CLIMATE JUSTICE & THE BUILT SPACE:

DESIGNING LOW CARBON BUILDINGS USING INDIA-SPECIFIC TOOLS

CBALANCE

Our Associate:

Part of the Anthesis Group

BESTFOOTFORWARD
The Sustainability Consultants

Case Study

Orange County Foundation:
Royal Orange County Residential Project

Introduction: The Orange County Foundation

The Orange County Foundation is a group of individuals who have experience in eco-friendly architecture and civil construction, and focus on sustainable urban development. The foundation has developed a self-sufficient green housing project at Pashan, Pune, the first of its kind, and is developing another green housing project ‘Royal Orange County’ (ROC) at Rahatani Pune.

Introduction: Royal Orange County Project, Pune

- 8 multistoried buildings – 353 residential flats
- LEED and Griha certified project
- Eco-friendly architectural design buildings
- Low-embodied carbon construction and building materials used
- Renewable energy – Solar and Wind power energy systems installed
- Waste management – onsite biodegradable waste composting
- Wastewater management system – Rootzone Cleaning System

Sewage Treatment Plant

- Compulsion of Star-rated and energy efficient appliance use

Project Objective:

- **Internal capacity building and skill development -** *to calculate carbon footprint and assess environmental performance of their construction projects by Orange County Foundation team*

- **Life-cycle process mapping of construction project -** *to develop a toolkit for carbon ERP integration into their system*

- **Carbon Footprinting of the design and construction phase -** *ROC project*

cBalance's Approach:

➢ Training to Orange County Foundation team on the topic of *Carbon Footprint, life-cycle of a construction project, and common carbon metrics of building operations*

➢ Subscription of annual enterprise-use license for cBalance Carbon Emission Factor Database (CEFD) - *provides India-specific emission factors for emission categories of Energy, Materials, Water & Wastewater, Waste, Mobility, Services, Food & Beverages, Industrial processes & AFLOU*

cBalance’s Approach:

➢ Training to use CEFD tool - to choose eco-friendly low-carbon embodied construction materials (cement, steel bars, lime and flyash bricks etc.)

➢ Life-cycle process mapping of the ROC project and toolkit development for Carbon Footprint calculation of their future projects by their own

➢ Carbon Footprinting of the design and construction phase - ROC project

Life-cycle Assessment & Project Boundary (Organizational & Operational):

Life Cycle Stages	Activities	Major GHG Emission Sources	Organizational Boundary	Operational Boundary	Control Type	Physical Boundary
Pre Construction Operations - Design & Upstream Processes						
Design	Project site visits, Site preparation	Direct & Indirect Energy Use	Within Boundary	Scope 1, Scope 2 (Electricity), Scope 3	Own Control	Construction Site
	Ousourced Consultant	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
Construction Equipment Procurement	Raw material extraction	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
	Manufacturing of construction equipment	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
Construction Material & Chemical Procurement	Raw material extraction	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
	Material Production	Direct & Indirect Energy Use	Within Boundary	Scope 3	Own Control	Manufacturing Plant Site
Fuel Procurement	Production of fuel	Direct & Indirect Energy Use, Fugitive Emissions (FE)	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
	Distribution of fuel	Fugitive Emissions	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
	Transportation of fuel	Direct Energy Use, Fugitive Emissions	Outside Boundary	Not Applicable	Not Applicable	Not Applicable

Life-cycle Assessment & Project Boundary (Organizational & Operational):

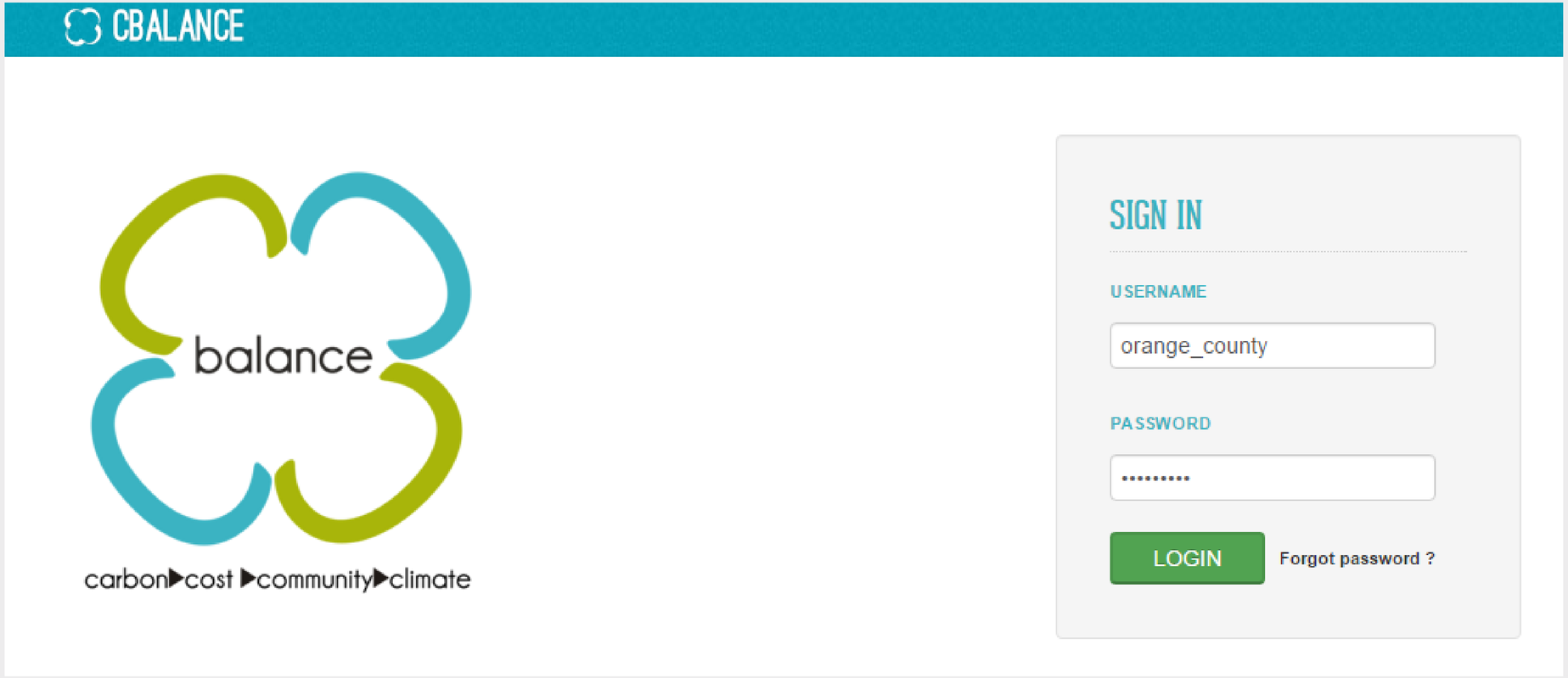
Life Cycle Stages	Activities	Major GHG Emission Sources	Organizational Boundary	Operational Boundary	Control Type	Physical Boundary
Transportation Processes						
Construction Equipment Transport	Transport of construction equipment to construction site	Direct Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
Construction Material & Chemicals Transport	Transport of construction material to construction site	Direct Energy Use	Within Boundary	Scope 3	Financial Control	Active construction site
Fuel Transport	Transport of fuel to construction site	Direct Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
During Construction Operations						
Excavation	Deforestation	Land-Use Change (AFLOU)	Within Boundary	Scope 1	Own Control	Active Construction Site
	Operation of Heavy Earth Moving Machines & other vehicles	Direct Energy Use	Within Boundary	Scope 3	Financial Control	Active Construction Site
Construction	Operations of construction equipments & facilities	Direct & Indirect Energy Use	Within Boundary	Scope 1, Scope 2 (Electricity), Scope 3	Own Control	Active Construction Site
	Operations of vehicles	Direct Energy Use	Within Boundary	Scope 1	Own Control	Active Construction Site
Maintenance	Maintenance of Heavy Earth Moving Machines & Other Vehicles	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable

