



# Topic 3.2. Full supply chain greenhouse gas (GHG) emissions assessment

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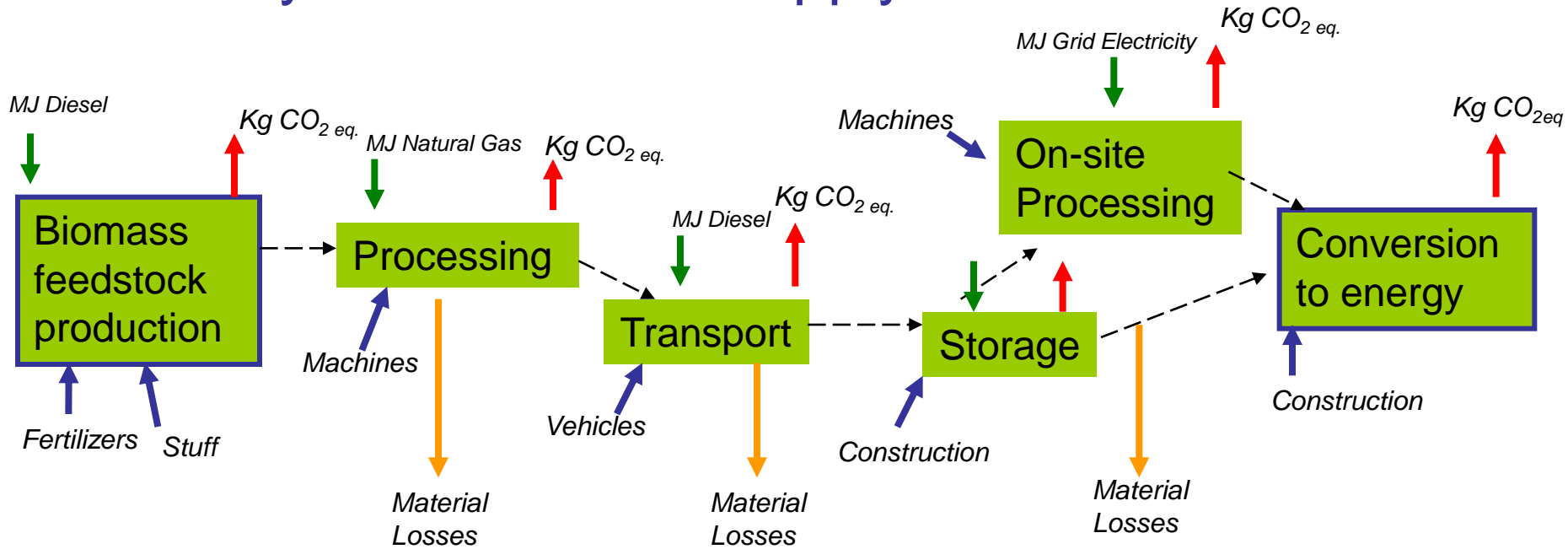
# Overview

- Task 3.2
- Introduce TSEC-Mini-Tool for Biomass Supply Chains
  - Major elements
  - Options and flexibility
- How it can be used

## Task 3.2:



# GHG Analysis of biomass supply chains in the UK

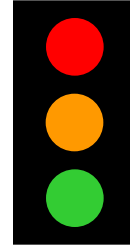


- Step 1: Define supply chains
- Step 2: Plug in numbers
- Step 3: Make it useful
- Step 4: Use it!



# Introducing: TSEC-Mini-Tool

- MS Excel – ‘traffic light system’ for users
- Covers :
  - 15 Types biomass
  - 6 Land-use reference systems
  - 3 Waste reference systems
  - 10 Transport options
  - 4 Outputs: Electricity, heat, CHP, or co-fired electricity.



## Output:

- Energy requirement and CO2 emissions specific to your supply chain
- Breakdown of where all emissions occur

*+ BEAT2*

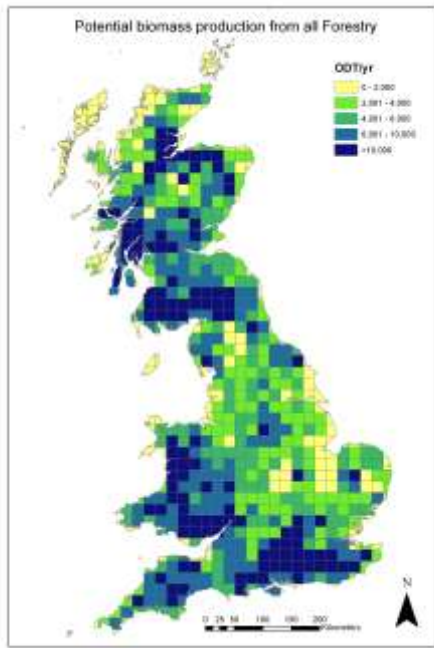
# Using the TSEC-Mini-Tool

## 1. Biomass Feedstocks:

•MJ/Kg CO2 eq. per ODT of:

- Miscanthus → Bales → Cubes
- Wheat Straw → Pellets
- Forest Residues →

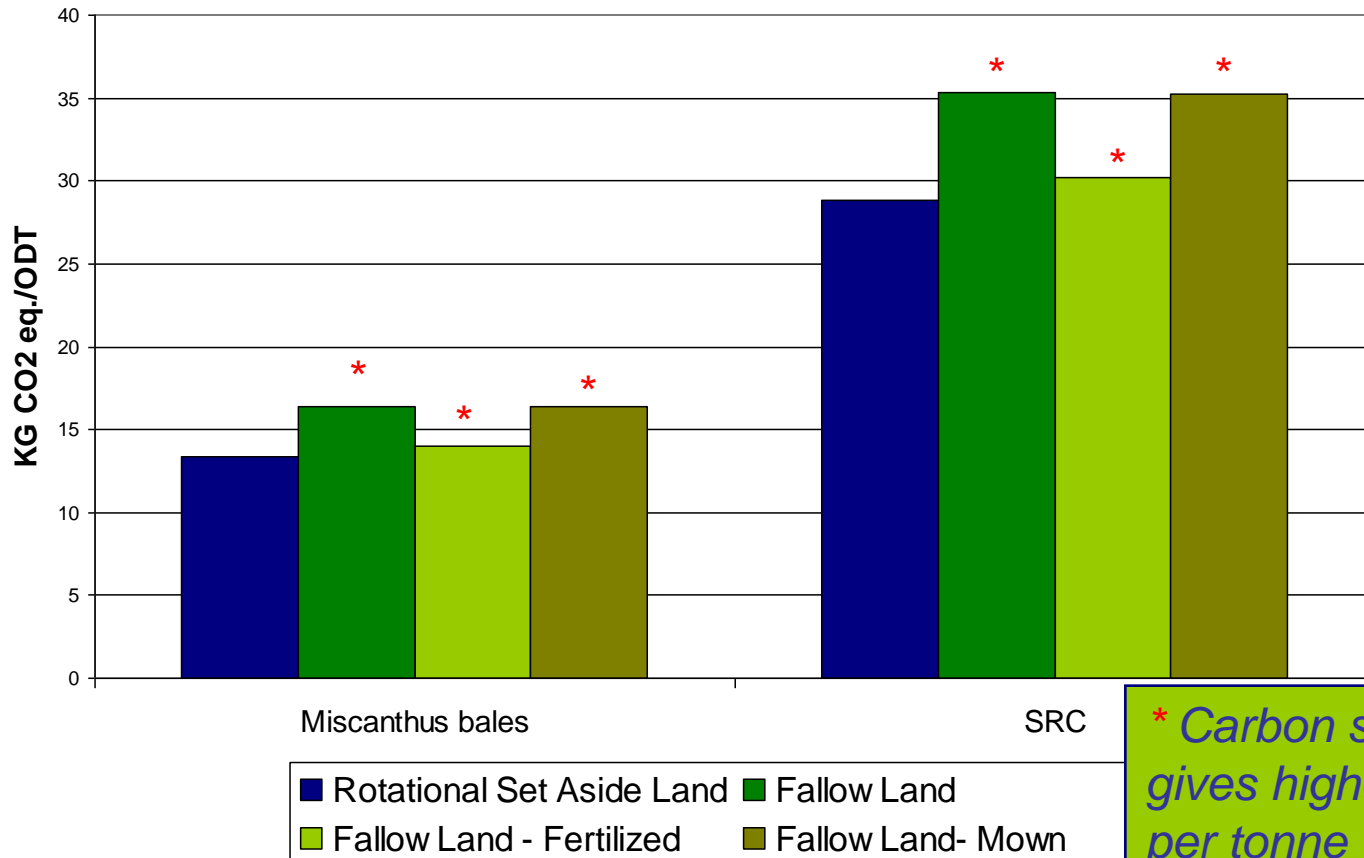
Stemtips & Branches  
Sawdust  
Slabwood  
Whole Tree Thinnings  
Roundwood



# 2a. Land-use Reference System



- For 'Crops':
  - 6 Options: Fallow land (combination of fertilized and mown), rotational set aside land & green manure



