

AC0410 ANNEX 4: LCAD tool user guide

LCAD is an Excel tool that contains detailed LCA data for a selection of pre-defined anaerobic digestion and other bioenergy scenarios that could arise on UK dairy or arable farms. The methodology behind the tool and selected results are presented in the main AC0410 report and methods annexes. LCAD is simple to use, based on drop-down selection boxes, but some brief user notes are described below.

1. Open the Excel tool on the **START** page (Click “Enable content” message and ignore any update message), and select from the desired methods in drop-down boxes in column C (described in column E) in section **1. METHODS**.
2. Go to either the **DAIRY** or **ARABLE** page, and parameterise section **2. BASELINE FARM** by selecting from the drop-down boxes in column C. Baseline farms are:
 - Large dairy farm in south-west England, 481 milking cows, 250 ha.
 - Average dairy farm in south-west England, 141 milking cows, 85 ha.
 - Large arable farm in east England, 400 ha winter wheat, spring barley and oil seed rape.
 - Large arable farm in east England as above but with 5,098 m³ imported pig slurry.

The dairy farms include user-defined options for slurry storage and marginal imported feed type (i.e. type of feed imported to compensate for lost fodder production in bioenergy scenarios). When the most likely settings are selected, “DEFAULT” is displayed in the adjacent cell (column D). The user can define the slurry application methods applied for the Dairy and Arable farm baselines.

3. Parameterise section **3. ANAEROBIC DIGESTION** or section **4. OTHER BIOENERGY** by selecting from the drop-down boxes in column C. Only one option can be selected at a time, and “NA” displays in the drop-down boxes for options not compatible with other selections.
4. Environmental burdens, expressed as kg/yr loading of CO₂e, PO₄e, SO₂e, MJe or Sb e are displayed for the baseline farm and selected bioenergy option in the main graph. The environmental burden displayed in the graph can be selected in cell K6 (step **5. DISPLAY**). NB. PO₄e and SO₂e represent eutrophying emissions (primarily nitrate leaching and ammonia volatilisation) and acidifying emissions (primarily ammonia volatilisation), respectively. MJe and Sb e represent resource depletion (primarily fossil fuel use/displacement)
5. Scrolling the results page to the right reveals the results tables, where results are expressed as changes in annual loadings relative to the baseline farm for the selected bioenergy option (see screen shot below for an arable AD scenario). Results to the right of the table state the amount of electricity or utilised thermal energy produced in the scenario, and express GHG burden changes as CO₂e relative to fuel energy content, and electricity or thermal energy generated. Values for fuel energy content are calculated based on attributional LCA (considering only the bioenergy system) and consequential LCA (considering effects outside the bioenergy system, such as iLUC and avoided landfill, etc). Attributional LCA values are comparable with Renewable Energy Directive values.

	A D ENTERPRISE					
	kg CO2e	kg PO4e	kg SO2e	MJe	kg Sb e	
dLUC total	0	0	0	0	0	
iLUC total	2480897	1981	0	0	0	
Pig enterprise difference	0	0	0	0	0	
Arable enterprise difference	-1273099	-7611	-6110	-7428620	-3573	
Displaced production	1273099	7613	6116	7428620	3573	
Feedstock cultivation	1014401	7557	4288	3017246	1451	
Feedstock trans/process	23184	36	158	308358	148	
AD Unit	1122276	643	2914	0	0	
Avoided electricity	-2664563	-406	-1431	-46453936	-22344	
Avoided heat	0	0	0	0	0	
Avoided waste	0	0	0	0	0	
Net	1976196	9812	5937	-43128333	-20745	
Net per ha used for AD	4940	25	15	-107821	-52	
Change as % farm burden	155%	129%	97%	-581%	-581%	

Conventional energy replaced		
kWhe	6,347,825	Net electricity generated
kWhth	0	Net heat used
MJ biogas/biofuel produced		
MJ biofuel	64,387,368	
gCO ₂ e/MJ	34	a.LCA
gCO ₂ e/MJ	72	c.LCA
kg CO ₂ e/kWhe	0.73	c.LCA

6. Scrolling the results page further to the right reveals section **6. ECONOMIC ASSESSMENT**. A limited number of economic parameters can be selected for sensitivity analyses in drop-down boxes at the top of columns AE and AJ (**DAIRY** page) or AF (**ARABLE** page). Economic results are displayed in the rows below, with and without subsidies, for the farm and also for energy end-users in the case biofuels and miscanthus pellets. Economic results are calculated for default scenarios, but some factors vary with user-defined options such as heat used, electricity generated in best case scenarios, digestsate application method, etc.

Table 1. Dairy scenario descriptions

	Scenario name	Feedstock	CHP capacity	Energy crop area	Slurry (10% DM)	Maize (30% DM)	Grass (25% DM)	Food waste (26% DM)	Misc-anthus (DM basis)
			kWe	ha	Tonnes fresh matter /yr input				
Large dairy farm	LD-BL	NA	NA	0					
	LD-S	Slurry	72	0	12016				
	LD-SG	Slurry, grass	135	38	12628		1536		
	LD-SMZ	Slurry, maize	130	26	13111	1177			
	LD-SF	Slurry, food waste	185	0	12016			2600	
	LD-M	Miscanthus	NA	25					315
Average dairy	MD-BL	NA	NA	0					
	MD-S (heat only)	Slurry	NA	0	2366				
	BAD-SGMZ	Slurry, grass, maize	112	66	168	905	1836		
	MD-M	Miscanthus	NA	8.5					107

