



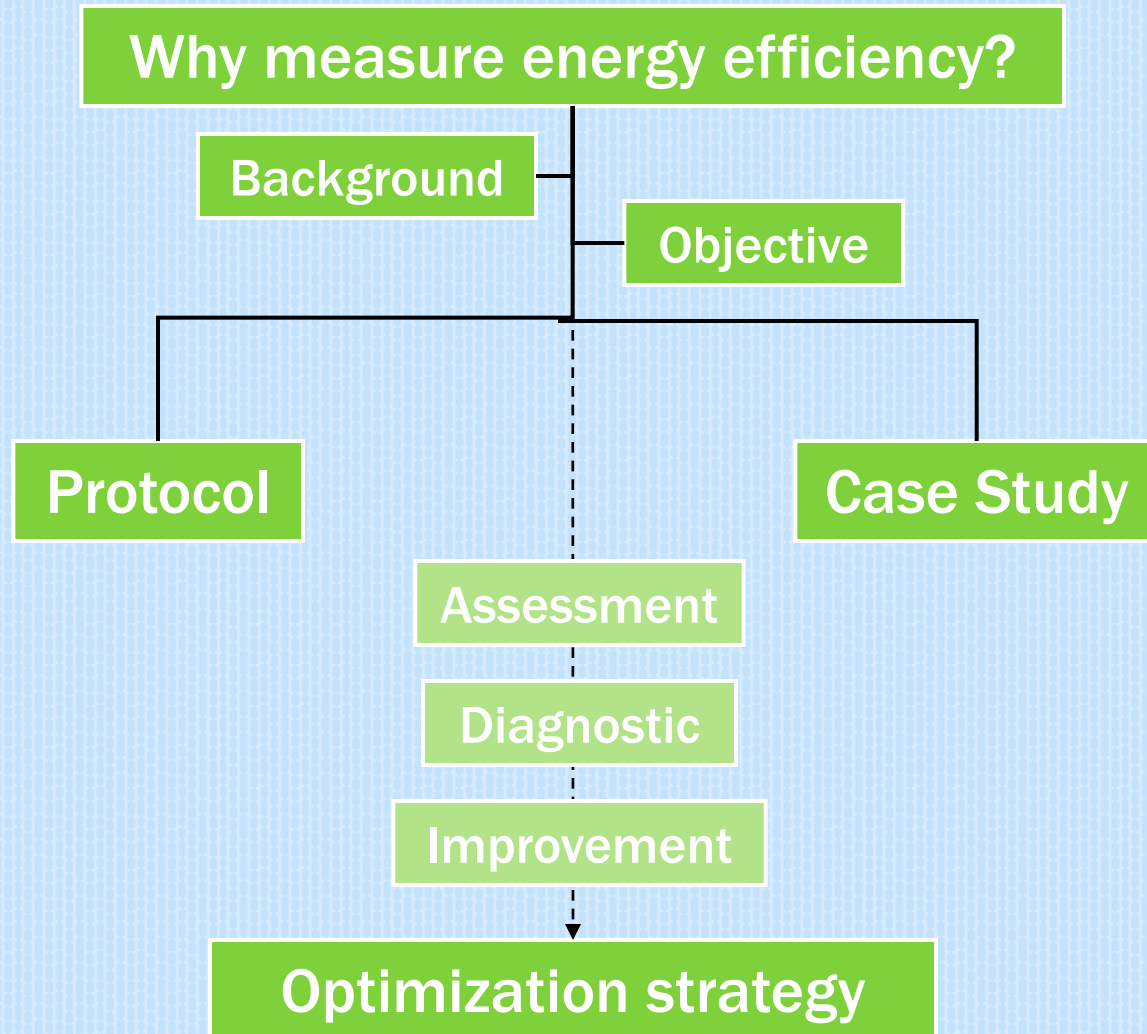
Centre de recherche, de développement et de transfert technologique acéricole inc.

