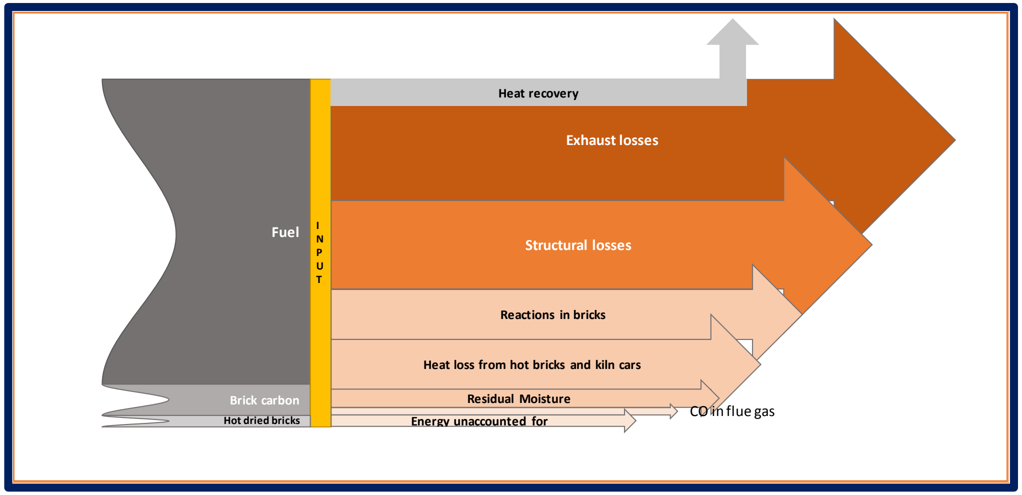
Thermal Tool

Clay Brick Fix Kiln Energy Assessment Tool



Outline

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- Introduction to the Thermal Tool
- Typical tunnel kiln plant
- Theoretical heat requirements
- Google Docs User Interface (UI)
- Worked example
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- Example best practice recommendations
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Why use the Thermal Tool?
Heat dominates energy use (by kwh) and needs an energy efficiency focus

ENERGY EFFICIENT CLAY BRICK EECB
swisscontact
CARBON TRUST

HEAT (>90%)

- Drying and firing are key opportunities for energy reduction
- Energy efficiency audits would benefit from a keener focus on opportunities for heating energy reduction

ELECTRICITY (<10%)

- Typically, lower amount of energy (kWh) but high overall cost
- Has often been the core focus of EE measures to date

Introduction to Thermal Tool

What is the thermal tool?

- Spreadsheet model built in Google Docs
- Not a physical tool like a multimeter

Who will use it?