Life-cycle Assessment & Project Boundary (Organizational & Operational):

Life Cycle Stages	Activities	Major GHG Emission Sources	Organizational Boundary	Operational Boundary	Control Type	Physical Boundary
Post Construction Operations						
Waste Removal	Removal through vehicles	Direct Energy Use	Within Boundary	Scope 1	Own Control	Active Construction Site
Waste Recycling	Solid waste recycling	Direct & Indirect Energy Use	Within Boundary	Scope 1, Scope 2 (Electricity), Scope 3	Own Control	Active Construction Site
Transfer of Construction Equipments	Transfer through vehicles	Direct Energy Emissions	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
Building Use Phase						
Operation & Maintenance	Maintenance of constructed building	Direct & Indirect Energy Use	Within Boundary	Scope 1, Scope 2 (Electricity), Scope 3	Own Control	Active Operational Building
Waste Management	Waste generation and disposal	Direct & Indirect Energy Use	Within Boundary	Scope 1, Scope 2 (Electricity), Scope 3	Own Control	Active Operational Building
Abandoning						
Demolishing	Demolishing the building after use	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
Waste Removal	Removal through vehicles	Direct Energy Emissions	Outside Boundary	Not Applicable	Not Applicable	Not Applicable
Waste Recycling	Solid waste recycling	Direct & Indirect Energy Use	Outside Boundary	Not Applicable	Not Applicable	Not Applicable

Carbon Emission Factor Database (CEFD) Tool:

http://cefd.cbalance.in/accounts/login/



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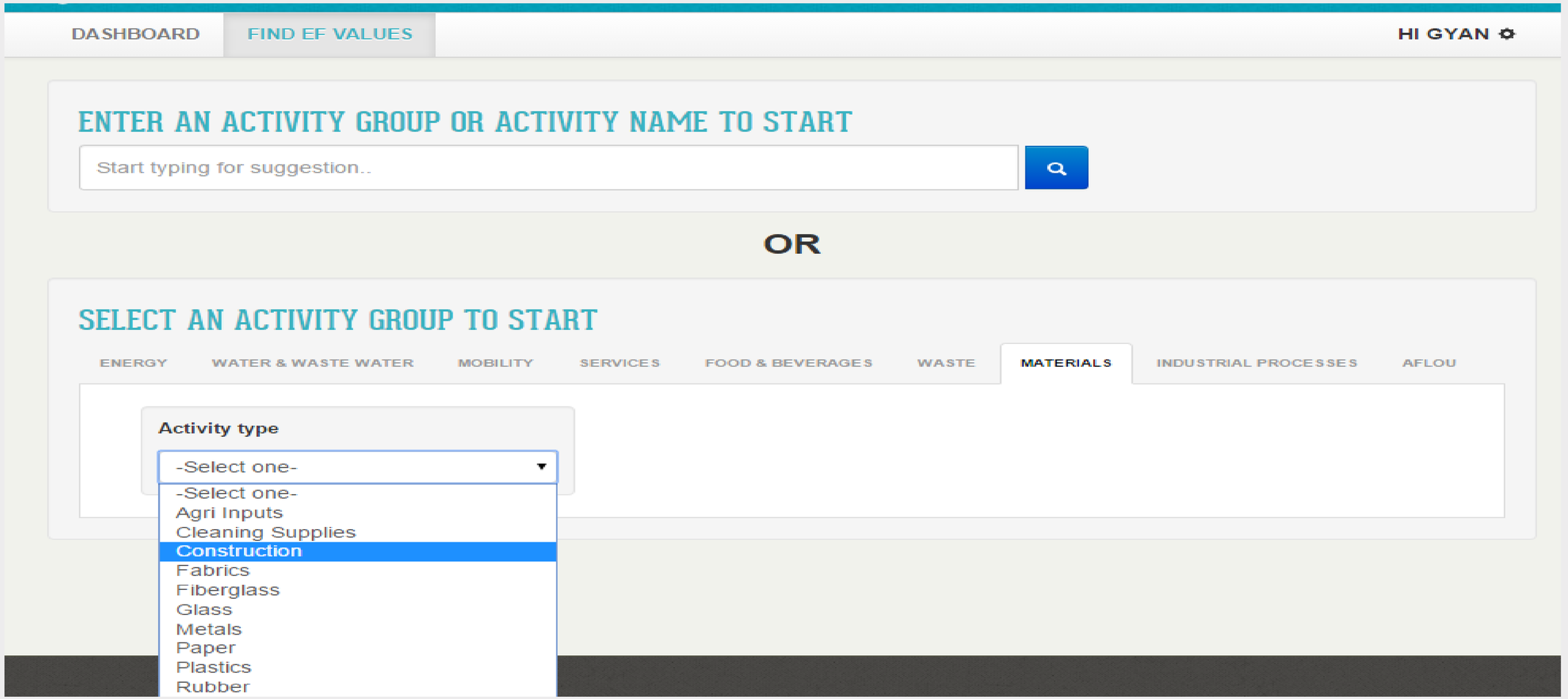

