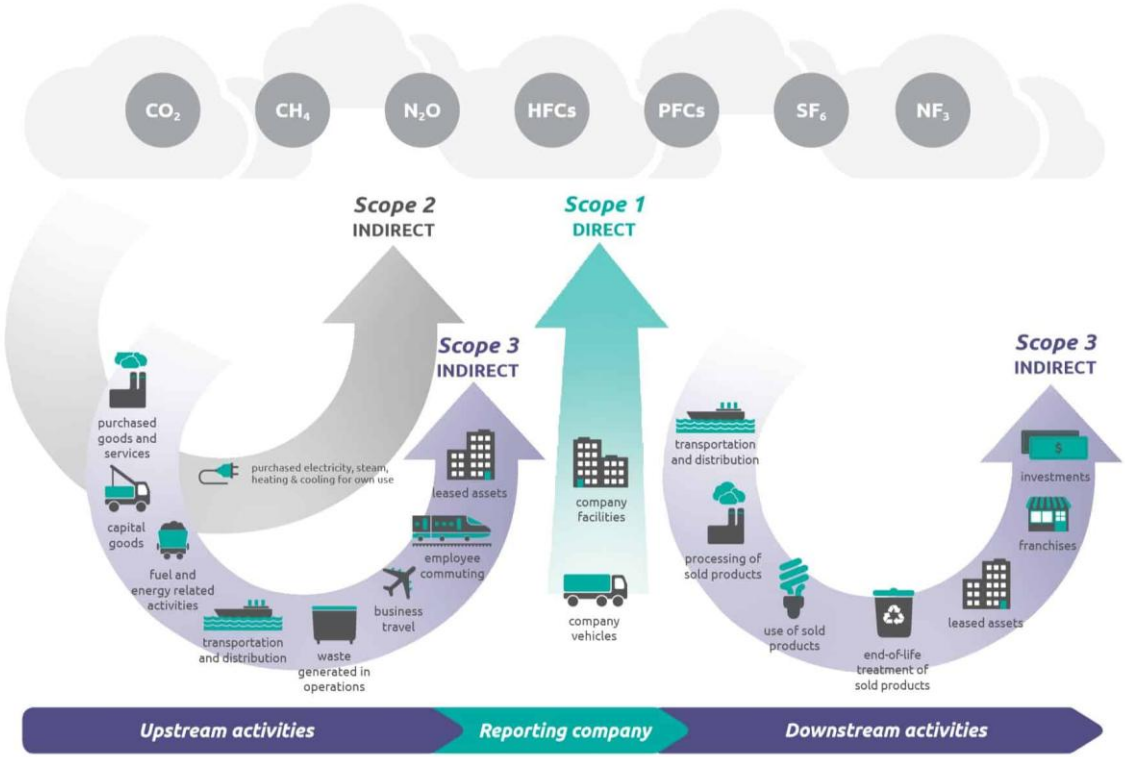
What:

- Based on LCA approaches, carbon calculators are designed to simplify calculations and make them accessible to more users.
- Calculators are built around emission factors (direct & modelled).
- Inclusions, exclusions and assumptions, in each calculator, can give the same grower different results based on the calculator used.
- Results are pegged to marketable yield.

Calculation standards and structure

Greenhouse Gas	100 Year Time Period			20 Year Time Period		
	AR4 2007	AR5 2014	AR6 2021	AR4 2007	AR5 2014	AR6 2021
CO_2	1	1	1	1	1	1
CH_4 fossil origin	25	28	29.8	72	84	82.5
CH_4 non fossil origin			27.2			80.8
N_2O	298	265	273	289	264	273

