Carbon-Neutral Maple Syrup Production

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Esprit Dans La Forêt

Net-Zero Maple Syrup Producer

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How is it possible for maple syrup producers to become carbon-neutral?

- Maple Syrup crop trees are a natural mechanism for carbon sequestration
  - The smallest maple tree that is tapped has already sequestered over a metric tonne of CO2 to-date
  - A small sugar bush of 100 young maples (10” dbh) sequesters 1 metric tonne of CO2 / year
  - All the maple trees tapped in Canada represent a sequestration opportunity equivalent to emissions from 500,000 households (e.g. Winnipeg or Quebec City)

Average Diameter at Breast Height (for converstion to circumference)	10	in
Type of Tree / Espece d'arbre	Maple, Sugar or Black / Erable à Sucre ou Noir	
Circumference of tree at Breast height / Circonférence à 1.5 m de taille	31.4	in
Age of Tree (leave blank if unknown) / L'age d'arbre (optionelle)		yrs
Diameter of tree at Breast height/ Diamètre	25.4	cm
Above Ground Weight / Hors sol Poids	618.0	kg
Total Green Weight / Poids verre	736.4	kg
Average Dry Weight / Moyenne de matière sèche	412.4	kg
Carbon Content / Contenu de carbonne	208.8	kg
CO2 Sequestered To Produce That Carbon / CO2 requis pour ce sequestration	765.0	kg
CO2 Sequstered Per Year / CO2 sequestrée par ans	9.56	kg CO2 per yr
Number of Trees of this average size	100	
CO2 Sequstered Per Year / CO2 sequestrée par ans	956	kg CO2 per yr

What about the fuel burned in evaporators?

- Burning wood, pellets, oil, or propane all cause CO2 emissions
- Nonetheless, a maple syrup producer can work within the carbon budget established by the annual sequestration of their sugar bush
- There are 2 key practices that producers can leverage to become carbon neutral:
  1. Reducing the amount of sap needing to be boiled (e.g. ice removal, reverse osmosis)
  2. More effective heat management within the evaporator itself (e.g. improved efficiency)
- The combination of these (to varying degrees) can result in net-zero emissions

With Reverse Osmosis			**Without Reverse Osmosis**		
Input Brix Level	2		Input Brix Level	2	
Output Brix Level From RO	8		Brix after Removing Ice	3	
Sap Reduction Factor	75%	Benefit from RO	Sap Reduction Factor	33%	Benefit from Ice Removal
Input Brix Level at start of boiling	8		Input Brix Level at start of boiling	3	
Syrup Brix Target	66.5		Syrup Brix Target	66.5	
Amount to Boil	22%	of original volume of sap	Amount to Boil	64%	of original volume of sap

Is this greenwashing?

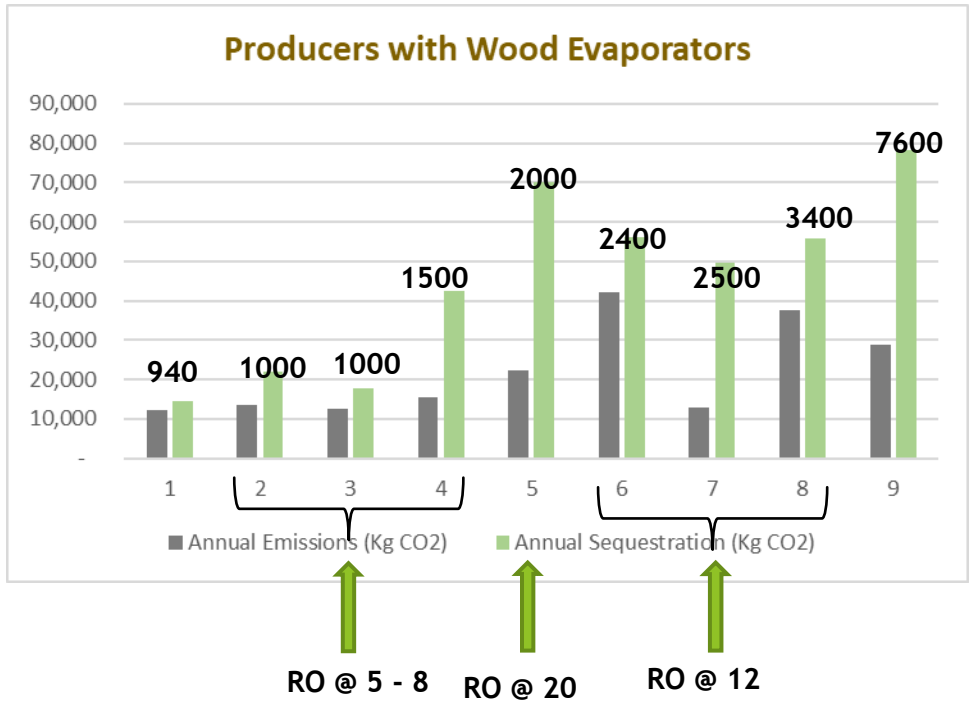
- Using bio-mass as fuel is net-neutral only over the 200-year lifecycle of a maple tree
  - Use of wood as fuel accelerates CO2 emissions compared to the natural cycle
- Our goal is to be climate friendly on an annual net-neutral basis
  - We count all fuel emissions regardless of whether the evaporator uses wood, oil, or propane as fuel
  - We follow internationally accepted rules for carbon accounting established by the GHG Protocol (ISO Standard-14064)
- We account for all Scope 1, 2, & 3 emissions
  - Scope 1: Direct Emissions
  - Scope 2: Indirect Emissions from Electricity
  - Scope 3: Other Indirect Emissions
    - Packaging (direct & indirect)
    - Shipping, Travel
    - Upstream oil & gas
    - Risk management is employed to assess Scope 3 emissions not disclosed by suppliers