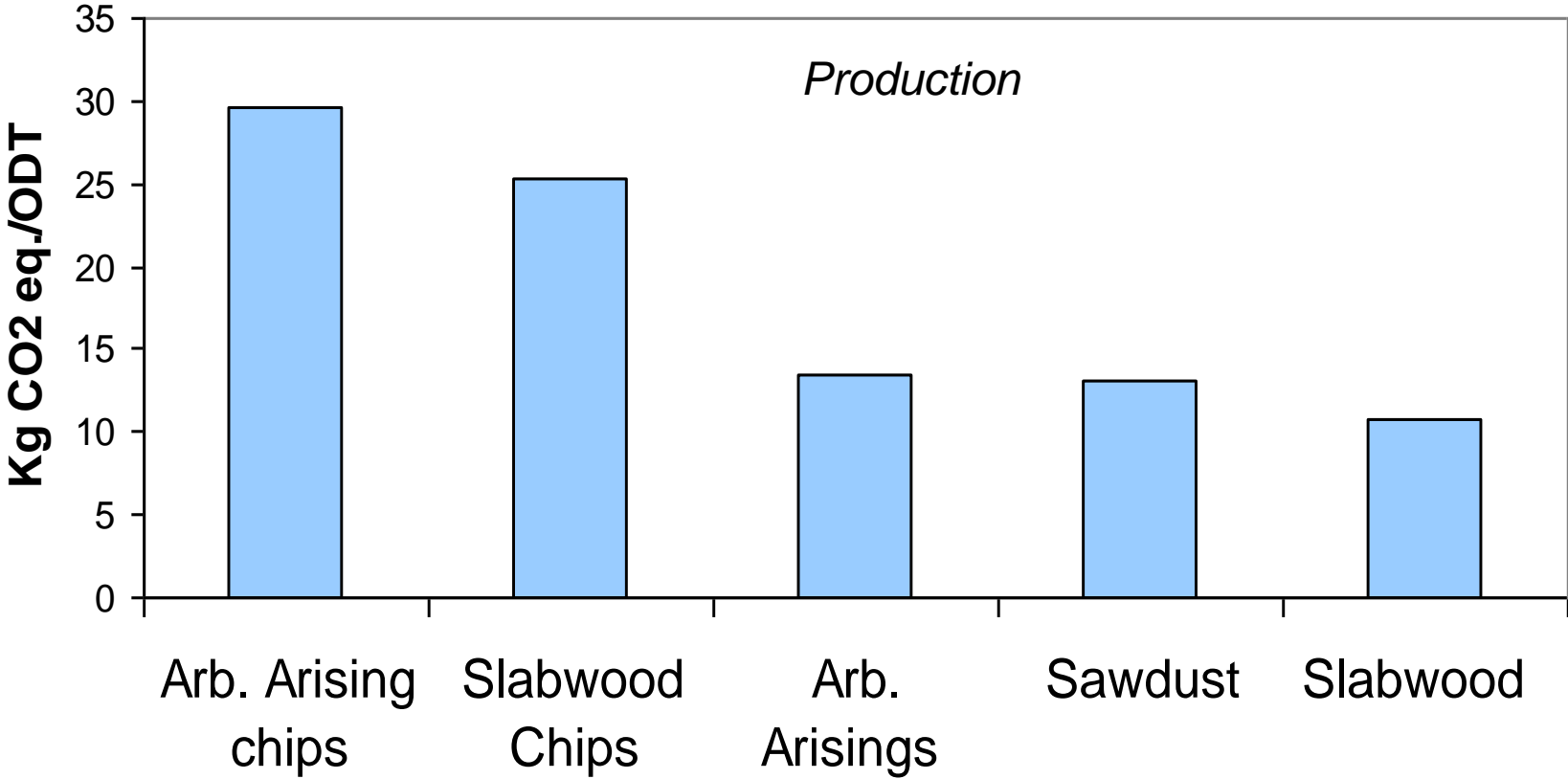


## 2b. Waste Reference System

- For 'Wastes'
  - Three options
    - **Mulching/natural decay** – *forest residues, waste wood, arboricultural arisings, olive residues*
    - **Burnt for onsite heat** – *sawmill residues*
    - **Landfill** – *waste wood, arboricultural arisings, olive residues*