ENERGY EFFICIENCY OF OIL-FIRED EVAPORATORS USED IN SUGARHOUSES

Alfa Arzate, eng., Ph.D.
Centre ACER
Saint-Norbert d'Arthabaska, Quebec

Annual Meeting of the North American Maple Syrup Council and IMSI
October 22-25, 2009
Bar Harbor, Maine

PRESENTATION OUTLINE



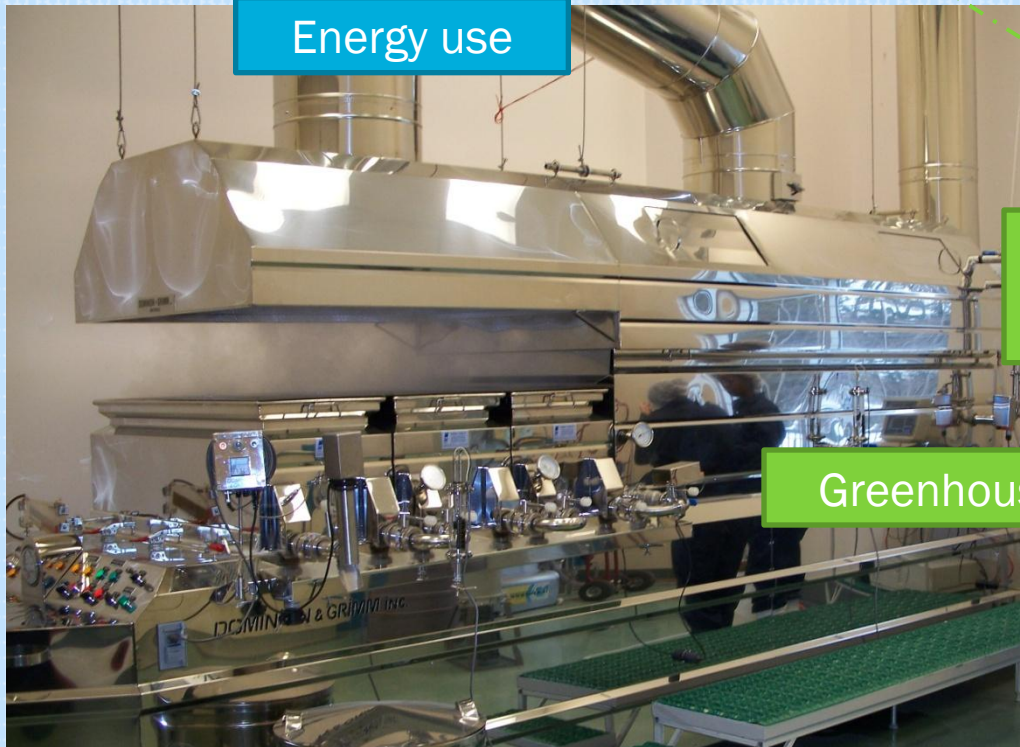
BACKGROUND

Optimize resource use

Energy use

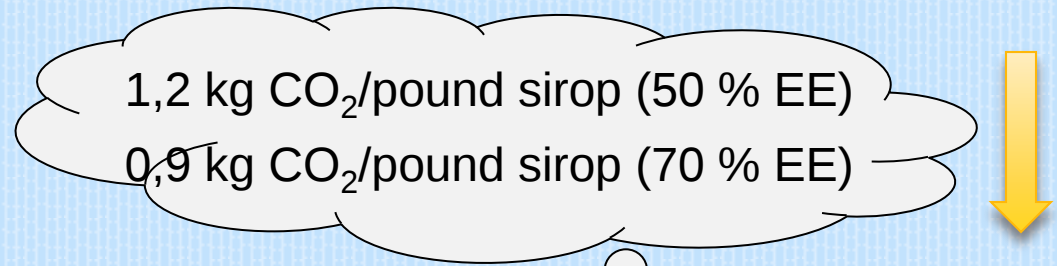
Reduce the impact on
the environment

Greenhouse gas emissions (GHGs)