Calculation standards and structure



Methodologies & standards

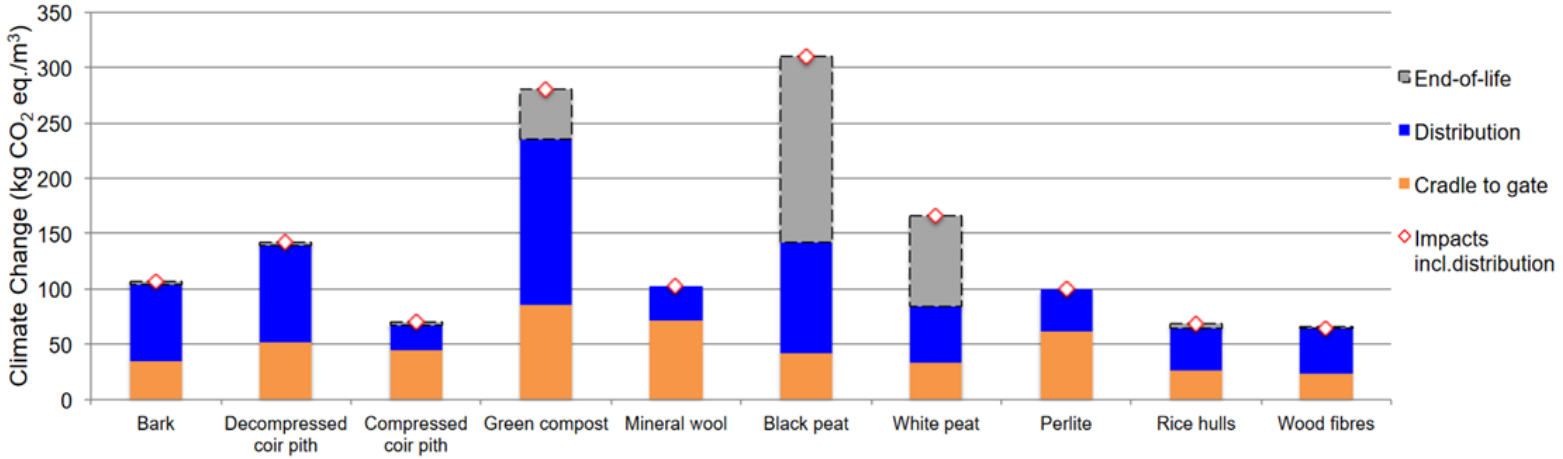
- Guidance and standards may or may not be adhered to in their entirety, and will depend on their appropriateness for specific use cases.
- There may be methodological incompatibilities between standards, which force developers to determine priorities for their user base.
- Standards and guidance commonly used include:
  - IPCC methodologies
  - GHG protocol
  - PAS2050 and PAS 2050-1
  - Various ISO's (e.g. 14040, 14044, 14064 series, 14067:2018, etc.)

Carbon audit data requirements

- Crop, resource and process specific data
- Well-defined boundaries of the calculation are needed
- Do you have enough visibility to ensure robustness
- Disparities in production practices should be segregated, e.g. different crop species, cultivars with different yield:input, alternative waste streams
- Seasonal variations for AYR cropping should be evaluated separately
- Should be based on product as supplied, i.e. include storage, pack house operations and packaging materials
- Attribute farm-level systems & processes to crop(s) appropriately