# Waste Reference System

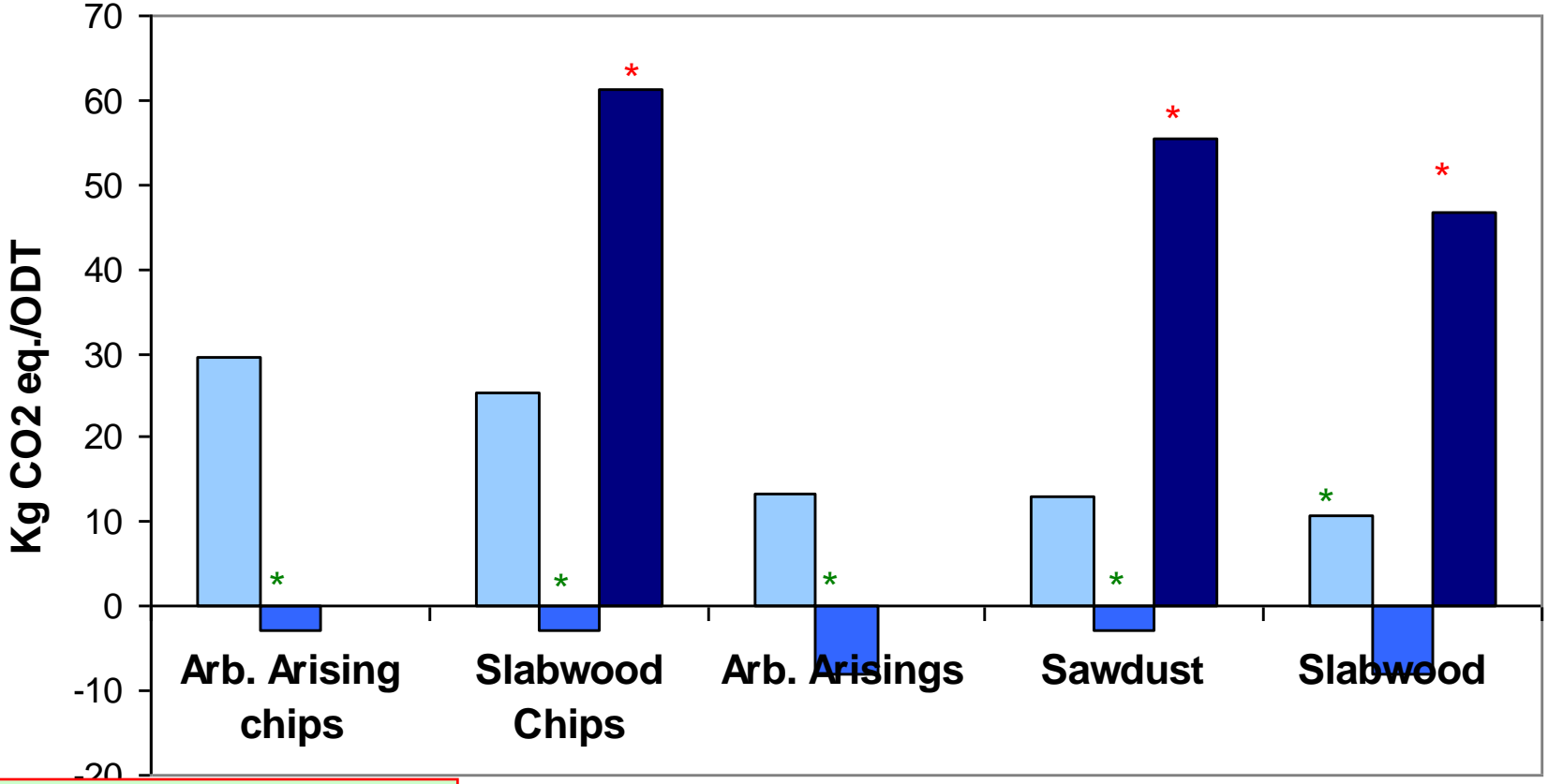


# Waste Reference System: Mulching



*\* Overall saving energy compared to reference system:  
Collecting, chipping and transport to parks for mulch*

# Waste Reference System: Onsite Heat

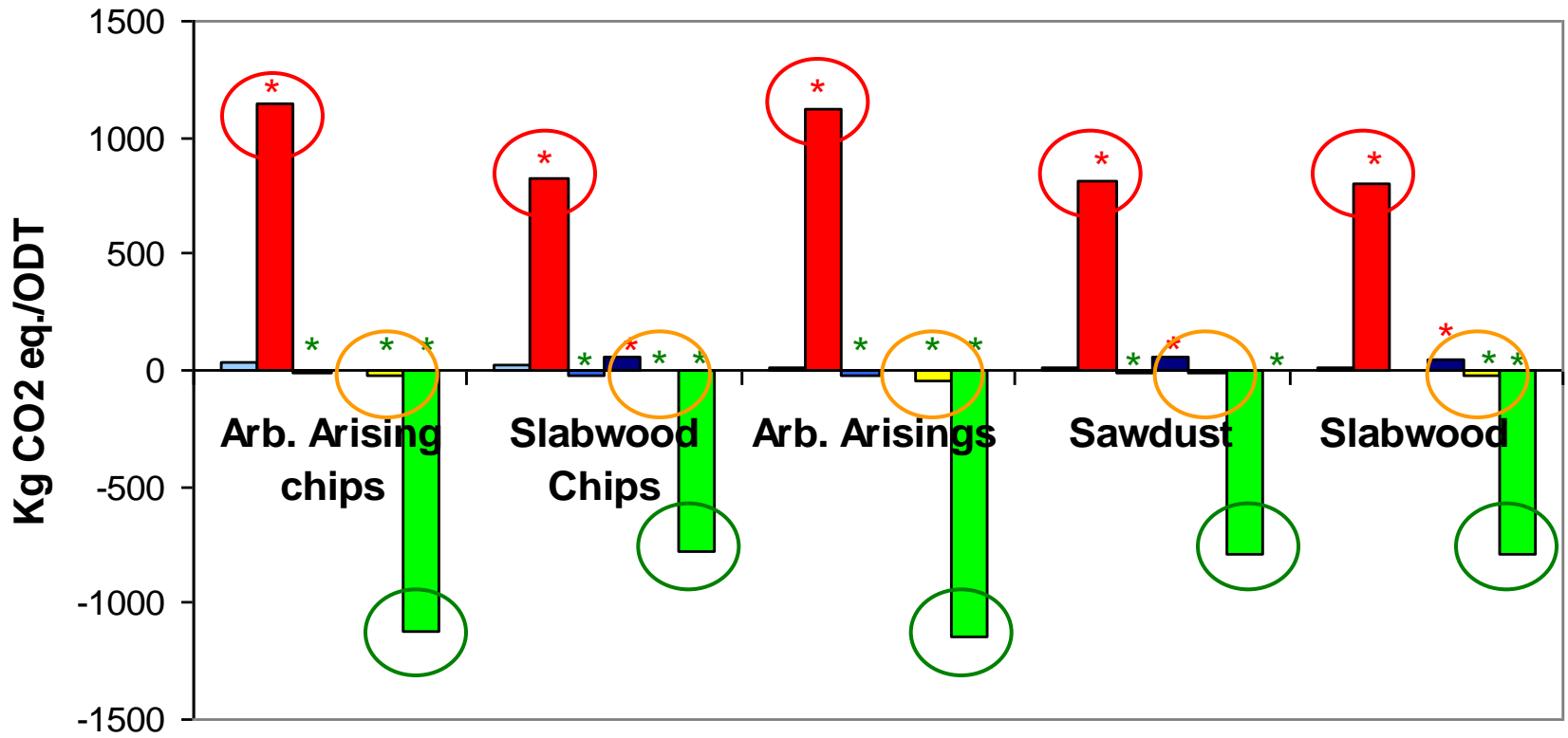


*\* Higher emissions per tonne – now have to produce heat from natural gas*



# Waste Reference System: Landfill

*Emissions from Landfill are highly dependent on degradation rates!*



■ No Reference     
 ■ Landfill 35% degrade     
 ■ Mulching  
■ Used for Heat     
 ■ Landfill 50% degrade     
 ■ Landfill 65% degrade