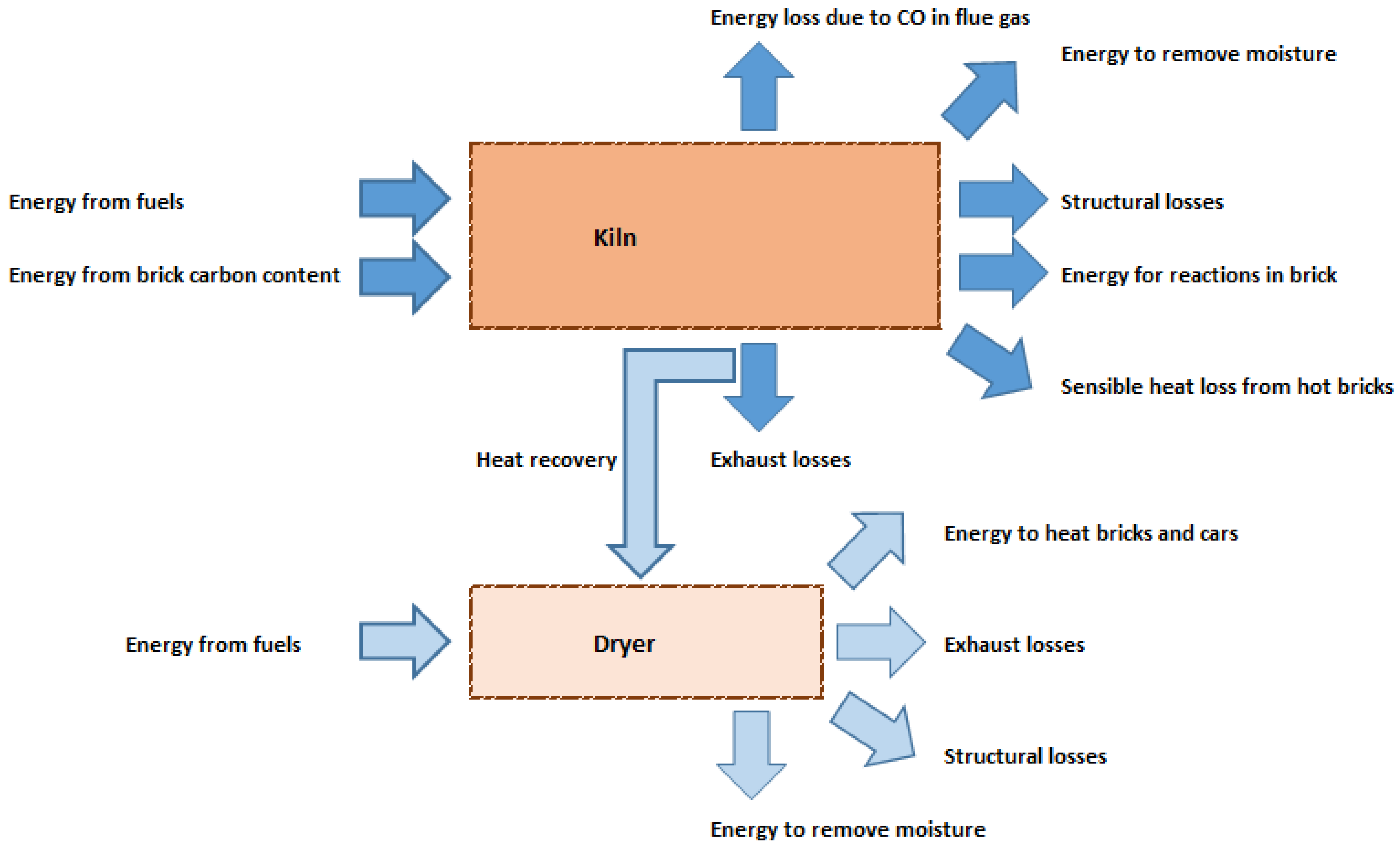
- Applies to fixed kilns only
- About 25% of brick manufacturers in South Africa

Why use it?