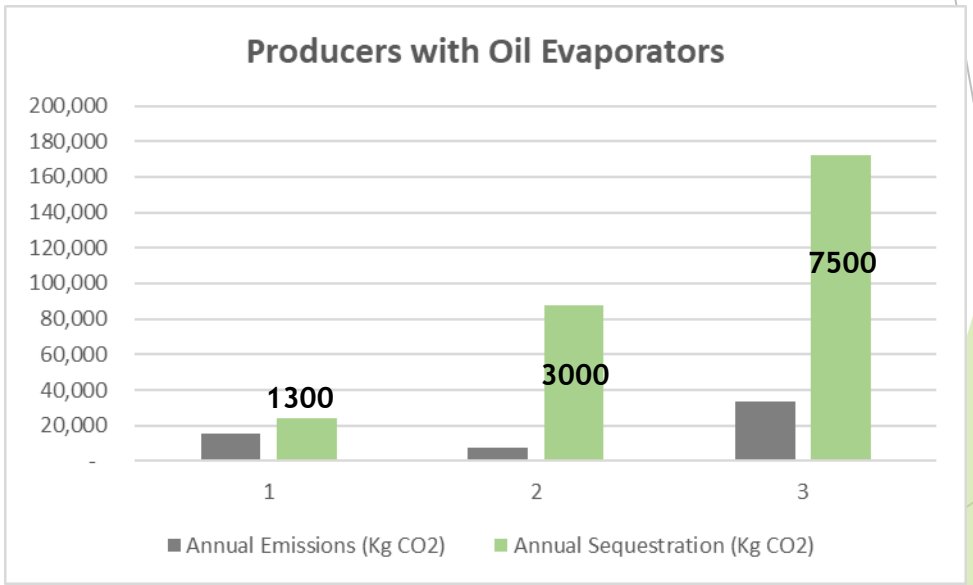
Carbon Footprint High Level Readout			Relevé de haut niveau de l'empreinte carbone
Total Trees	2,666		Totale des arbes
Total Taps	1,335		Entailles totale
Expected Syrup Yield per Tap	2.22	L	Montant de sirop anticipée par entaille
Total Syrup	2,967	L	Totale de sirop
Overall Carbon Budget	24,395	kg CO2/yr	Bilan de carbone
Evaporator Emissions	9,454		Émissions d'évaporateur
Other Scope 1 Emissions	945		Autres émissions de portée 1
Scope 2 Emissions	80		Émissions de portée 2
Scope 3 Packaging	401		Portée 3 émissions d'emballage
Scope 3 Customer	2,095		Portée 3 émissions des clients
Lifecycle Fuel Emissions	1,970		Émissions du cycle de vie du combustible
Other Scope 3 Allocation	200		Autres émissions de portée 3
Total Emissions Estimate	15,146	kg CO2/yr	Totale d'émissions
Excess Sequestration	9	T CO2/yr	Marge de manœuvre dans le bilan carbone
Per Tree	3.47	kg CO2/yr	Par Arbre
Per Tap	6.93	kg CO2/yr	Par Entaille
Per L Syrup	3.12	kg CO2/yr	Par L de Sirop

Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard developed by the World Business Council for Sustainable Development and the World Resources Institute

This might work for the little guy but what about large-scale producers?

- Larger producers have larger carbon budgets and are more efficient due to: scale, larger reverse osmosis capacity, and use of more heat-efficient evaporators
- To-date we have evaluated producers totalling 60,000 taps that are carbon-negative annually:





How do you determine CO2 sequestered?

- We inventory trees in the sugar bush (including both tappable & non-tappable trees)
  - Actual inventory (small sugar bushes) or Basal survey or Simplified inventory based on number of taps
- We calculate:
  - Total biomass based on national allometric parameters for Canada by tree species by tree component (crown, stem, roots, foliage)
  - Total CO2 sequestration based on converting biomass to dry weight and % carbon by species and chemical ratio of Carbon to CO2 during sequestration
  - Annual sequestration from the total CO2 divided by the rate of tree growth based on sugar bush type and management practices

Area (acres)	80		***Non-Tappable / Non-utilisable***	***Tappable Ranges /Catégories Utilisable***						
Area (Ha)		32		*1*	*2*	*3*	*4*	*Taps in Each Range /Entialles par Catégorie*		
	Species / Espèce		4-30 in	31-47 in	48-62 in	63-77 in	78+ in			**Type**
	Maple, Sugar or Black / Erable à Sucre ou Noir		3300	2640	680			6620		Maple / Erable
	Maple Silver or Striped / Erable Argenté		0					0		Maple / Erable
%Non-Maple	Maple Red / Erable Rouge		0					0		Maple / Erable
13%	Other Hardwood / Autre Feuillu		429	343	88	0	0	860		Hardwood / Feuillu
2%	Other Softwood / Autre Résineux		66	52	13	0	0	131		Softwood / Résineux
		Subtotal Trees / Arbes	3795	3035	781	0	0	7611	Trees / Arbes	
		Subtotal Taps / Entailles		2640	1360	0	0	4000	Taps / Entailles	Per Ha
		Basal Area	74.84 -	217.94	115.19	-	-	408	Sq M	12.6
		Avg Diameter (in)	6.24	11.90	17.06	18.40	18.40		4,391 Sq Ft	
		Total Sequestration / Yr	78,163.8	Kg CO2 / yr		Average Per Tree		10.27	Kg CO2 / yr	

How easy is it for producers to become net-zero?

1. A simplified assessment can be done in an hour
   - Provides conservative assessment of your net carbon footprint
   - Enables you to determine if you are already a climate friendly maple syrup producer
2. Based on initial assessment you can
   - Implement improvement activities, usually to improve evaporator efficiency
   - Obtain a more detailed assessment certified by The Lanigan Group

How can you improve heat management in wood evaporators?

1

Improve the generation of heat by employing energy released by BOTH primary & secondary combustion

- Primary combustion occurs at 550’F (the ignition point of wood)
- Secondary combustion occurs at 1100’F (the ignition point of the exhaust gases)
- We DO NOT NEED TO INCREASE HEAT to produce secondary combustion, we need to optimize air flow