Resource specific data

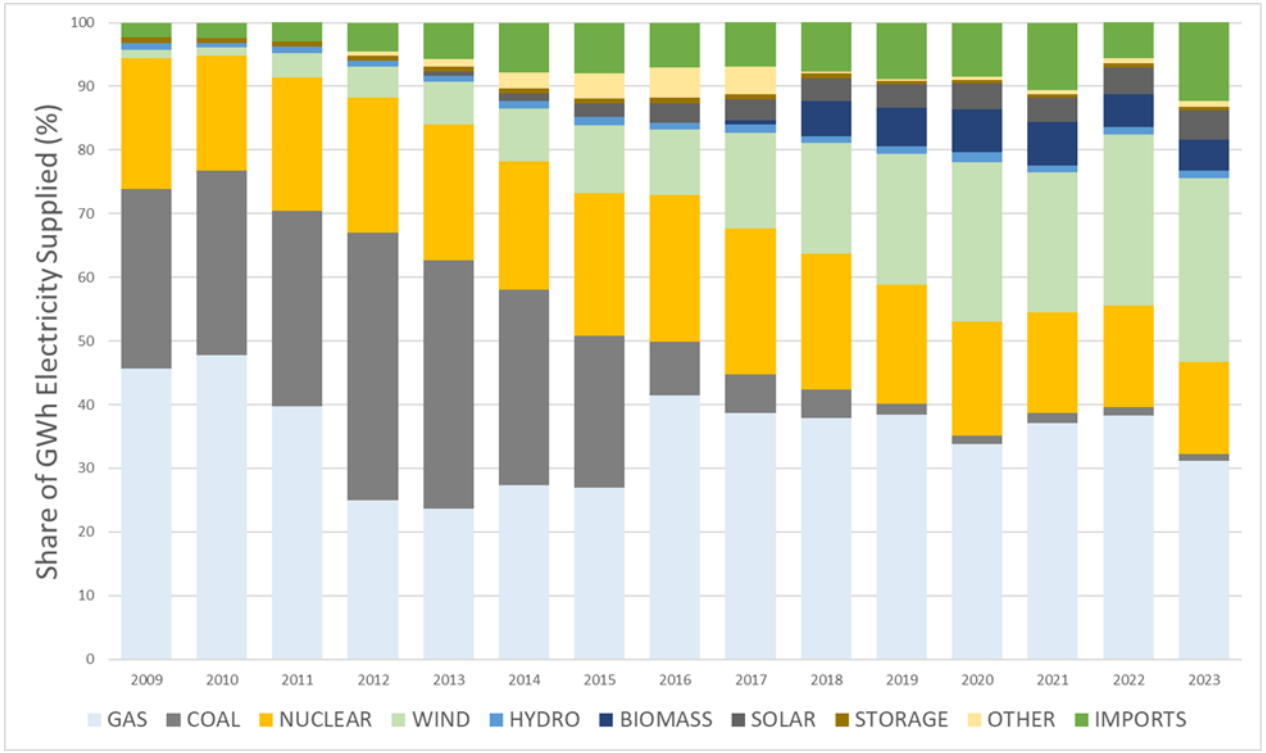
Growing media



- Above covers extraction, production & transport to Europe (i.e. embodied)
- Waste streams can be medium specific & limited for some

Source: Comparative Life Cycle Assessment of growing media

GB energy mix



Fuel Type	Carbon Intensity gCO_2/kWh
Biomass[i]	120
Coal	937
Gas (Combined Cycle)	394
Gas (Open Cycle)	651
Hydro	0
Nuclear	0
Oil	935
Other	300
Solar	0
Wind	0
Pumped Storage	0
French Imports	~ 53
Dutch Imports	~ 474
Belgium Imports	~ 179
Irish Imports	~ 458

Data Source: NESO

Mitigation potential

Main Effects			Cumulative Efflux CO_2-C (g/pot)	N_2O-N (mg/pot)	CH_4 (mg/pot)
Irrigation Effect					
Drip			74.61[w,ns]	84.98 b	16.92 a
Overhead			67.12	13.56 a	0.62 b
p:			*0.287*	*<0.001*	*0.001*
Fertilizer Placement Effect					
Dibble			71.45[ns]	98.87 b	16.75 a
Incorporated			70.28	125.70 a	0.78 b
p:			*0.709*	*0.016*	*0.001*
Interaction Effects					
Irrigation Regime		**Fertilizer Placement**			
Drip	-	Dibble	74.46[ns]	75.31 c	30.79 a
Drip	-	Incorporated	74.77	94.66 c	3.05 b
Overhead	-	Dibble	68.44	122.43 b	2.72 b
Overhead	-	Incorporated	65.80	156.74 a	-1.48 b
p:			*0.638*	*0.418*	*0.006*

[z]Boxwood (*Buxus microphylla*) was potted into one-gallon nursery containers containing a 6:1 (v:v) pinebark:sand substrate, amended with 3.0 kg m^{-3} dolomitic limestone. Cumulative efflux for nine months (July 25, 2013 - April 17, 2014) was calculated using the trapezoid rule (n=6).

[y]The same volume of irrigation [6.35 cm (0.25 in), three times daily] was delivered to all plants via either overhead impact sprinklers (1.8 m high) or individual drip stakes (Netafilm PC Spray Stakes; Double Spray; 6.6 GPH).

[x]The same fertilizer rate [76 g of Polyon 17-5-11 with blended minors (Harrell's LLC, Lakeland, FL)] was used for both dibble and incorporated fertilizer treatments.