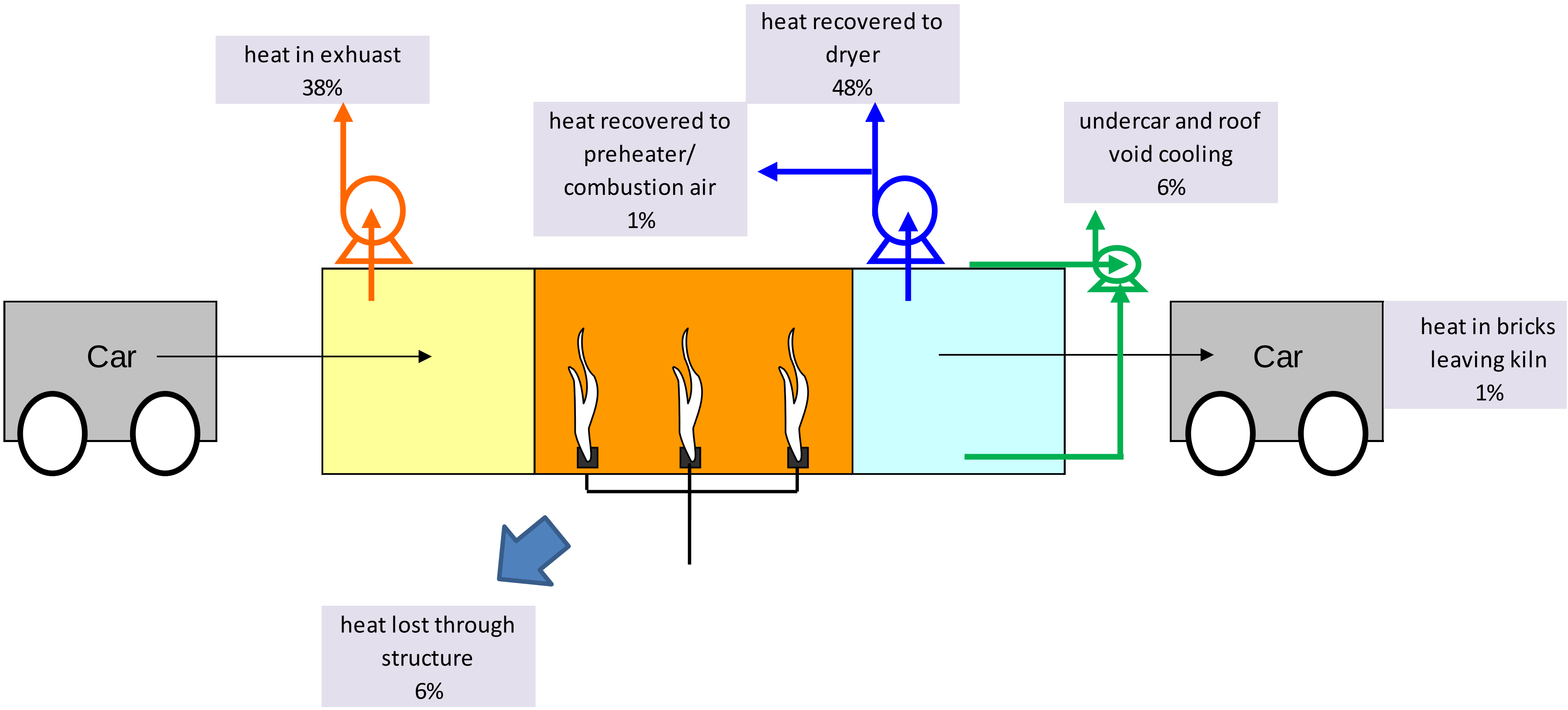
- Identifies and quantifies potential cost savings
- Visualise Specific Energy Consumption (SEC)
- Track progress on SEC improvements
- Scenario planning
- Training
- What can you think of?