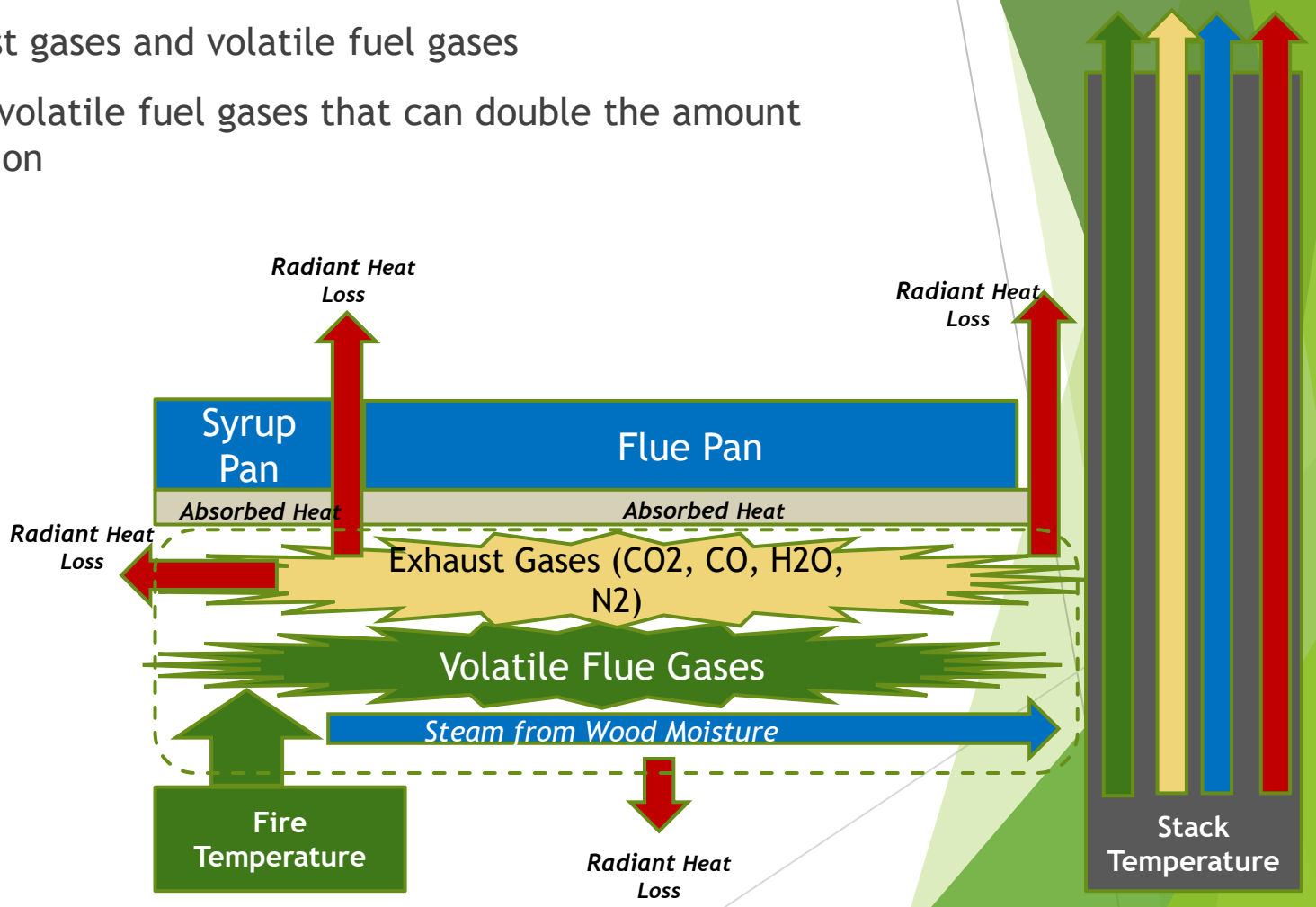
2

Improve the use of heat by the evaporator once it has been generated

- Maximize the retention of hot exhaust and flue gases
- Create air flow that recirculates heat into secondary combustion chambers
- Reduce heat loss due to radiation and escape of hot gases
- Avoid premature loss of heat due to suction via the chimney

1st Law of Thermodynamics – Preservation of Energy

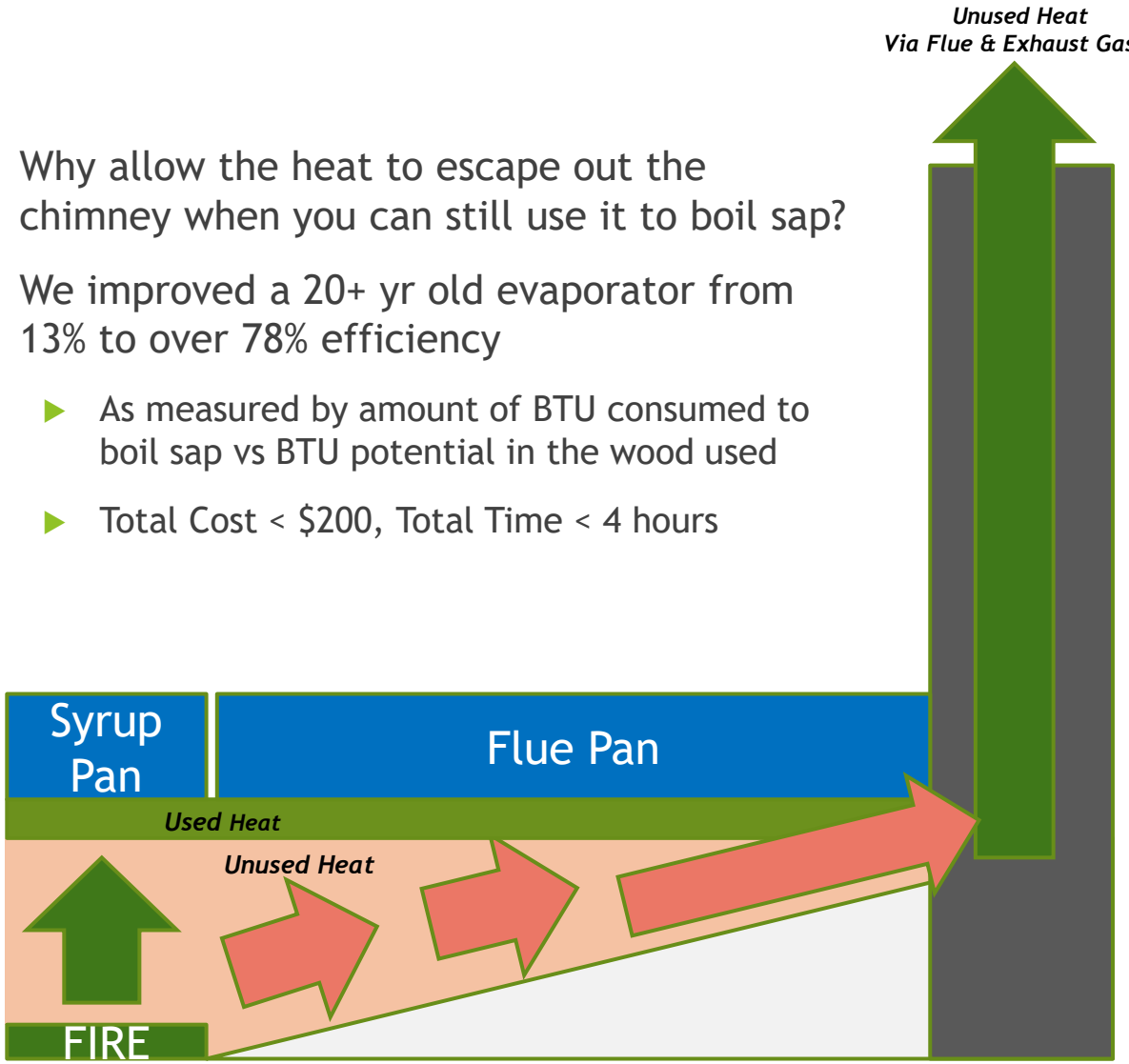
- Primary combustion produces both exhaust gases and volatile fuel gases
- Secondary combustion releases energy in volatile fuel gases that can double the amount of energy released from primary combustion
- If your stack temp is too high, you are wasting heat that should be used to boil sap
- Almost all commercial wood evaporators are less than 50% efficient, older evaporators are less than 15%
- Don't believe manufacturer claims of >80% efficiency, they are measuring combustion efficiency (how well it burns wood) not evaporation efficiency
- Improving evaporator efficiency produces dramatic reduction in fuel consumption & in CO2 emissions