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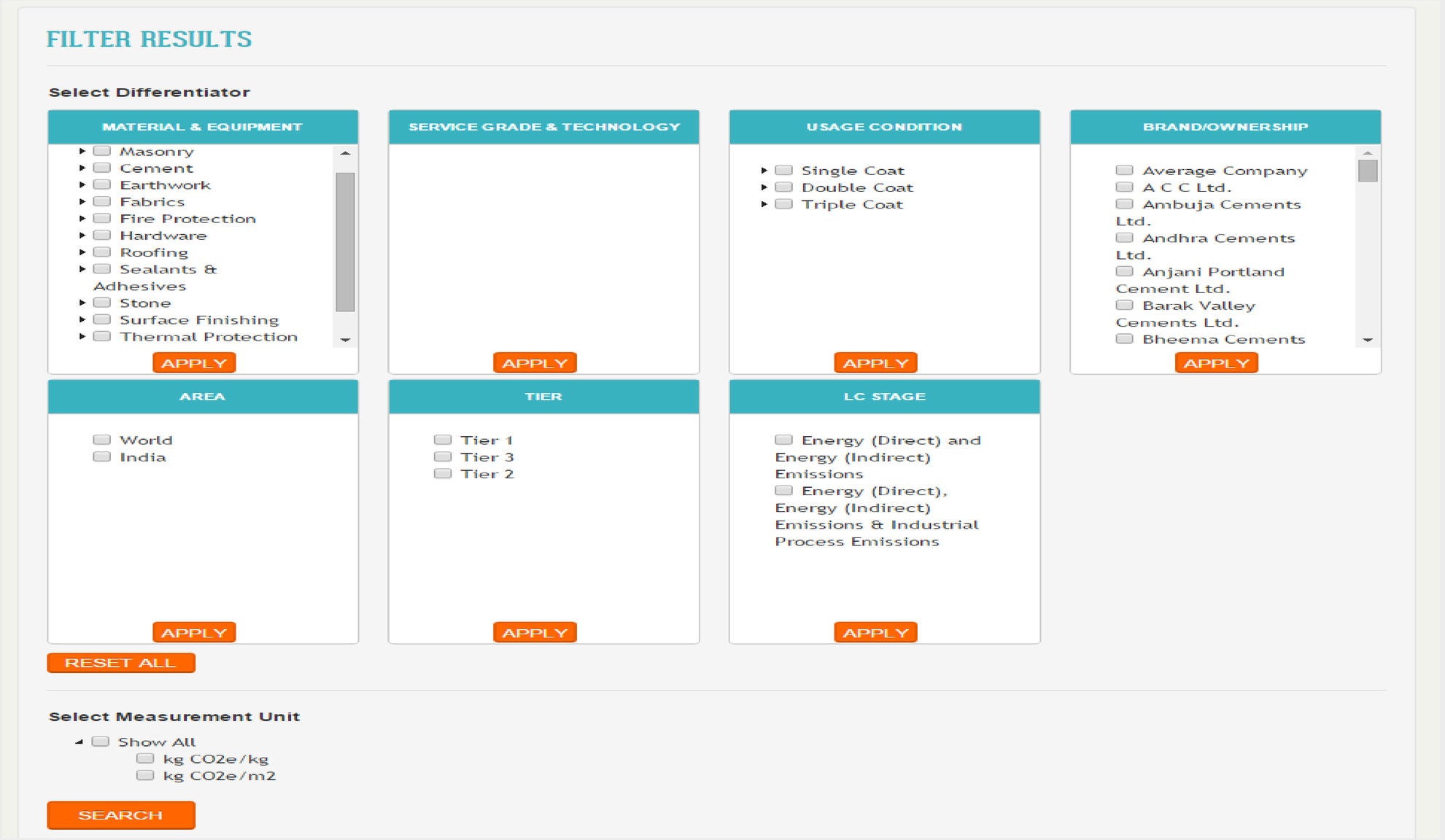
Carbon Emission Factor Database (CEFD) Tool:



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Carbon Emission Factor Database (CEFD) Tool:

FILTER RESULTS

Back to EF Filter List

1 results found for: Activity: Construction **Differentiators** A C C Ltd. **Region:** India **Measurement Units:** kg CO2e/kg

- If a single EF value is displayed in the form m = EF value, the Activity is linearly and directly related to GHG emissions and the GHG emissions will be a simple product of the Activity data and the EF.
- Where more than one EF value is displayed, the relation between the GHG emission, the EF and the Activity Data is of the following type:

ACTIVITY TYPE	DESCRIPTION	MEASURE UNIT	COEFFICIENTS	
Construction	Cement, A C C Ltd., India, Tier 3, Energy (Direct), Energy (Indirect) Emissions & Industrial Process Emissions	kg CO2e/kg	m_1 = 0.82 | m_2 = None | m_3 = None | m_4 = None | c = None	USE VALUE

THE FORMULA

Activity Type: Construction
Description: Cement, A C C Ltd., India, Tier 3, Energy (Direct), Energy (Indirect) Emissions & Industrial Process Emissions
Measure Unit: kg CO2e/kg

y = 0.82x Copy

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Carbon Emission Factor Database (CEFD) Tool:

FILTER RESULTS

Back to EF Filter List

3 results found for: Activity: Electricity **Differentiators** Grid Electricity, Residential, India - Western Region, Maharashtra, Mumbai **Region:** India **Measurement Units:** kg CO2e/kWh, kg CO2e/Rs

If a single EF value is displayed in the form m = EF value, the Activity is linearly and directly related to GHG emissions and the GHG emissions will be a simple product of the Activity data and the EF.

Where more than one EF value is displayed, the relation between the GHG emission, the EF and the Activity Data is of the following type:

ACTIVITY TYPE	DESCRIPTION	MEASURE UNIT	COEFFICIENTS	
Electricity	Grid Electricity, Residential, Grid Fuel Mix, India - Western Region, Maharashtra, Mumbai, Tier 2, Energy (Direct) Emissions	kg CO2e/kWh	m_1 = 1.05670736817 | m_2 = None | m_3 = None | m_4 = None | c = None	USE VALUE
Electricity	Grid Electricity, Residential, Grid Fuel Mix, India - Western Region, Maharashtra, Mumbai, Tier 2, Energy (Direct) Emissions	kg CO2e/Rs	m_1 = 0.222528757381 | m_2 = -3.55023873387e-05 | m_3 = 3.85642183891e-09 | m_4 = -1.47939031544e-13 | c = 13.4958178686	USE VALUE
Electricity	Grid Electricity, Residential, Grid Fuel Mix, India - Western Region, Maharashtra, Tier 2, Energy (Direct) Emissions	kg CO2e/kWh	m_1 = 0.96829186652 | m_2 = None | m_3 = None | m_4 = None | c = None	USE VALUE