[w]Within a column, means followed by the same letter are not significantly different ($p \leq 0.05$) according to the LSMeans statement under the Proc Mixed procedure of SAS.

[ns]Not significantly different.

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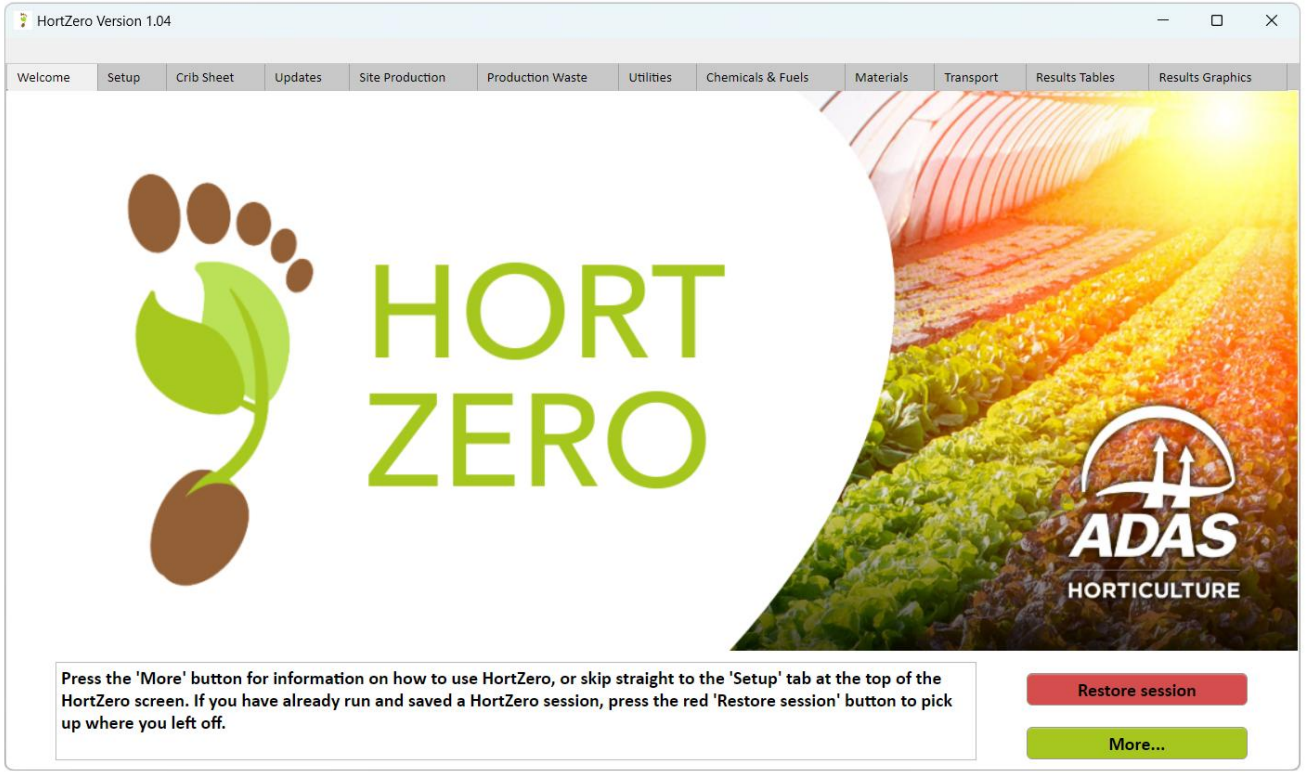
Data Source: 10.24266/0738-2898-36.2.58

Emissions reductions - cumulative impacts

- Combination of potential quick wins (e.g. fertiliser selection, recycled & recyclable materials), equipment selection and maintenance, and thorough understanding the origin of emissions and farm operations.
- Emissions can only be reduced and not eliminated.
- Reductions, where practical, should be combined with on-farm activities which capture and store carbon (explore SFI, and similar mechanisms).
- Where neutrality is the goal, consider offsetting unavoidable emissions. Review schemes under the Woodland Carbon Code (WCC) and the Peatland Carbon Code on the UK Land Carbon Registry

How to measure emissions



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