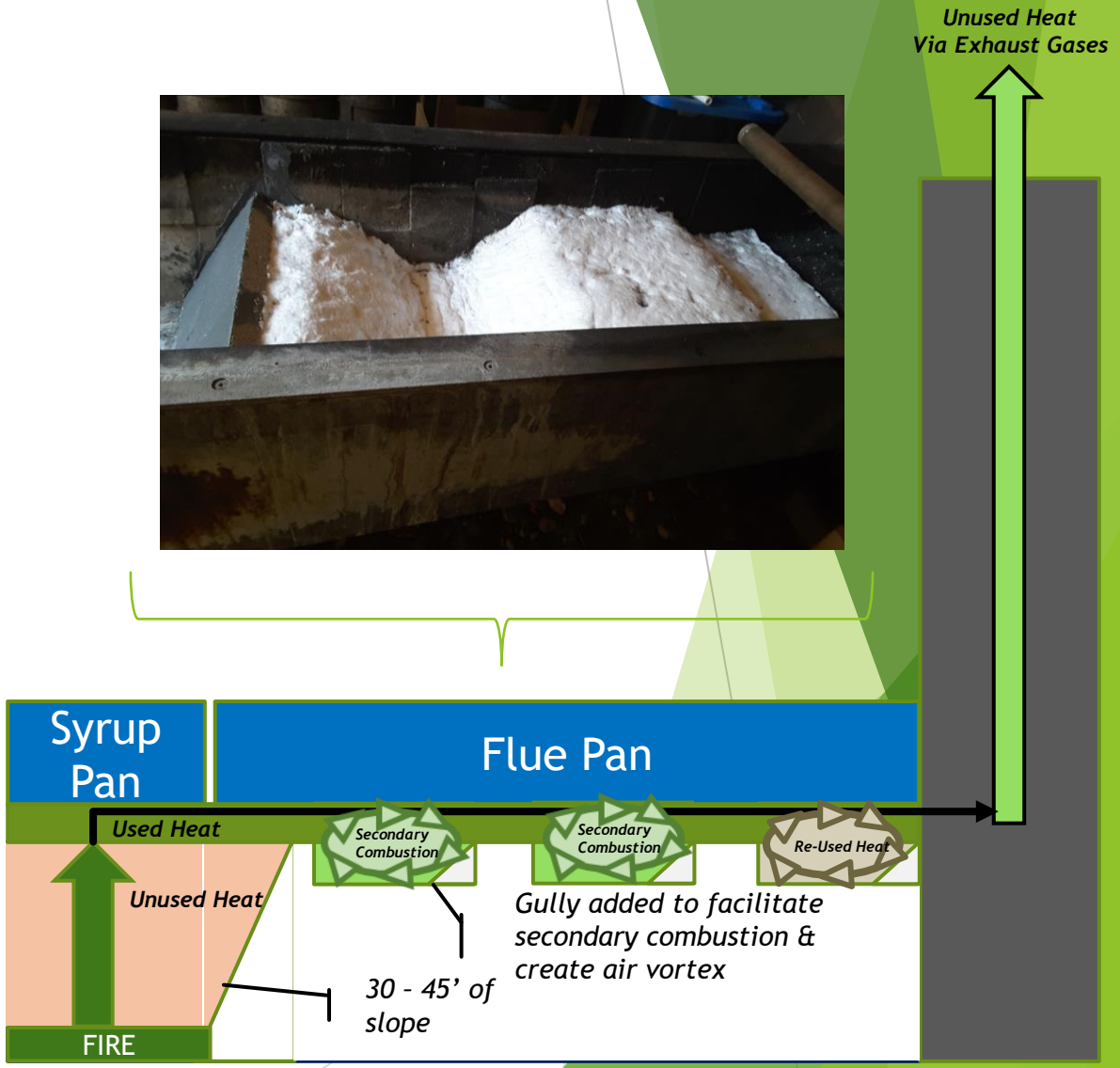
Stack Temp = Fire Temp - (Absorbed Heat - Radiant Heat Loss)

Improving use of heat in a wood evaporator

- Why allow the heat to escape out the chimney when you can still use it to boil sap?
- We improved a 20+ yr old evaporator from 13% to over 78% efficiency
  - As measured by amount of BTU consumed to boil sap vs BTU potential in the wood used
  - Total Cost < $200, Total Time < 4 hours