THE FORMULA

Activity Type: Electricity
Description: Grid Electricity, Residential, Grid Fuel Mix, India - Western Region, Maharashtra, Mumbai, Tier 2, Energy (Direct) Emissions
Measure Unit: kg CO2e/Rs

$$y = -1.47939031544e\text{-}13x^4 + 3.85642183891e\text{-}09x^3 + -3.55023873387e\text{-}05x^2 + 0.222528757381x + 13.4958178686$$

Copy

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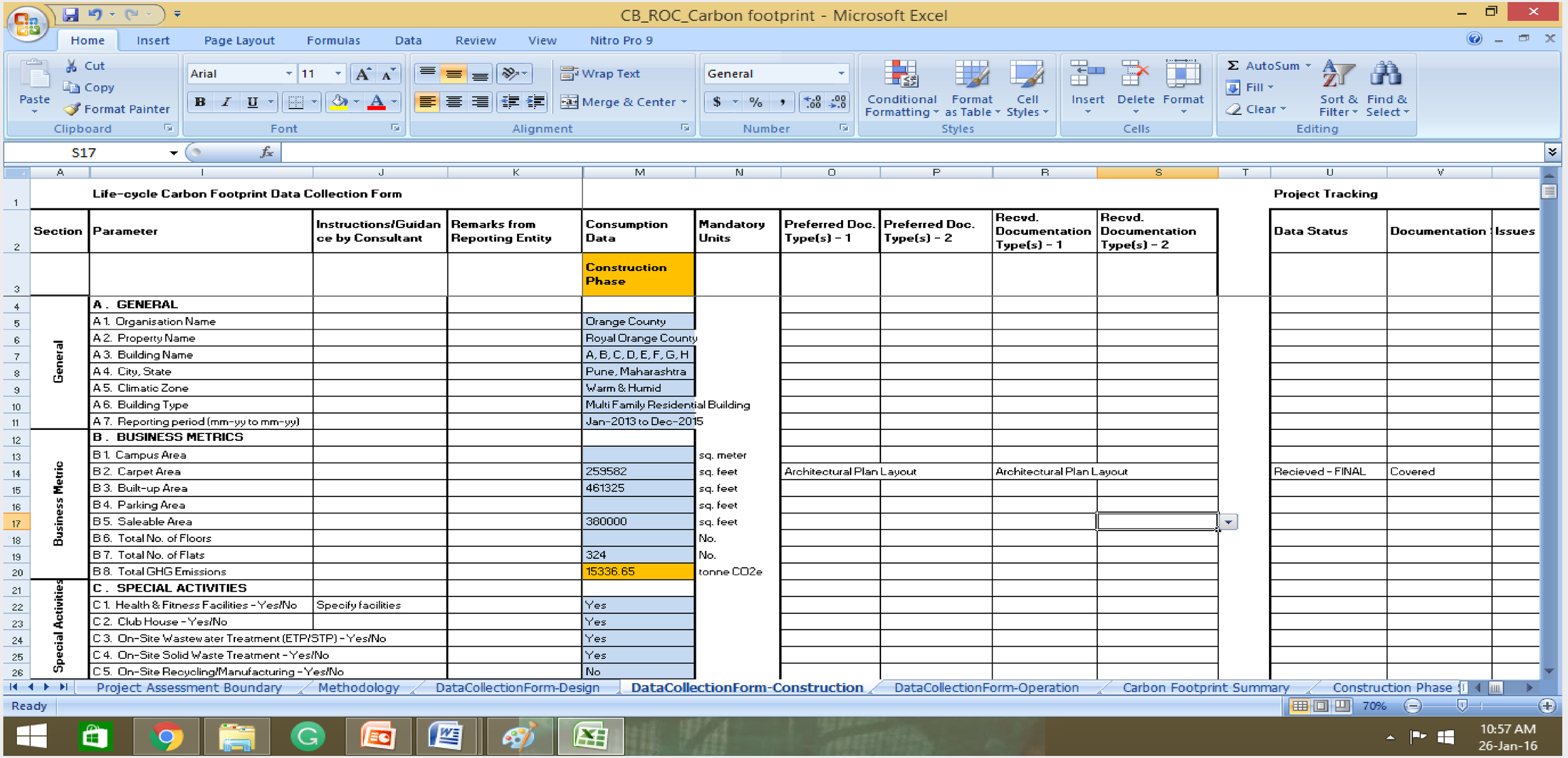
Developed Excel Toolkit: to calculate carbon footprint by Orange County team



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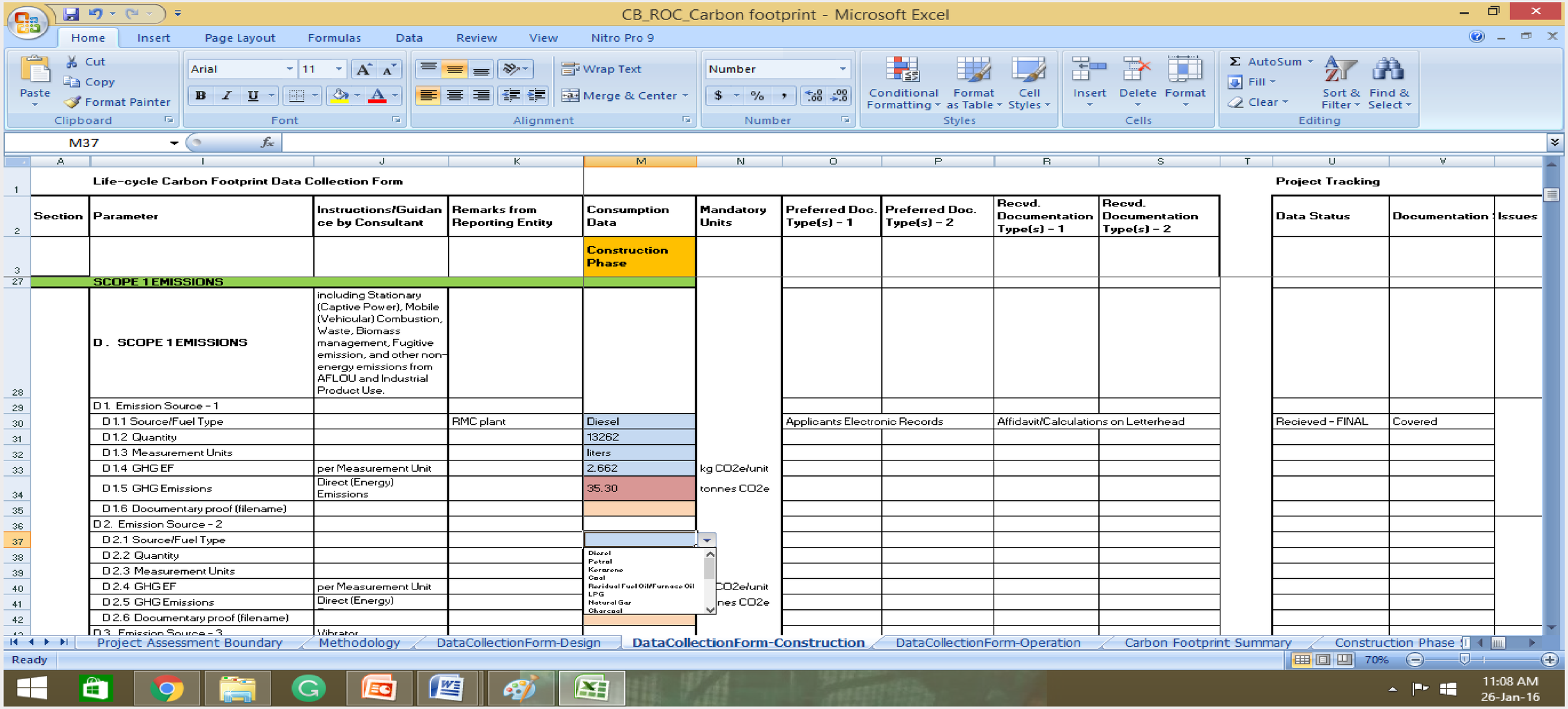