*\* Higher emissions per tonne – where carbon is sequestered in landfill*

*All situations include energy recovery*

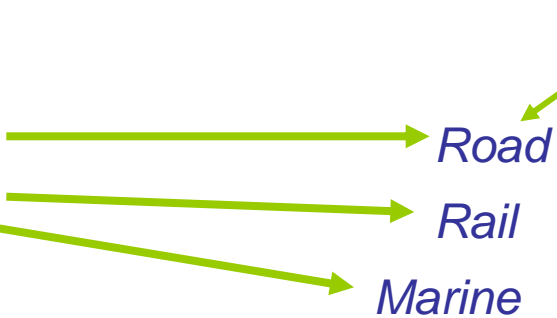
*\* Lower emissions when methane emissions are avoided*

... 'per ODT biomass'

- Can depend on many factors
  - Quantifiable things
    - Inputs
    - Yield
    - Moisture Content
    - Material losses
  - Decisions on:
    - Landfill behaviour
    - Landuse
    - Reference system

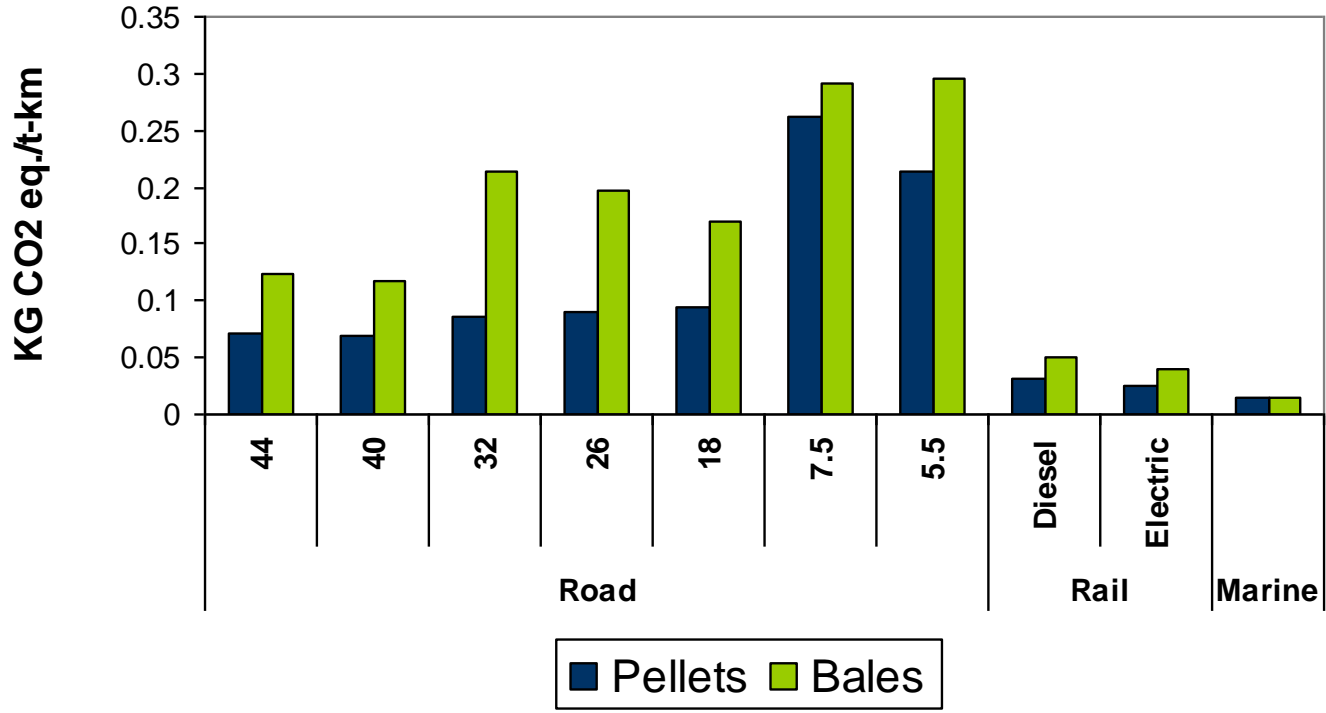
**TSEC Mini Tool is flexible**

# TSEC-Mini-Tool



(7 Truck Sizes)