Increase the value of the finished product

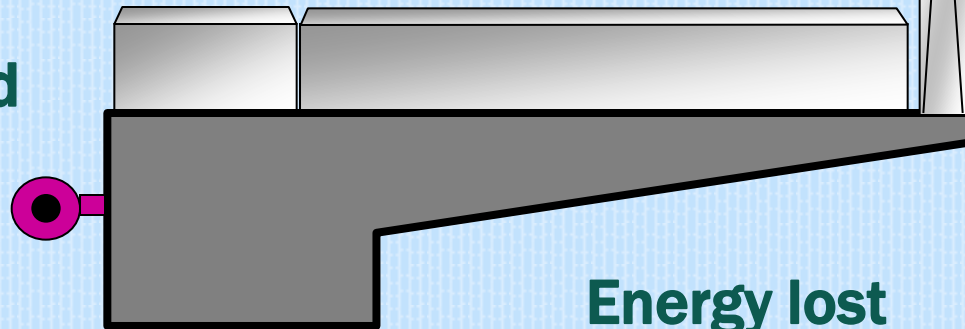
BACKGROUND



Energy used

8 °Brix
98.5 % CE

Energy supplied



1\$/L oil

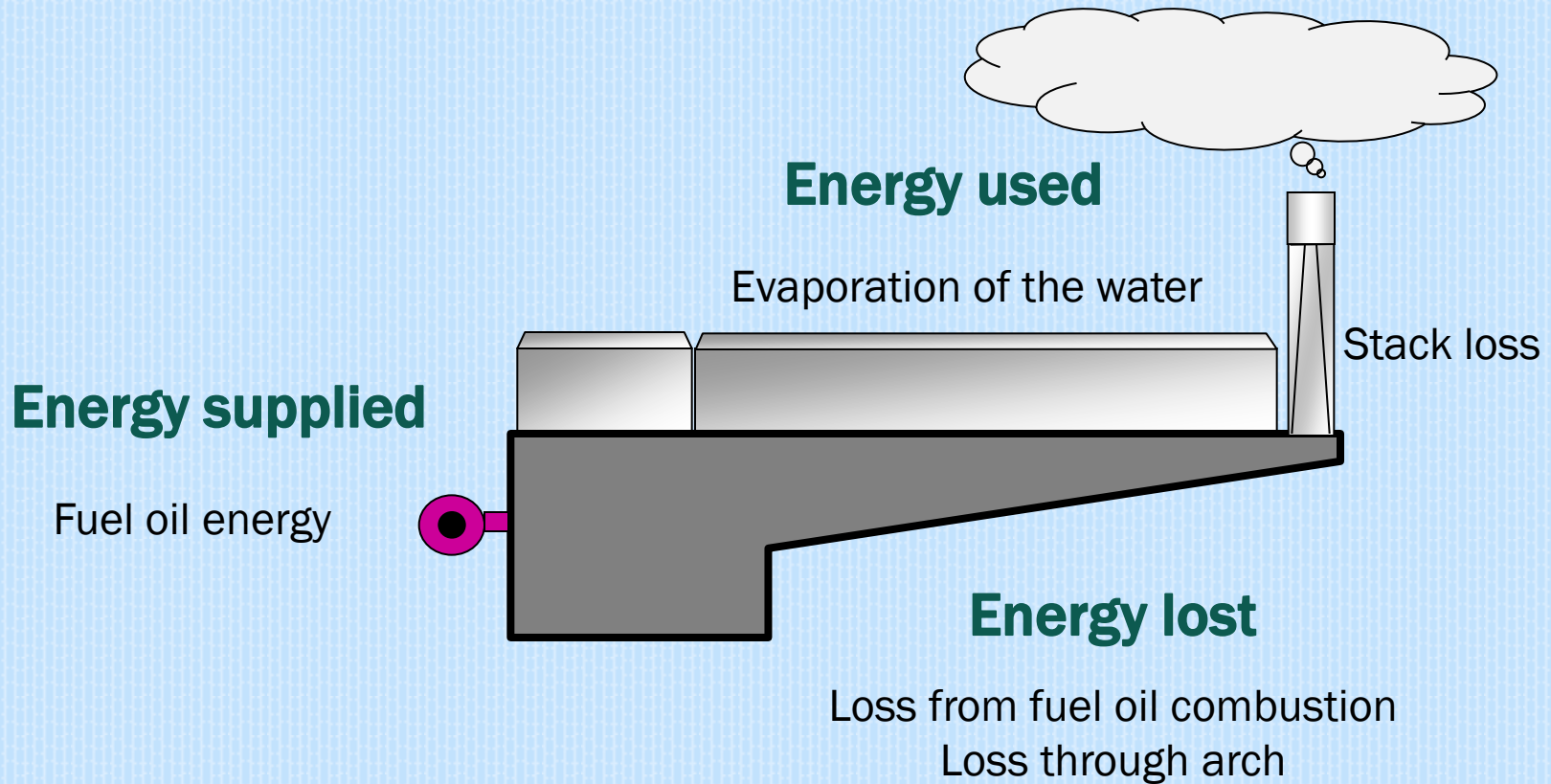
0,36\$/pound sirop

50 % EE

0,26\$/pound sirop

70 % EE

BACKGROUND



OBJECTIVE

Develop an standard and easy-to-use protocol
to assess the energy efficiency of oil-fired
maple syrup evaporators

OBJECTIVE

First step toward...

- ✓ improving the energy efficiency of oil-fired maple syrup evaporators and,
- ✓ decreasing the operating cost of evaporation.

PROTOCOL



Centre de recherche, de développement et de transfert technologique acéricole inc.

Siège social et station expérimentale
142, Rang Lainesse
Saint-Norbert d'Arthabaska
Québec G0P 1B0
Téléphone : (819) 369-4000
Télécopieur : (819) 369-9589

PROTOCOLE

QUALIFICATION DE L'EFFICACITÉ ÉNERGÉTIQUE D'UN SYSTÈME
D'ÉVAPORATION DE SÈVE D'ÉRABLE OU DE CONCENTRÉ DE
SÈVE FONCTIONNANT À L'HUILE

Par : Alfa Arzate, Ph.D.

Collaborateurs : Aline Batungwanayo, ing. jr

Guy Boudreault, tech. for.

Julien Lavoie, tech.

851-PRT-1008

Saint-Norbert d'Arthabaska, 31 octobre 2008.

Qualification of the energy
efficiency of an oil-fired maple syrup
evaporator
(protocol available in French)