Inefficient Evaporator



Efficient Use of Heat

Rules of Thumb For Fuel Consumption

Assuming 1 L of syrup / tap & 1 tap / tree in an average sugarbush		
Oil	Each tap is a tree that sequesters 32.4 kg CO_2e / L of syrup produced	If you consume 1 L of oil / L of maple syrup produced: • Each L of oil emits 4.3 Kg of CO_2e • If you consume less than 1 L of oil for each litre of maple syrup produced, you will be better than carbon neutral
Wood	If you produce > 100 L syrup per cord of wood consumed • The 100 trees it takes to produce 100 L will sequester 3,241 kg CO_2e	Emissions vary depending on type & age of wood, but an average of 2800 kg CO_2e / bush cord is reasonable

Wood Evaporator Efficiency

Divide your total syrup produced (Litres) by Cord of wood consumed

Evaporator Efficiency	Output: L Syrup (@ 66 Brix) / Cord												
	50	80	100	200	300	400	500	600	700	800	1000	1500	2000
2.5	19%	30%	37%	74%									
6	8%	12%	15%	31%	46%	61%	77%				*Unattainable*		
8	5%	9%	11%	22%	33%	44%	54%	65%	76%	87%			
Input 10	4%	7%	8%	17%	25%	33%	41%	50%	58%	66%	83%		
Brix 12	3%	5%	7%	13%	20%	26%	33%	40%	46%	53%	66%		
16	2%	4%	5%	9%	14%	18%	23%	27%	32%	36%	45%	68%	
18	2%	3%	4%	8%	12%	15%	19%	23%	27%	31%	39%	58%	77%
20	2%	3%	3%	7%	10%	13%	17%	20%	23%	27%	33%	50%	66%
Colour Legend	**Unacceptable**					**Not Good**				**Good**		**Very Good**	

Top 3 Reasons For Becoming Net-Zero

- Most maple syrup producers are motivated to transition based on one or more of the following reasons:
  1. Good for the environment
     - Ethically responsible
     - Enables immediate action on fighting climate change instead of waiting for others
  2. Increases efficiency
     - Don't like cutting wood, buying so much fuel, …
     - Lowers costs
  3. Financial benefit
     - Increased sales to climate-conscious customers via positive brand association
     - Opportunity for product differentiation in a crowded market
     - Potential for downstream tax breaks or carbon credits in future

Summary

- Carbon Neutral maple syrup production is within reach for all maple syrup producers regardless of their size or fuel usage
- Most producers will employ a combination of both reverse osmosis and improved heat management to attain carbon-neutral production
  - Producers who do not use reverse osmosis will need to pay more attention to heat management
- Our freely distributed guide (available in both English & French) facilitates the transition
- Next Steps:
  - Download and read the detailed guide on Becoming Net-Zero Maple Syrup Producer
  - Make the decision to transition to net-zero emission production & inform paul@espritdanslaforet.ca
    - We answer your questions and provide further support if you require it
    - Schedule for a preliminary assessment of your carbon footprint

Questions?

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See also the Net-Zero page at www.spiritintheforest.ca

Supplementary Info

Case Study: Oil Evaporator Efficiency from an Ontario producer using RO with over 4,000 taps

Oil Heat Calculator / Calcul de Chauffage avec Huile **This tab is important for analyzing your net carbon footprint / Ce tableau est necessaire pour l'analyse de carbone.**

This tab is essential if you are using oil to fuel your evaporator
Ce tableau est necessaire si vous utiliser huile comme carburant.
Calculates the efficiency of your boil based on oil consumption.
Donner la consummation d'huile, la feuille va calculer l'efficacité de votre broullage
You can hide the rows for the types of wood you do not use (right-click Hide Row).
Vous pouvez cachée les linges pour les espèce de bois qui vous n'utilise pas.

Amount of Oil Used Montant d'Huile consumée	1589	L	Oil Heat Potential Chauffage potentiel dèHuile	0.039548342	M BTU / L	62,842,316	BTU Potential
Total Syrup Produced Montant de Syrop Produit	3100	L	Input Brix Brix aux commencement	9	If you use RO, enter the output brix from your RO here. Si vous utilise OI, entrer le Brix emis par l'OI ici.		
			Syrup Brix Brix de sirop	67			
			To Boil A bouillir	86.6%			

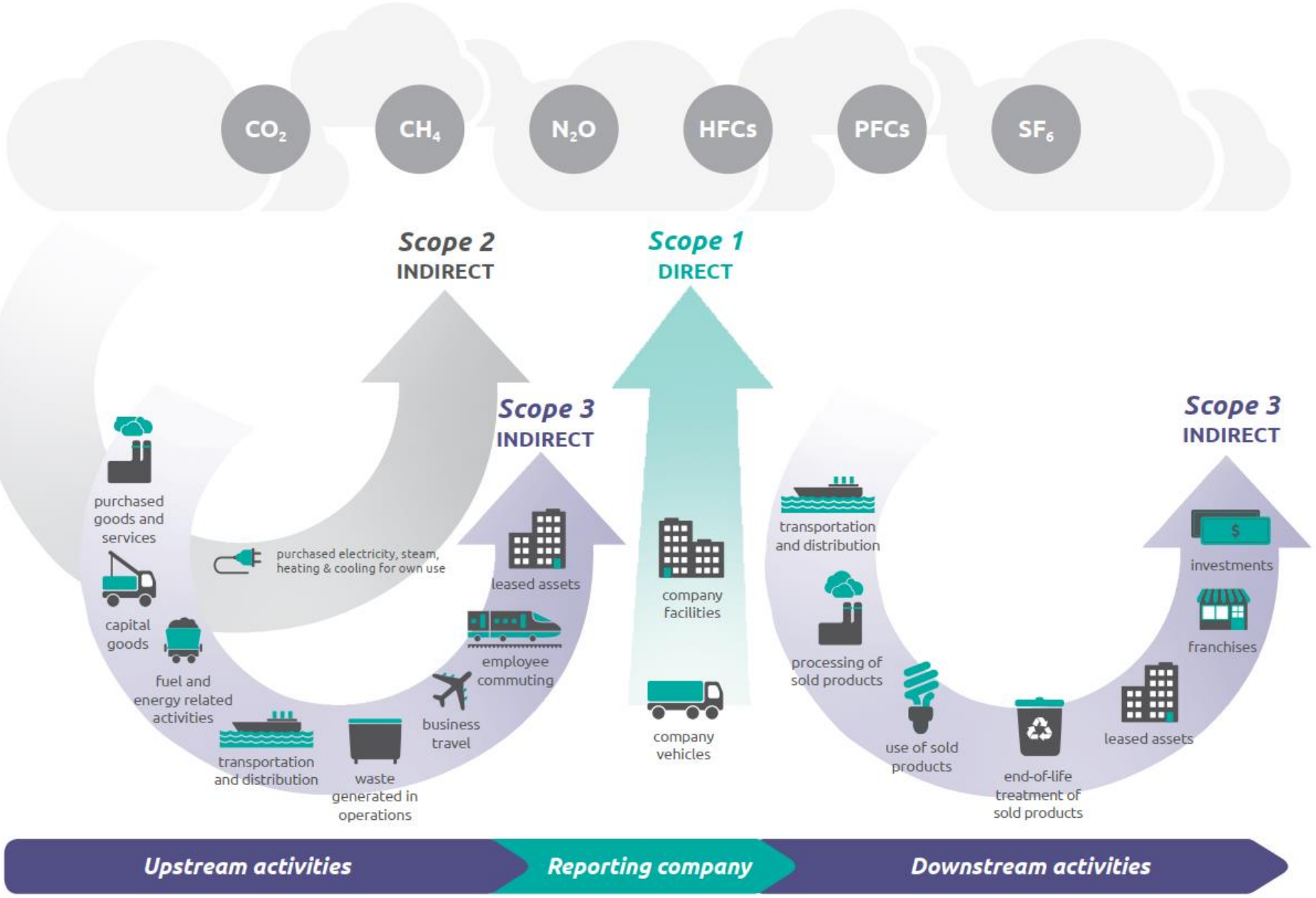
Amount of Water Evaporated Montant de l'eau bouilli	23,078	BTU Required BTU Requis	58,409,856