Typical tunnel kiln plant

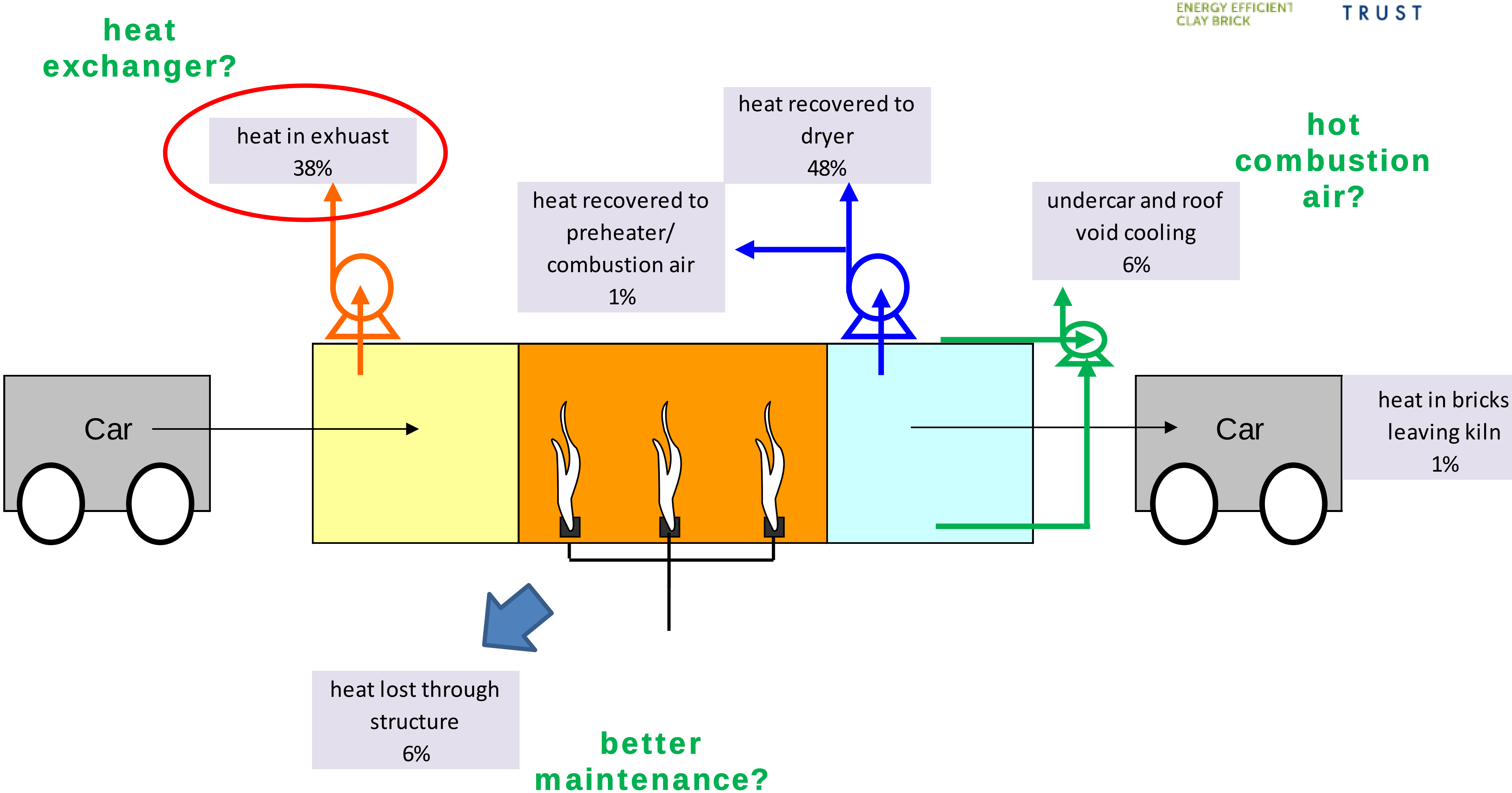
Typical tunnel kiln plant heat balance



Typical tunnel kiln plant heat balance



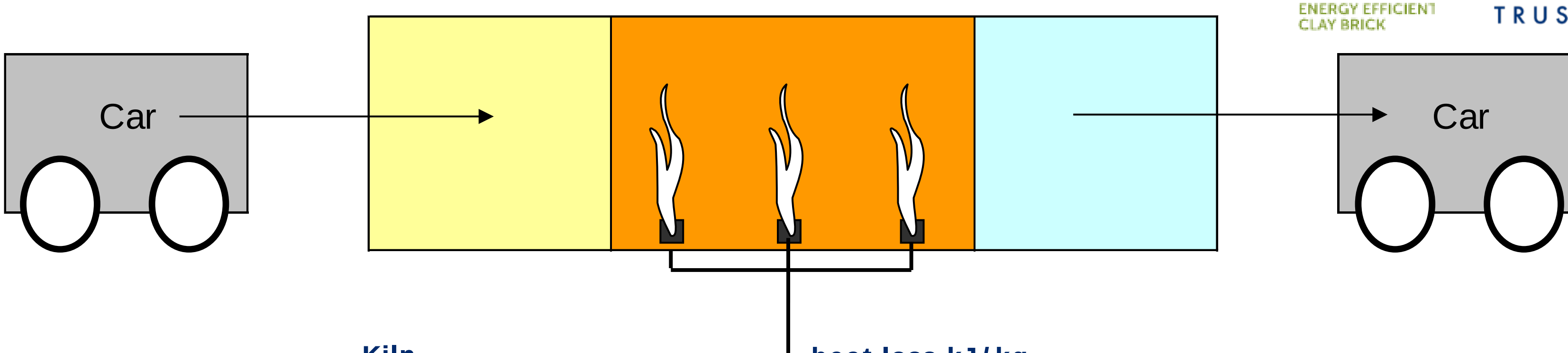
Typical tunnel kiln plant heat balance



Theoretical energy requirements

Product / Process	Minimum Energy Requirement MJ/kg
Drying extruded brick, 15% moisture content	0.7
Drying extruded brick, 28% moisture content	1.0
Minimum energy for firing (fossil fuels)	1.0