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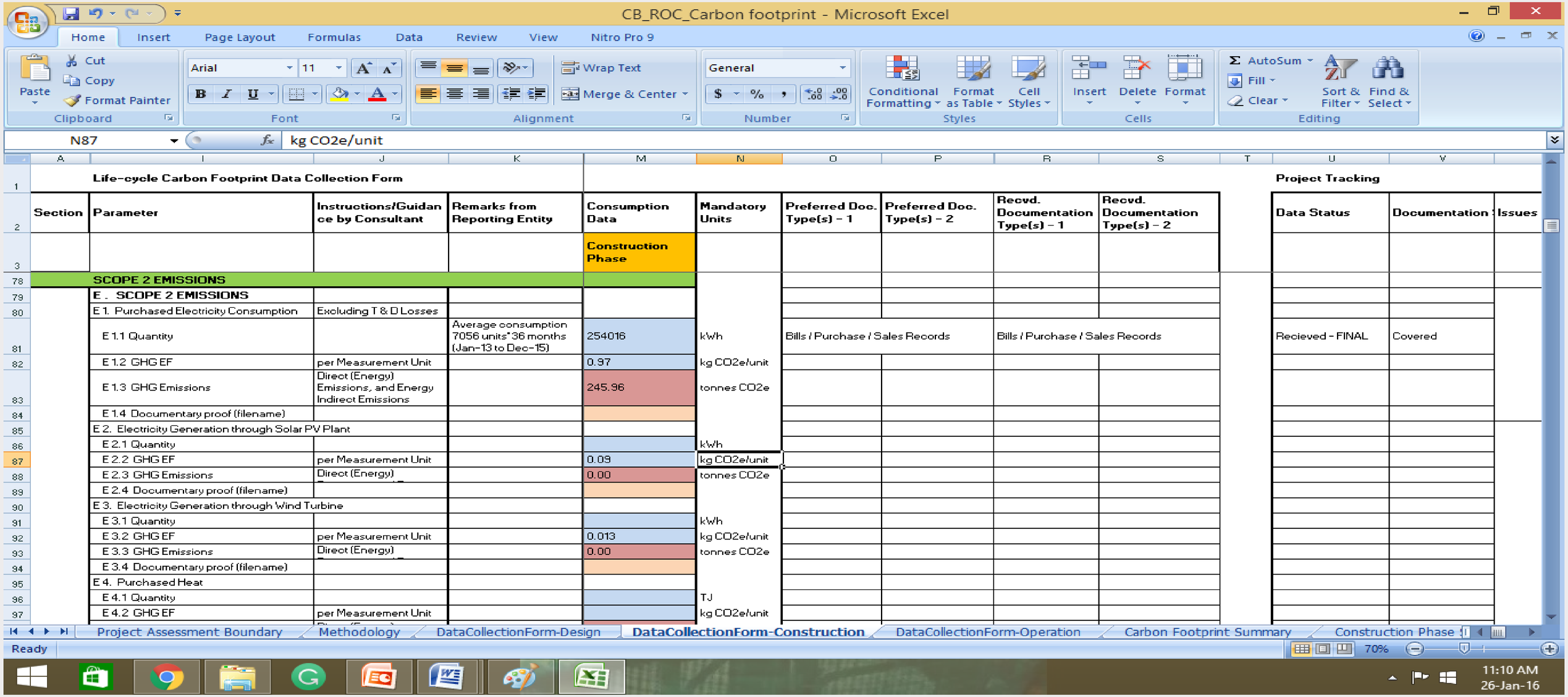