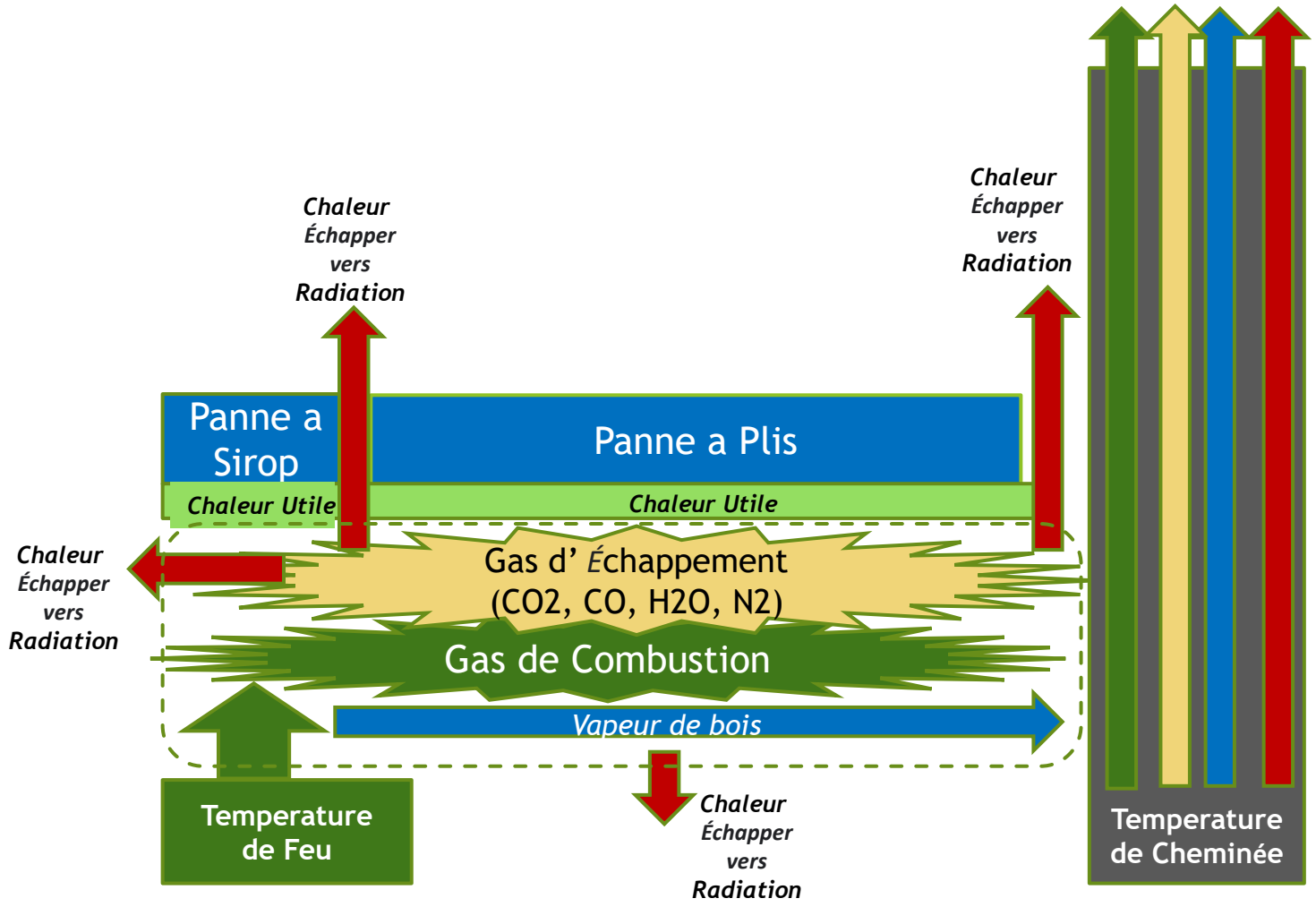
Evaporator Efficiency L'efficience de l'evaporateur	93%	This is how efficient your evaporator is in boiling sap using current oil Ceci indique l'efficacité avec l'huile courant