Recoverable heat	0.8
Extruded brick	0.9
Soft mud brick	1.2

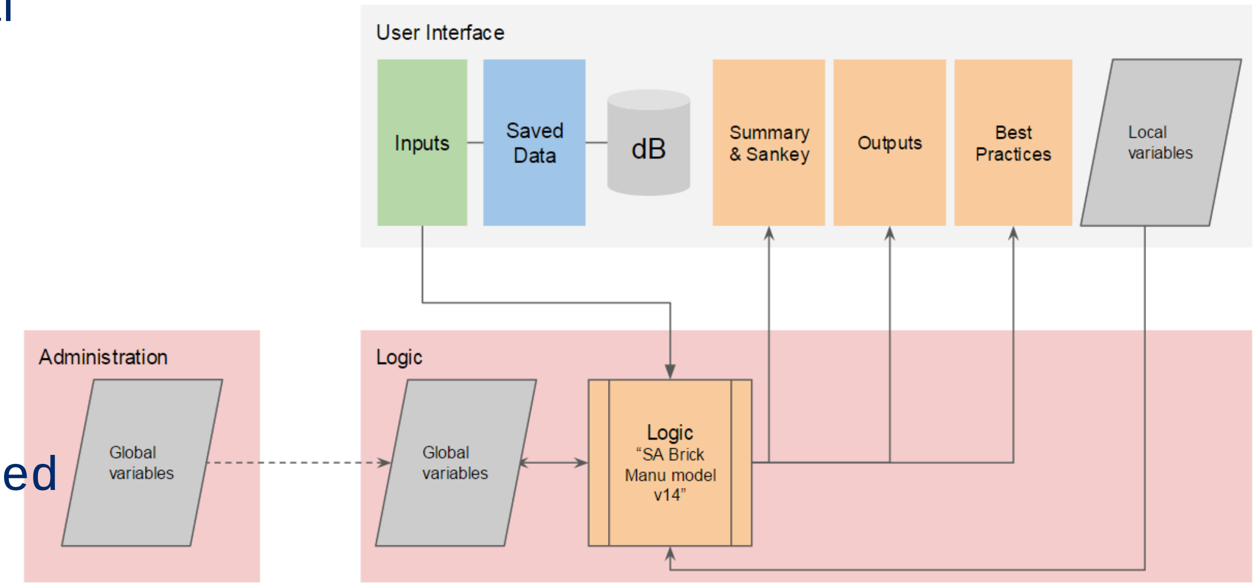
Theoretical energy requirements



Kiln	heat loss kJ/kg
brick go in at 20ºC and come out at 100ºC	65
air goes in at 20ºC and comes out at 100ºC 200% excess air	20
kiln is 100m long, 3m high and 5m wide all surfaces are at 60ºC	15
1% residual moisture	25
TOTAL FIRING	120
Dryer	
dryer 18% m/c to 0%	500
TOTAL THERMAL	620
	0.6 MJ/kg