Volume-based t-km emissions

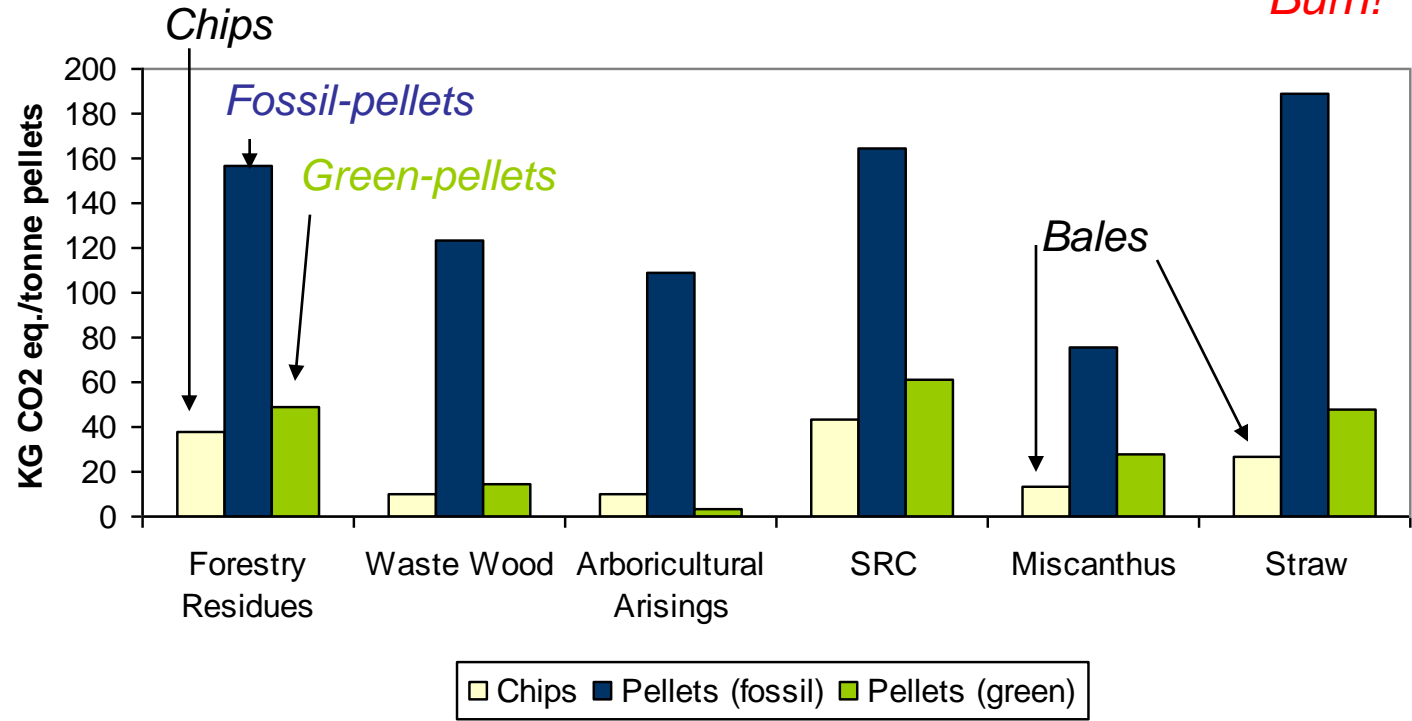
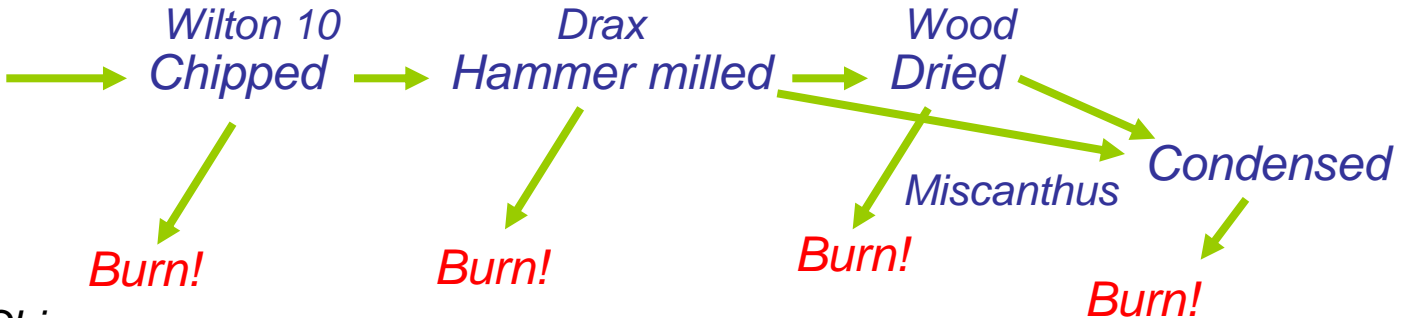