BL = baseline farm scenario (250 ha LD-BL; 85 ha SD-BL); BE = bioenergy; LD = large dairy; MD = medium dairy; BAD = Beef+AD farm (conversion from medium dairy)

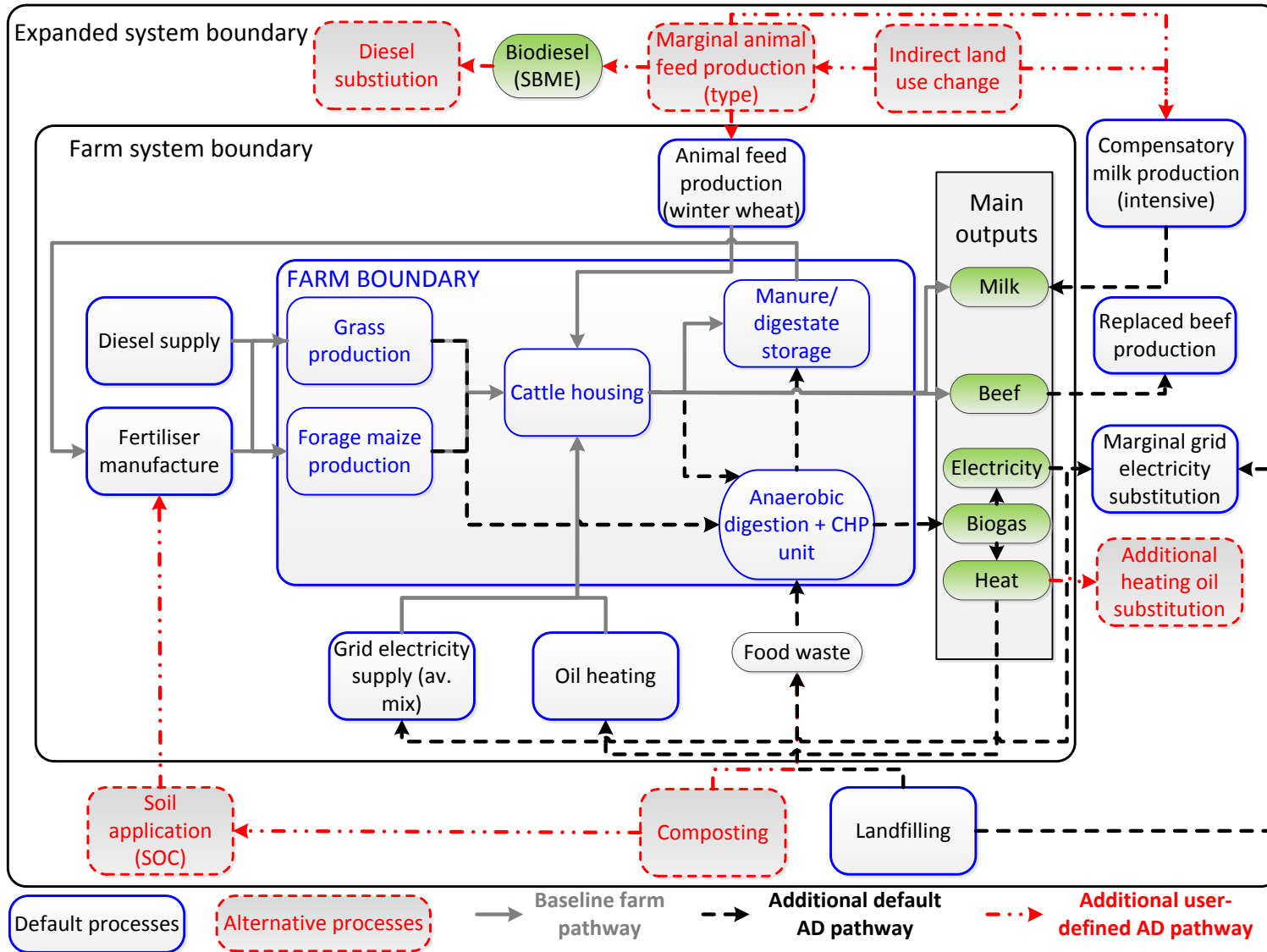


Figure 1. Dairy LCA schematic.

Table 2. Arable scenario descriptions

Scenario name	Feedstock	CHP capacity	Energy crop area	Manure (10% DM)	Maize (30% DM)	Grass (25% DM)	Food waste (20% DM)	Misc-anthus (DM basis)	Winter wheat grain (85% DM)	Rape seed (85% DM)
		kWe	ha	Tonnes/yr input						
A-BL	NA	NA	0							
A-F	Food waste	484	0				10,000			
A-MZ	Maize in rotation	1000*	40		1800					
A-MZ100	Maize in monoculture	882	400		18,000					
A-G	Grass	1000**	40			1600				
A-M	Miscanthus	NA	40					504		
A-Eth	Winter wheat	NA	100						875	
A-Biod	Oil seed rape	NA	100							330
AP-BL	NA	NA	0							
AP-SF	Pig slurry, food waste	324	0	5,229			6,000			

BL = baseline farm scenario (400 ha arable farm)

BE = bioenergy

*Central AD unit supplied by 19,370 t maize annually, produced on 40 ha in each of 10.8 supply farms modelled on the baseline arable farm

** Central AD unit supplied by 23,302 t grass annually, produced on 40 ha in each of 14.6 supply farms modelled on the baseline arable farm