Google Docs User Interface (UI)

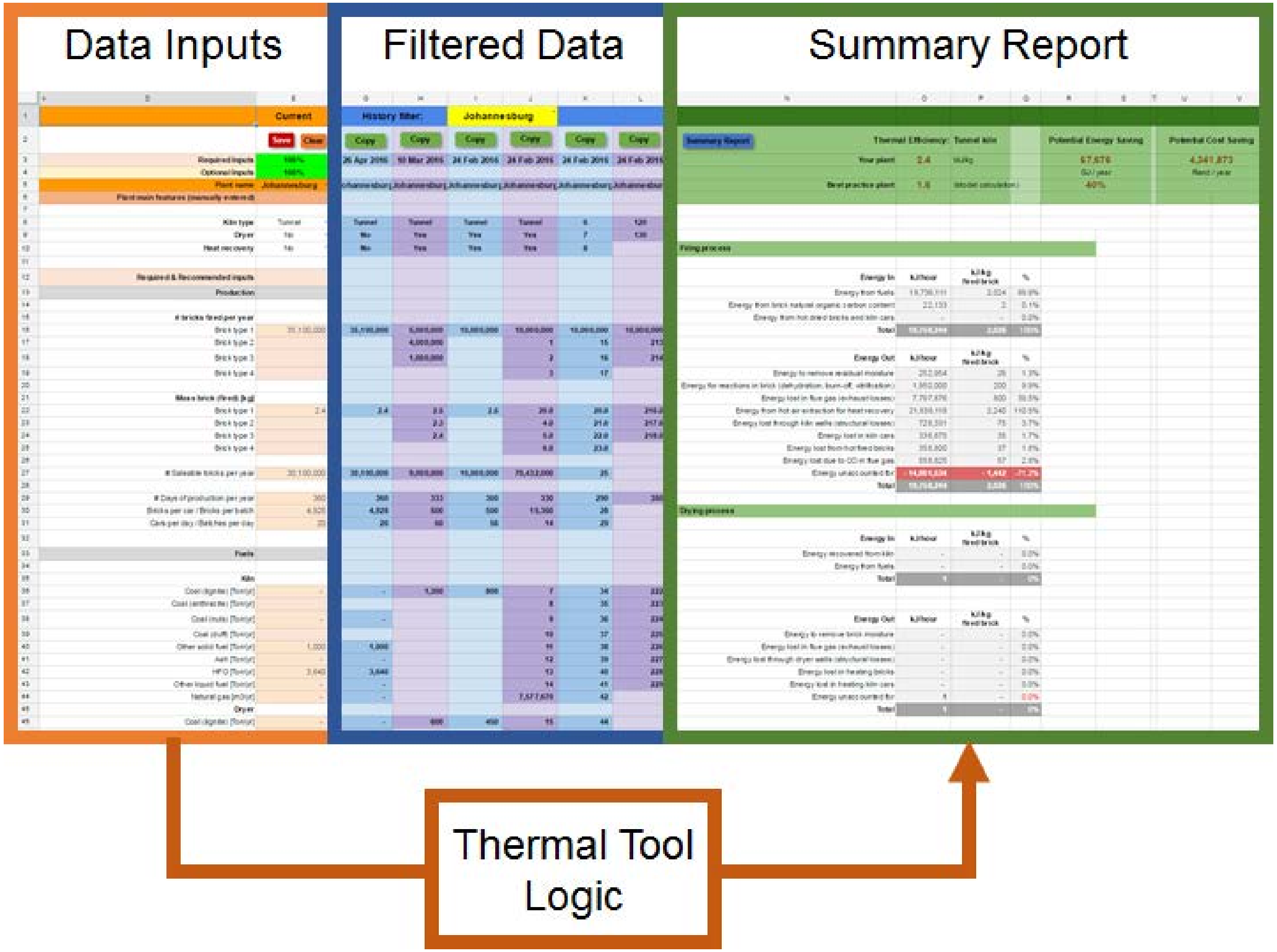
- Each company has their own, exclusive UI built in Google Docs
- UI is accessed through an authorised Google account
- Online user manual



Advantages

- IP remains controlled
- Internet based
- Interface via tablet
- Secure for each user
- No adulteration of model
- Individual users can determine own methods
- Work in progress

Google Docs User Interface (UI)



Worked Example:
Why is energy so important?