3 Commonly Held Myths About The Importance of Climate Action in the Maple Syrup Industry

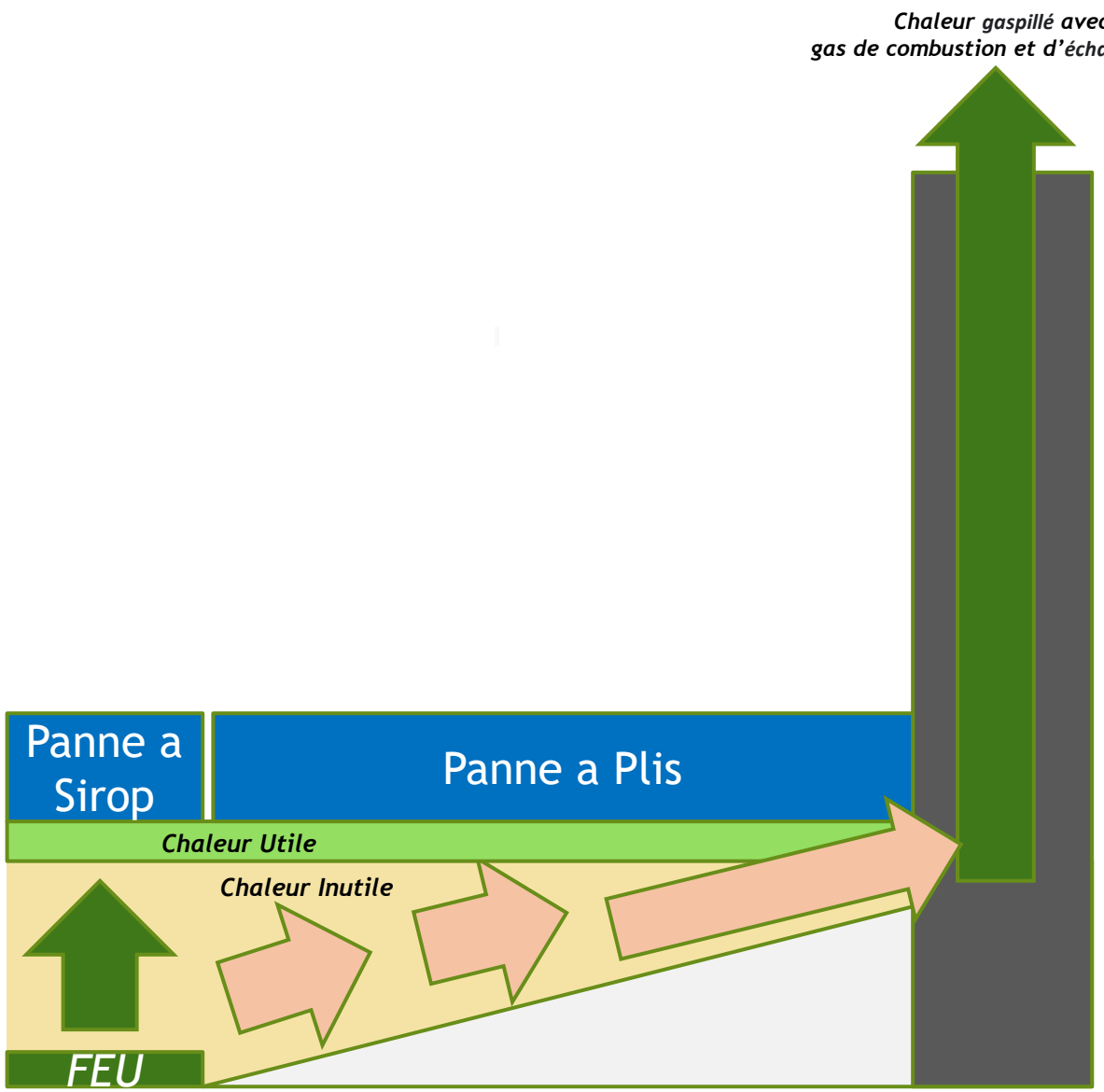
1. **The first myth** is whether anything we do matters because of bigger emitters elsewhere.
   - Our collective actions add up and can influence others.
   - The efficiency & marketing benefits of being net-zero are compelling regardless of the level of climate impact overall
2. **The second myth** is that maple syrup production using wood or pellet evaporators is inherently carbon neutral because wood is a renewable resource.
   - While this is true over the lifetime of a maple tree (if many simplifying assumptions are made), it is not much help if severe global warming becomes irreversible within a decade. We can do much better by being carbon neutral now & every year.
   - Only by ensuring all your emissions are in balance with your sugarbush's sequestration can you prove that you are carbon neutral.
3. **The third myth** is based on the question of "additionality". This myth would have us believe that the sequestration of carbon by our sugarbush does not matter because they are already sequestering carbon regardless of our activities
   - The entire climate problem is caused by our society's inability to operate in balance with nature. If, as a society, we bring our activities back into balance, the problem is solved.
   - By ensuring our maple syrup production is within the budget of sequestration established by the trees that we tap, we are solving our part of the problem at a local level and acting as role models for others.
   - The principle of "additionality" only applies if you are trying to sell carbon credits to others. However, in agriculture and forestry, the IPCC has introduced the concept of "Managed Land" on which natural sequestration can be used to offset human-caused emissions. In Canada & the USA, most of the land occupied by sugarbushes is designated as "managed" by Environment Canada.
     - Once you bring your own activities into a net-zero balance, any excess sequestration beyond that point is of general benefit to others.

Figure [1.1] Overview of GHG Protocol scopes and emissions across the value chain