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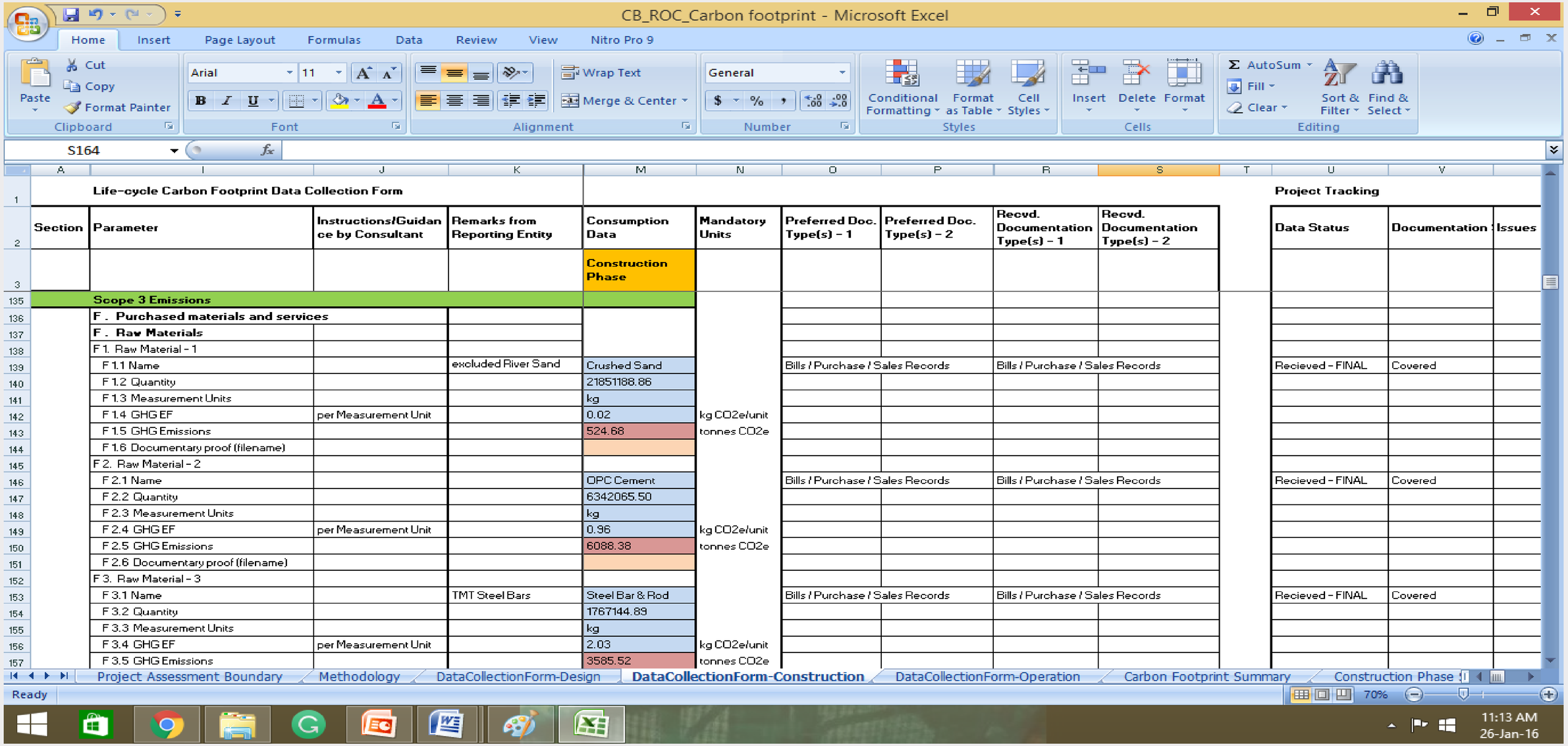

CB_ROC_Carbon footprint - Microsoft Excel

Life-cycle Carbon Footprint Data Collection Form

Section	Parameter	Instructions/Guidance by Consultant	Remarks from Reporting Entity	Consumption Data	Mandatory Units	Preferred Doc. Type(s) – 1	Preferred Doc. Type(s) – 2	Recvd. Documentation Type(s) – 1	Recvd. Documentation Type(s) – 2	Project Tracking: Data Status	Project Tracking: Documentation	Project Tracking: Issues
				Construction Phase								
	Scope 3 Emissions											
	F . Purchased materials and services											
	F . Raw Materials											
	F 1. Raw Material - 1											
	F 1.1 Name		excluded River Sand	Crushed Sand		Bills / Purchase / Sales Records		Bills / Purchase / Sales Records		Recieved - FINAL	Covered	
	F 1.2 Quantity			21851188.86								
	F 1.3 Measurement Units			kg								
	F 1.4 GHG EF	per Measurement Unit		0.02	kg CO2e/unit							
	F 1.5 GHG Emissions			524.68	tonnes CO2e							
	F 1.6 Documentary proof (filename)											
	F 2. Raw Material - 2											
	F 2.1 Name			OPC Cement		Bills / Purchase / Sales Records		Bills / Purchase / Sales Records		Recieved - FINAL	Covered	
	F 2.2 Quantity			6342065.50								
	F 2.3 Measurement Units			kg								
	F 2.4 GHG EF	per Measurement Unit		0.96	kg CO2e/unit							
	F 2.5 GHG Emissions			6088.38	tonnes CO2e							
	F 2.6 Documentary proof (filename)											
	F 3. Raw Material - 3											
	F 3.1 Name		TMT Steel Bars	Steel Bar & Rod		Bills / Purchase / Sales Records		Bills / Purchase / Sales Records		Recieved - FINAL	Covered	
	F 3.2 Quantity			1767144.89								
	F 3.3 Measurement Units			kg								
	F 3.4 GHG EF	per Measurement Unit		2.03	kg CO2e/unit							
	F 3.5 GHG Emissions			3585.52	tonnes CO2e							

Project Assessment Boundary | Methodology | DataCollectionForm-Design | DataCollectionForm-Construction | DataCollectionForm-Operation | Carbon Footprint Summary | Construction Phase

Ready

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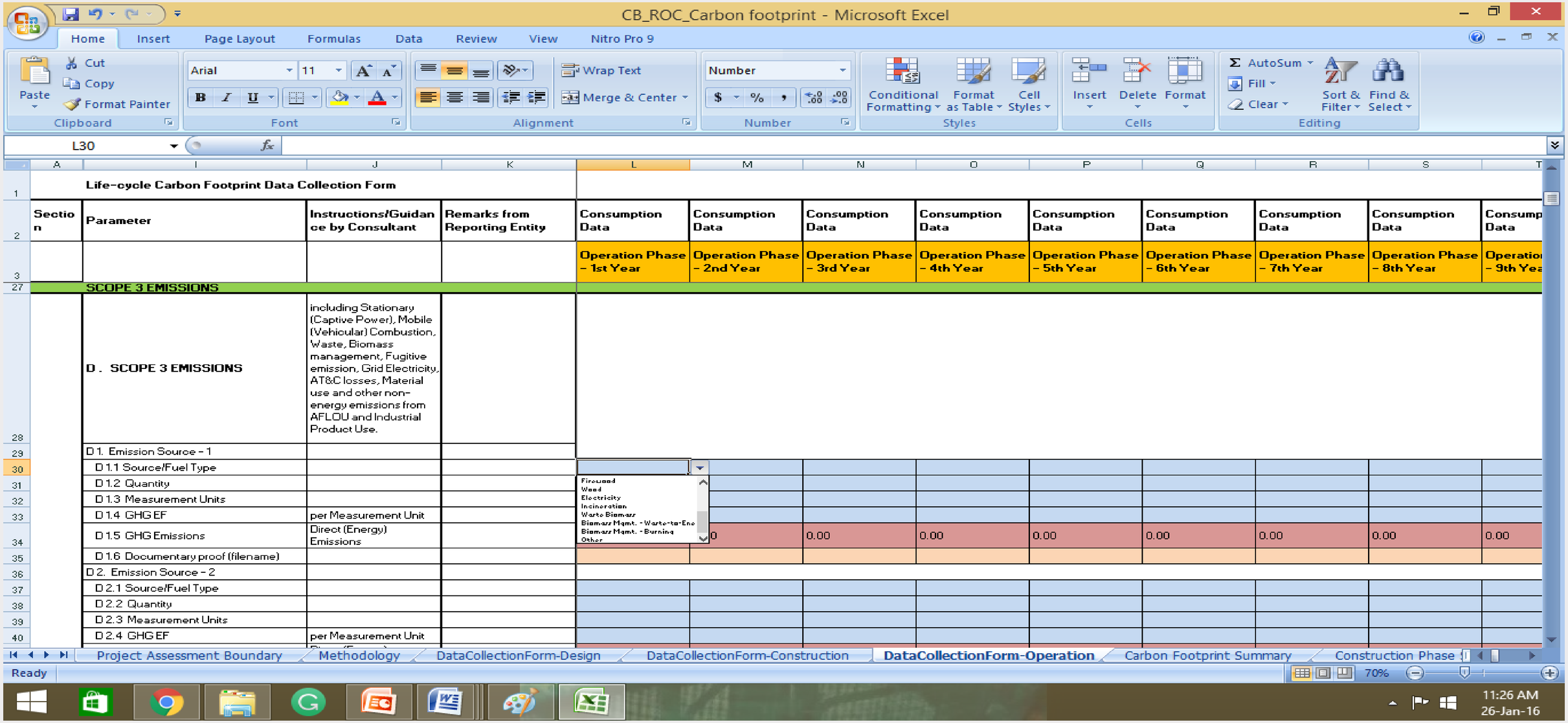
Developed Excel Toolkit: to calculate carbon footprint by Orange County team