		Sep 15	Oct 15	Nov 15	Dec 15	Jan 16
		Actual	**Actual**	**Actual**	**Actual**	**Actual**
Production Costs % Split						
All	Energy Costs	45.0%	44.9%	43.7%	44.3%	41.9%
All	Manpower Costs	29.8%	29.5%	27.8%	32.3%	30.7%
All	Raw Material Costs	8.1%	7.6%	10.1%	5.2%	6.5%
All	Maintenance Costs	12.7%	13.2%	13.7%	12.9%	14.8%
All	Overhead Costs	4.4%	4.8%	4.7%	5.3%	6.1%
All	Total Production Costs	100.0%	100.0%	100.0%	100.0%	100.0%

- How much time is spent on spend dealing with people issues?
- How much time on breakdowns / maintenance issues?
- Does energy get anywhere near 42% of the attention?

Worked Example:
Why is energy so important?

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Energy Costs as %								
Fuel oil	55%	61%	70%	72%	72%	68%	72%	70%
Electricity	37%	38%	24%	22%	21%	25%	22%	23%
Diesel	8%	1%	7%	6%	7%	7%	6%	7%
Total	100%	100%	100%	100%	100%	100%	100%	100%
Energy consumption % of total								
Fuel oil - (1Ltr = .91kg)	90%	92%	91%	92%	92%	90%	91%	91%
Electricity	8%	7%	7%	6%	6%	7%	7%	7%
Diesel (500ppm)	2%	0%	2%	2%	2%	3%	2%	1%
Total	100%	100%	100%	100%	100%	100%	100%	100%

- Fuel oil is 90% of energy consumption but 70% of cost
- Electricity is only 7% of energy consumption but 23% of cost

Worked Example:
Choosing the product mix

-Production Summaries		Nov'15	Dec'15	Jan'16	Feb'16	Last 12 Months
NFP	1.000	2 490.000	2 422.500	1 909.000	1 788.500	20 680.500
NFP 2nd	1.000	132.000	70.000	57.000	54.000	1 283.000
Face	1.000	-	-	-	-	-
Face 2nd	1.000	-	-	-	-	-
Maxi	1.300	-	147.347	446.118	158.413	1 361.074
Maxi 2nd	1.300	-	12.813	15.142	5.242	100.755
Econo	0.850	-	-	-	-	60.180
Econo 2nd	0.850	-	-	-	-	6.120
S/maxi	1.700	-	-	69.737	270.841	360.580
S/maxi 2nd	1.700	-	-	1.622	12.974	50.816
Total		2 622.000	2 652.660	2 498.620	2 289.969	23 903.026
NFP		2 622.000	2 652.660	2 498.620	2 289.969	23 903.026

- Product mix changes all the time
- No two periods have ever been the same
- Don’t spend too much time on the detail

Worked Example: HFO usage

	B	C	D	AN	AO	AP	AQ	A	AS	A
1				Nov'15	Dec'15	Jan'16	Feb'16		Last 12 Months	
2										
118										
119										
120	No of production days			30	31	31	29		325	
121	Average No of cars per day			20.2	19.9	19.5	19.4		18.4	
122	Fuel used (ltr)			350 580	338 653	341 197	302 602		3 871 520	
123	Average fuel used per day			11 686	10 924	11 006	10 435		11 912	
124										
125										
126										