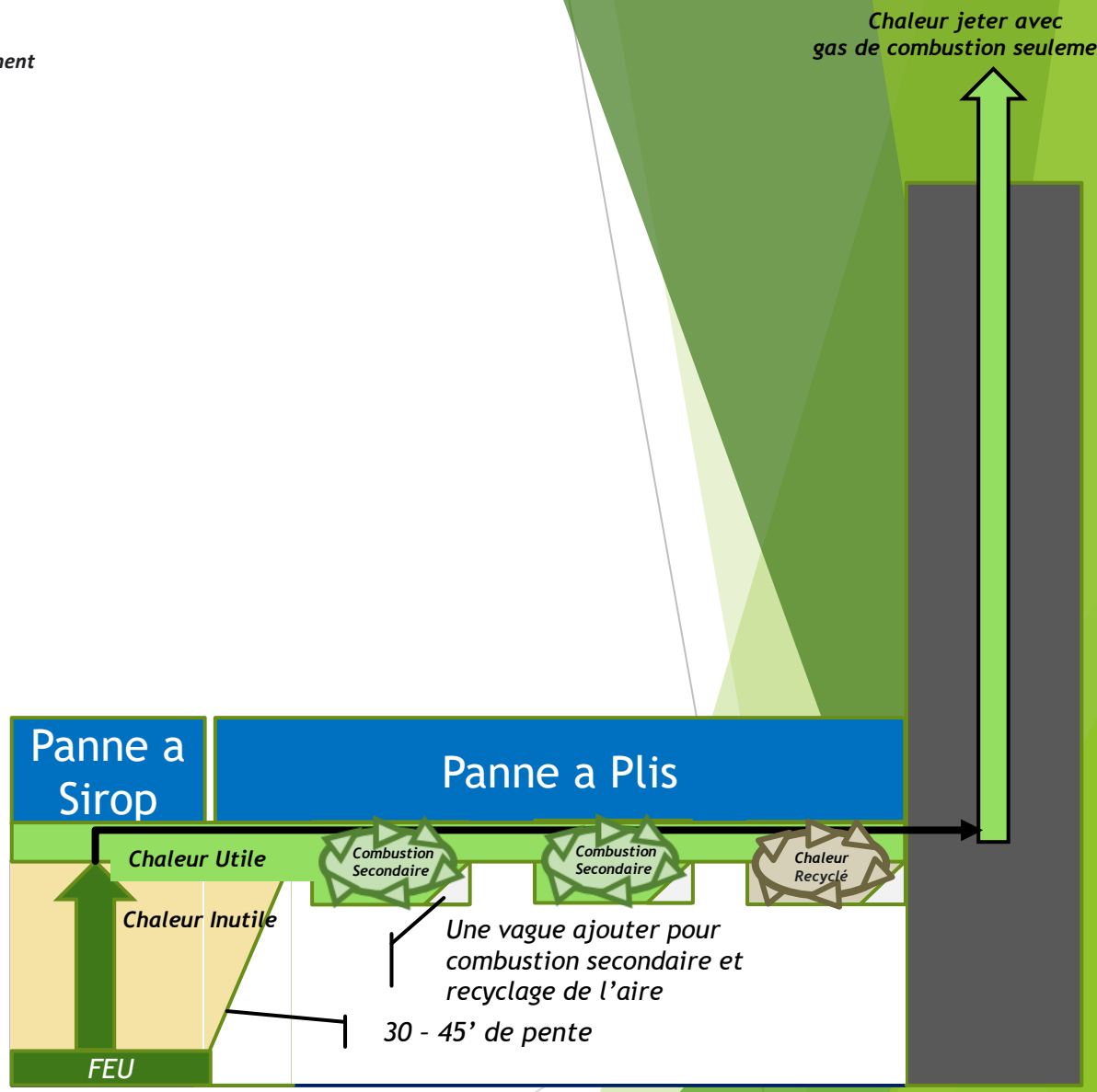




Temperature de Cheminée =
Temperature de Feu - (Chaleur Utiliser - Chaleur Échapper)



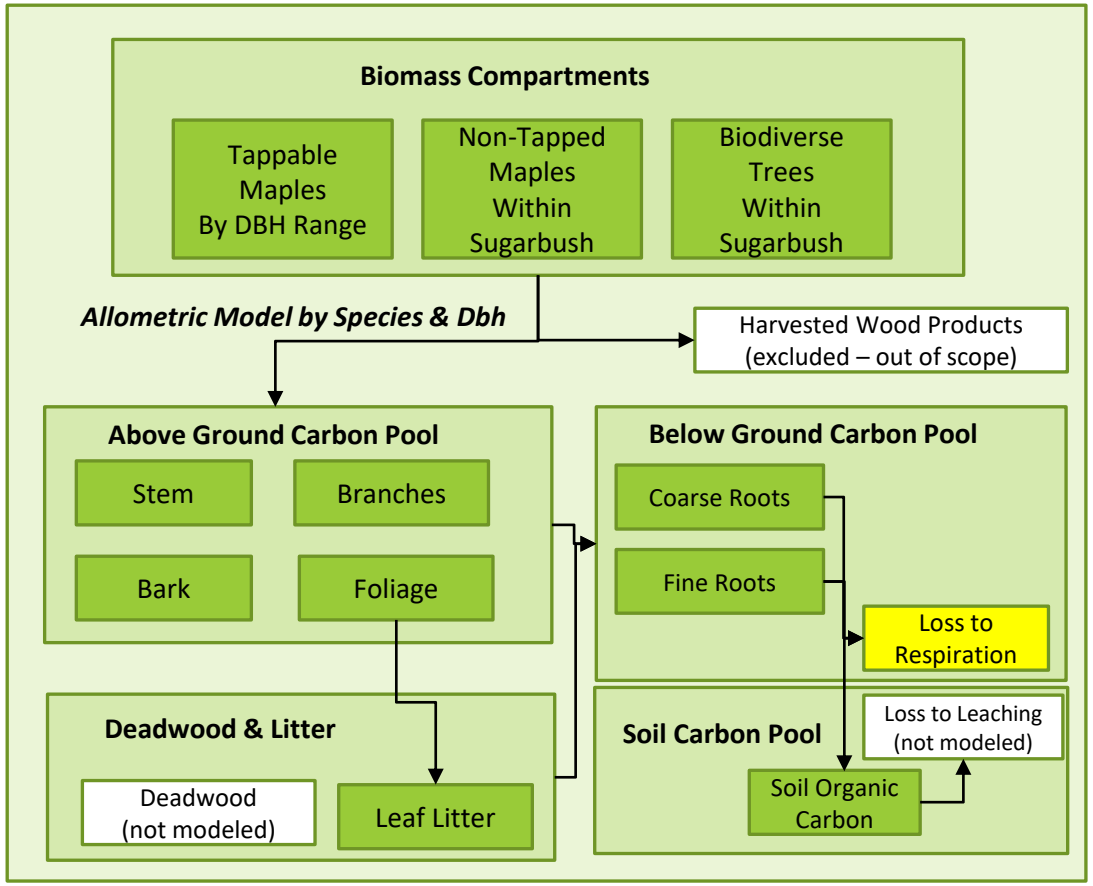
Evaporator Inefficace



Evaporator Efficace

Maple Syrup Producer Carbon Modeling

Annual Sequestration By IPCC-Specified Carbon Pool



Annual Emissions By ISO 14064 Scope of Activity