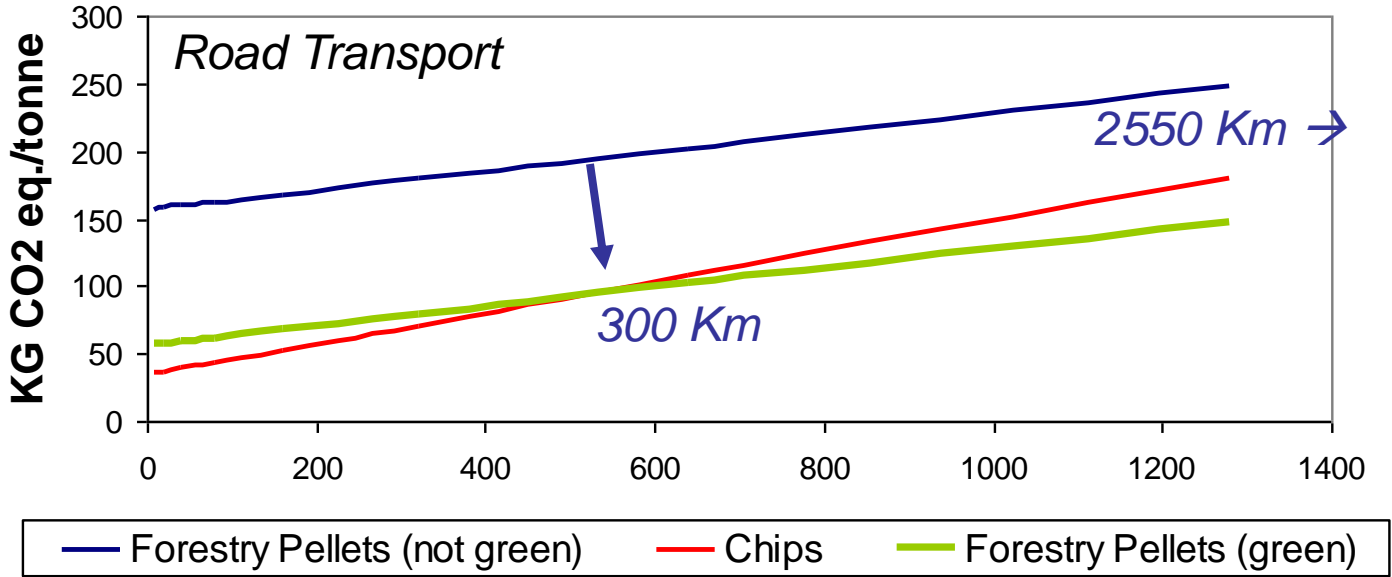
# TSEC-Mini-Tool

Can use fossil fuels or biomass to power each step

Biomass  
(stored  
-transported)



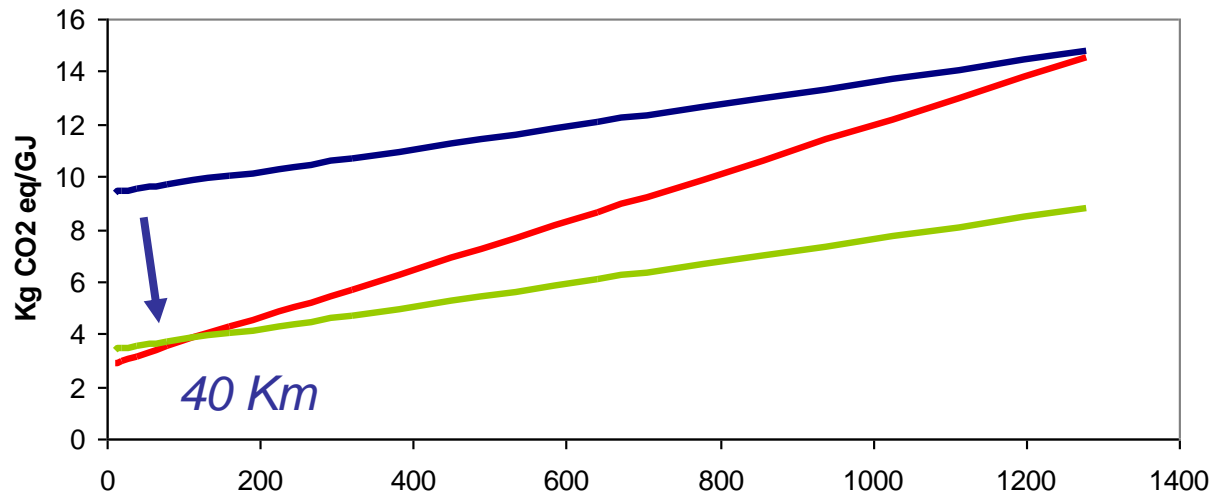
# GHG Benefit of Pellets?