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Activity Data Summary & Respective GHG Emissions:

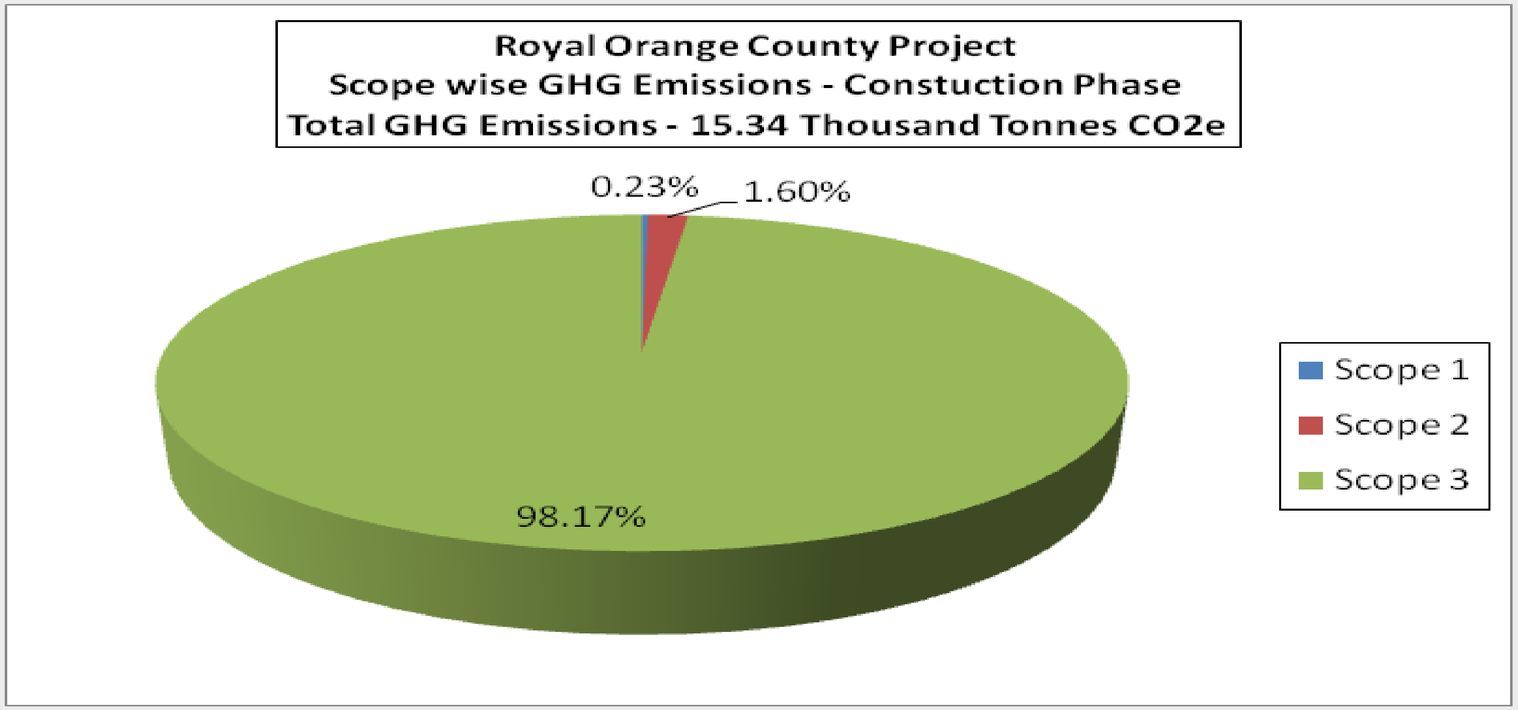
GHG Emissions Category	Activity Category	Activity	Quantity	Unit	GHG Emissions (Tonne CO2e)	% GHG Emissions
Scope 1	Fossil Fuels	Diesel	13,262	liters	35.30	**0.23%**
Scope 2	Purchased Electricity	Grid Electricity	254,016	kWh	245.96	**1.60%**
	Power Generation - Solar	Electricity through Solar PV Plant	-	kWh	-	**0.00%**
	Power Generation - Wind	Electricity through Wind Turbine	-	kWh	-	**0.00%**
Scope 3	Materials	Crushed Sand	21,851,189	kg	524.68	**3.42%**
	Materials	OPC Cement	6,342,066	kg	6,088.38	**39.70%**
	Materials	Steel Bar & Rod	1,767,145	kg	3,585.52	**23.38%**
	Materials	PPC Cement	705,000	kg	447.68	**2.92%**
	Materials	Stone Chips, Ravali	21,003,680	kg	1,369.62	**8.93%**
	Materials	Lime Powder	605,636	kg	281.94	**1.84%**
	Materials	Rheobuild BASF 1125	44,348	kg	262.10	**1.71%**
	Materials	Plaster	247,523	kg	49.48	**0.32%**
	Materials	Paints	45,614	sq. meter	162.39	**1.06%**
	Materials	Granite	112,910	kg	171.80	**1.12%**
	Materials	Fly Ash	737,454	kg	-	**0.00%**

Activity Data Summary & Respective GHG Emissions:

GHG Emissions Category	Activity Category	Activity	Quantity	Unit	GHG Emissions (Tonne CO2e)	% GHG Emissions
Scope 3	Materials	Fly Ash Brick	2,703,327	kg	333.32	**2.17%**
	Materials	Lime Brick	3,681,744	kg	489.31	**3.19%**
	Materials	Red Brick	117,070	kg	44.99	**0.29%**
	Materials	RCC Pipe	174,770	kg	234.52	**1.53%**
	Materials	Tiles	205,733	kg	408.69	**2.66%**
	Materials	Steel Finished Products	27,350	kg	57.44	**0.37%**
	Materials	Iron Products	23,698	kg	44.49	**0.29%**
	Materials	Rubble Stone	1,992,111	kg	12.99	**0.08%**
	Materials	Tanker Water	6,938	Numbers	6.57	**0.04%**
	Purchased Services	Excavation - Diesel	15,055	liters	40.07	**0.26%**
	Purchased Services	Vibrator - Petrol	750	liters	1.73	**0.01%**
	Upstream Emission of Used Fuels	Upstream Emission of Used Fuels - Diesel	13,262	liters	3.95	**0.03%**
	Upstream Emission of Used Fuels for Grid Electricity Generation	Upstream Emission of Used Fuels for Grid Electricity Generation	254,016	kWh	31.14	**0.20%**
	Grid Electricity - AT&C Losses	AT&C Losses	254,016	kwh	74.74	**0.49%**
	Mobility - Freight & Logistics	Road Transport	351,117	vehicle-km	327.87	**2.14%**
				Total	**15,336.65**	**100.00%**

GHG Emissions Summary: Royal Orange County Project – Construction Phase

	Design Phase	Construction Phase	Operation Phase	Total
GHG Emissions	Tonnes CO2e	Tonnes CO2e	Tonnes CO2e	Tonnes CO2e
Scope 1	0.00	35.30		35.30
Scope 2	0.00	245.96		245.96
Scope 3	0.00	15,055.39	0.00	15,055.39
	Total GHG Emissions			**15,336.65**
	Total GHG Emissions per sq. feet built-up area			**0.033**



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Results:

A) Subscription to the CEFD and in-person training empowered Orange County Foundation team:

➢ *to calculate the carbon footprint of their projects using India-specific GHG emission factors*

➢ *to assess life-cycle environmental performance and sustainable impact of their projects*

➢ *to choose sustainable alternatives over conventional construction and building material*

Results:

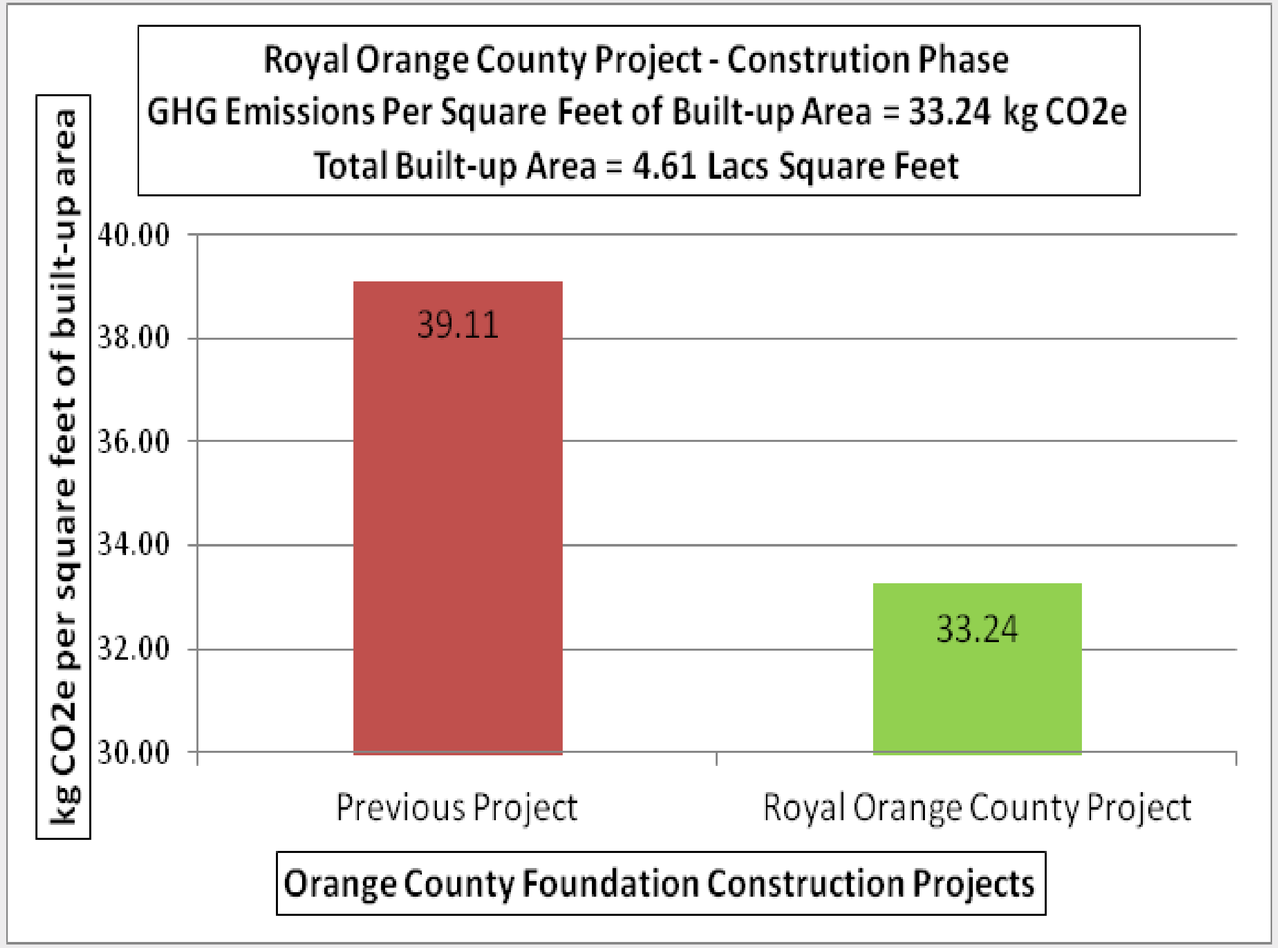
A) Subscription to the CEFD and in-person training empowered Orange County Foundation team:

➢ *to compare environmental performances of two different construction projects*

➢ *to create a baseline and frame future strategies to reduce the carbon footprint*

Results:

B) Successfully achieved a ***15% reduction in GHG emissions*** compared with previous projects – from selection of low-carbon embodied construction materials with help of CEFD Tool



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