Example UI outputs

Firing process

Energy In	kJ/hour	kJ/kg fired brick	%
Energy from fuels	23,005,352	2,761	98.9%
Energy from brick natural organic carbon content	2,049	0	0.0%
Energy from hot dried bricks and kiln cars	249,166	30	1.1%
Total	23,256,567	2,791	100%

Energy Out	kJ/hour	kJ/kg fired brick	%
Energy to remove residual moisture	222,895	27	1.0%
Energy for reactions in brick (dehydration, burn-off, vitrification)	1,666,660	200	7.2%
Energy lost in flue gas (exhaust losses)	8,766,130	1,052	37.7%
Energy from hot air extraction for heat recovery	8,349,138	1,002	35.9%
Energy lost through kiln walls (structural losses)	1,592,181	191	6.8%
Energy lost in kiln cars	-	-	0.0%
Energy lost from hot fired bricks	996,663	120	4.3%
Energy lost due to CO in flue gas	58,852	7	0.3%
Energy unaccounted for	**1,604,050**	**192**	6.9%
Total	23,256,567	2,791	100%

there will always be unaccounted energy <10% is good

Drying process

Energy In	kJ/hour	kJ/kg fired brick	%
Energy recovered from kiln	8,349,138	1,002	100.0%
Energy from fuels	-	-	0.0%
Total	8,349,138	1,002	100%

Energy Out	kJ/hour	kJ/kg fired brick	%
Energy to remove brick moisture	4,157,676	499	49.8%
Energy lost in flue gas (exhaust losses)	908,269	109	10.9%
Energy lost through dryer walls (structural losses)	442,272	53	5.3%
Energy lost in heating bricks	664,442	80	8.0%
Energy lost in heating kiln cars	-	-	0.0%
Energy unaccounted for	**2,176,479**	**261**	26.1%
Total	8,349,138	1,002	100%

aim for >60%

Energy saving opportunities for your plant		Best practice	Your plant	Energy saving [kJ/kg]	Cost saving [Rand/year]
Reduce moisture content of dried bricks entering kiln	**Moisture**	**1.0%**	**3%**	**113**	**1,008,006**
Ensure bricks are fully dried (below 2% moisture content) prior to entering the kiln.					
Minimise the standing time between dryer and kiln to avoid the re-absorption of moisture.					
Improve combustion efficiency	**CO in flue gas**	**0.05%**	**0.09%**	**47**	**422,963**
Measure kiln O2 profile and use to adjust the burner air, kiln draft and rapid cooling air to return to optimum setting.					
Carry out ongoing daily visual checks on kiln burners to ensure complete combustion at point of entry.					
Use of best quality coal available locally with consistent calorific value and consistent particle size consistent with firing system in place.					
Add fuel only to the kiln when it will quickly combust, i.e. when red heat can be seen or the temperature is above 800°C.					
Oil burners: optimise pulse time and droplet size, drops should combust before reaching kiln deck but not prematurely.					
Improve efficiency of heating	**SEC (MJ/kg)**	**.80**	**2.02**		
Addition of internal fuel (carbon) to minimise the amount of external firing of solid fuel required.					
Maintaining a steady rise in temperature through the efficient combustion of fuel. Controlled continuous firing of kilns is preferable to over-fuelling the kiln, e.g. install PLCs & PID controllers.					
Reduce excess air and air ingress levels	**Excess air**	**200%**	**341%**	**256**	**2,279,724**
Reduce exhaust fan speed to reduce air ingress and reduce heat loss through exhaust.					
Reduce excess combustion air by reducing supply pressure or closing damper positions on individual burners.					
Measure kiln O2 profile and use to adjust the burner air, kiln draft and rapid cooling air to return to optimum setting.					
Use a combustion analyser to measure and minimise excess air levels.					
Reduce waste levels by improving the consistency of the raw materials	**Wastage**	**2.0%**	**13%**	**406**	**3,618,006**
Improvement of raw material mixes by incorporating small quanitities of imported materials. Test mixes first in the laboratory					

Example best practice recommendations

Contact information

For further information, please contact:

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