*Include energy Density!*

*Pellets:*  
17 GJ/tonne

*Chips:*  
12 GJ/tonne

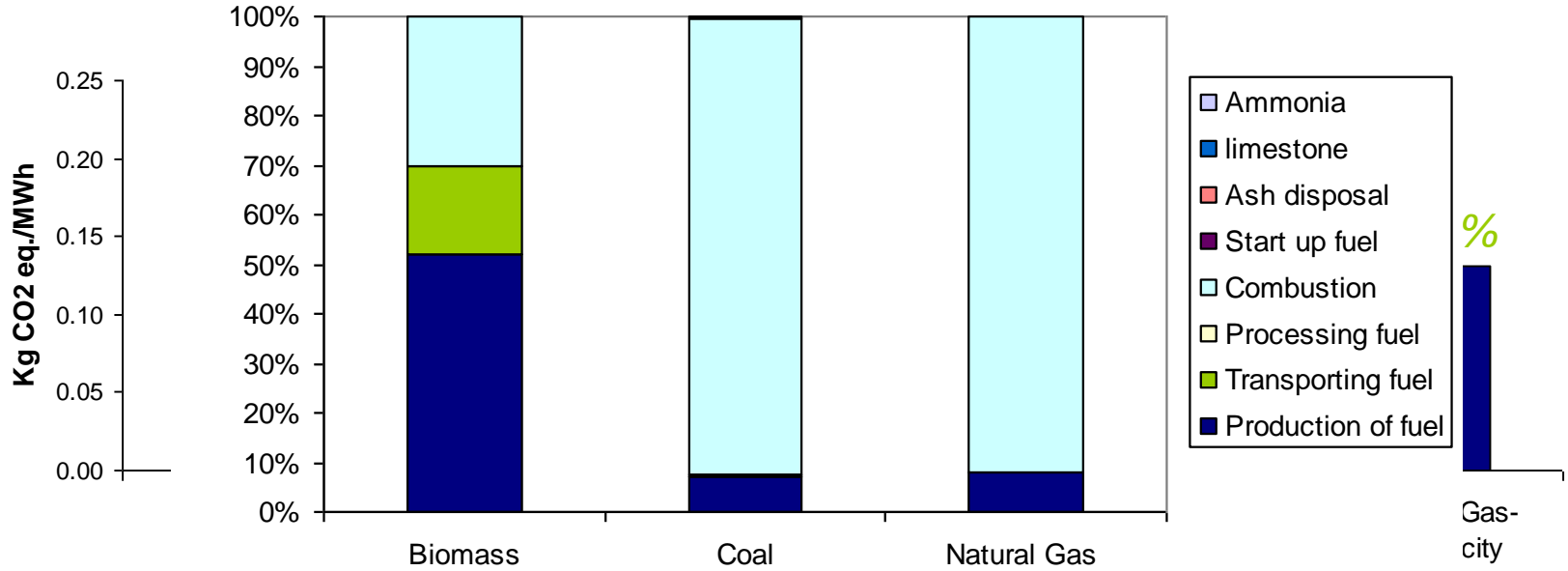


# TSEC-Mini-Tool

*Biomass  
(stored-  
transported  
-processed  
-stored again maybe)*

→ *Burn!*

- *Dedicated Electricity – Wilton 10*
- *Dedicated Heat - Barnsley*
- *CHP – Not SHP!*
- *Co-fired with Coal - Drax*



*Quantify % savings and kg CO2 eq. saved*

	A	B	C	D	E	F	G
40							
41	<b>Per MWh</b>						
42	Stage	Primary Energy	Carbon Dioxide Emissions	Methane Emissions	Nitrous Oxide Emissions	Total GHG Emissions	Electricity Consumed
43	<b>Biomass</b>	(MJ/MWh)	(Kg CO2/MWh)	(Kg CH4/MWh)	(Kg N2O/MWh)	(Kg CO2 eq./MWh)	MJ/MWh
44	Input Material	266	20	0	0	19	0
45	Fuel Delivery to Fuel Hub	118	8	0	0	8	0
46	Processing	0	0	0	0	0	0
47	Storage	0	0	0	0	0	0
48	Combustion	0	0	0	0	14	0
49	Start Up Fuel	0	0	0	0	0	0
50	Ash Disposal	0	0	0	0	0	0
51	Credit (Fertilizer Displaced)	0	0	0	0	0	0
52	<b>Sum</b>	<b>384</b>	<b>28</b>	<b>0</b>	<b>0</b>	<b>42</b>	<b>0</b>
53							
54	<b>Reference System:</b>						
55	<b>Coal</b>						
56	Fuel Production and Combustion	8683	730	2	0	805	0
57	Coal Pulverisation	27	1	1	1	2	7
58	Start Up Fuel	0	0	0	0	0	0
59	Flue Gas Desuiphurisation	52	0	0	0	0	0
60	Ash Disposal	0	0	0	0	0	0
61	<b>Sum</b>	<b>8763</b>	<b>731</b>	<b>3</b>	<b>1</b>	<b>808</b>	<b>7</b>
62							
63	<b>Natural Gas</b>						
64	Fuel Production and Combustion	8305	403	1	0	424	0
65	Fugitive Emissions	0	0	2	0	46	0
66	NOx Reduction: Ammonia Usage	10	1	0	0	1	0
67	<b>Sum</b>	<b>8315</b>	<b>404</b>	<b>3</b>	<b>0</b>	<b>471</b>	<b>0</b>
68							
69	Saving per Year: Ref: Coal	8378	703	3	1	766	
70	% Saving per Year: Ref: Coal	96	96	99	96	95	
71	Saving per Year: Ref: Natural Gas	7931	375	3	0	429	
72	% Saving per Year: Ref: Nat. Gas	95	93	99	-5779	91	
73							
74							

# Conclusions



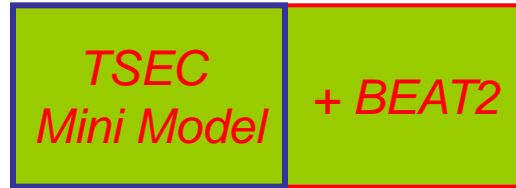
## **Biomass looks good**

*.... But what was the question?*

What does TSEC and stakeholders want to know about GHG's?

# What now?

- Test it
- OK? Use it!  
Answer questions:
- Run
- Scenarios:
  - ‘Energy security’- Only UK biomass
  - ‘Cost effectiveness’ – Only cheap biomass
  - ‘Super Carbon-Saving’ – Only low-CO2 biomass
  - ‘Land-limited production’ – Mostly wastes/residues
  - ‘Energy efficiency’- more efficient technology
  - Case Studies – biomass mixes at various scales
  - Yield Scenarios: future crop yields
- Speculate biomass’ contribution to future GHG savings





Thank you!