PROTOCOL

1

Technical data compilation

2

Determination of pure water evaporation rate

3

Instantaneous energy efficiency calculation

4

Diagnostic formulation

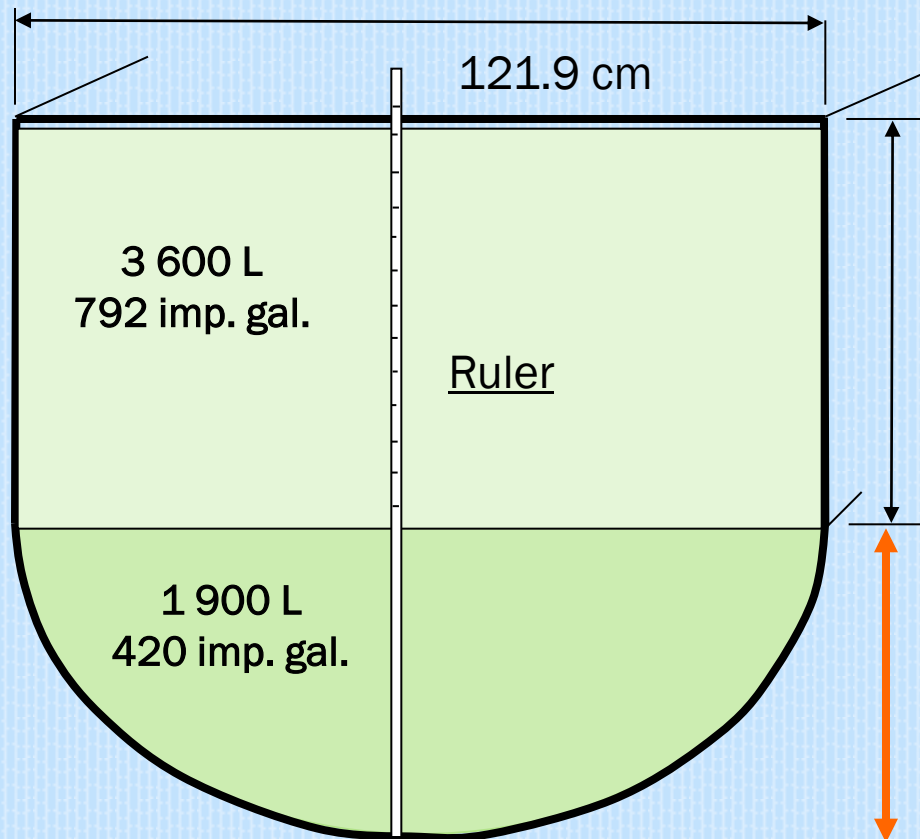
PROTOCOL

■ Technical data compilation

Oil-fired evaporator	
Installation date	2006
Dimensions	6 x 16 pi
Number of pans	3 sap pans / 3 syrup pans
Preheater	Yes
Liquid height in sap pans	1 ¼ in
Liquid height in syrup pans	2 in
Burner	2 x two speed Carlin (801 CRD)
Nozzles	2 x 6.5 and 6 (45° H)
Number of tapholes	25 000
Regulator box, automatic draw-off and draft control	

PROTOCOL

■ Measuring water flowrate



Measurement section

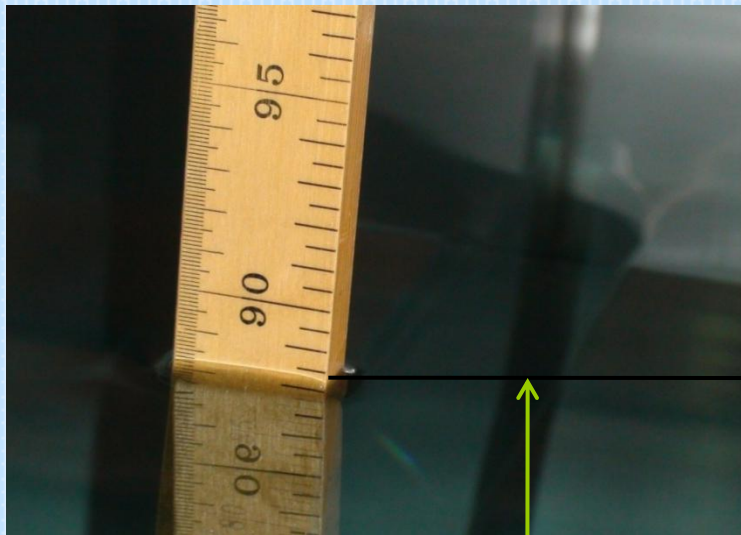
60.95 cm
13 imp.gal/cm
1.3 imp.gal/mm

Inaccurate section

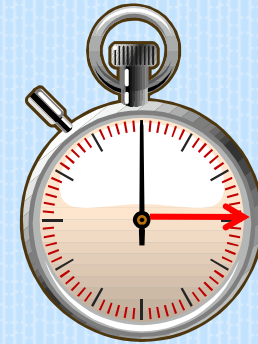
Bernier, R., 2009

PROTOCOL

Calibration factor



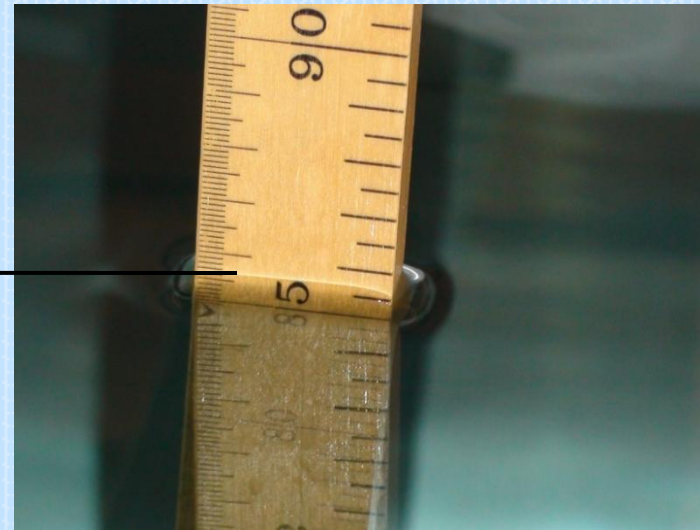
88.0



85.5

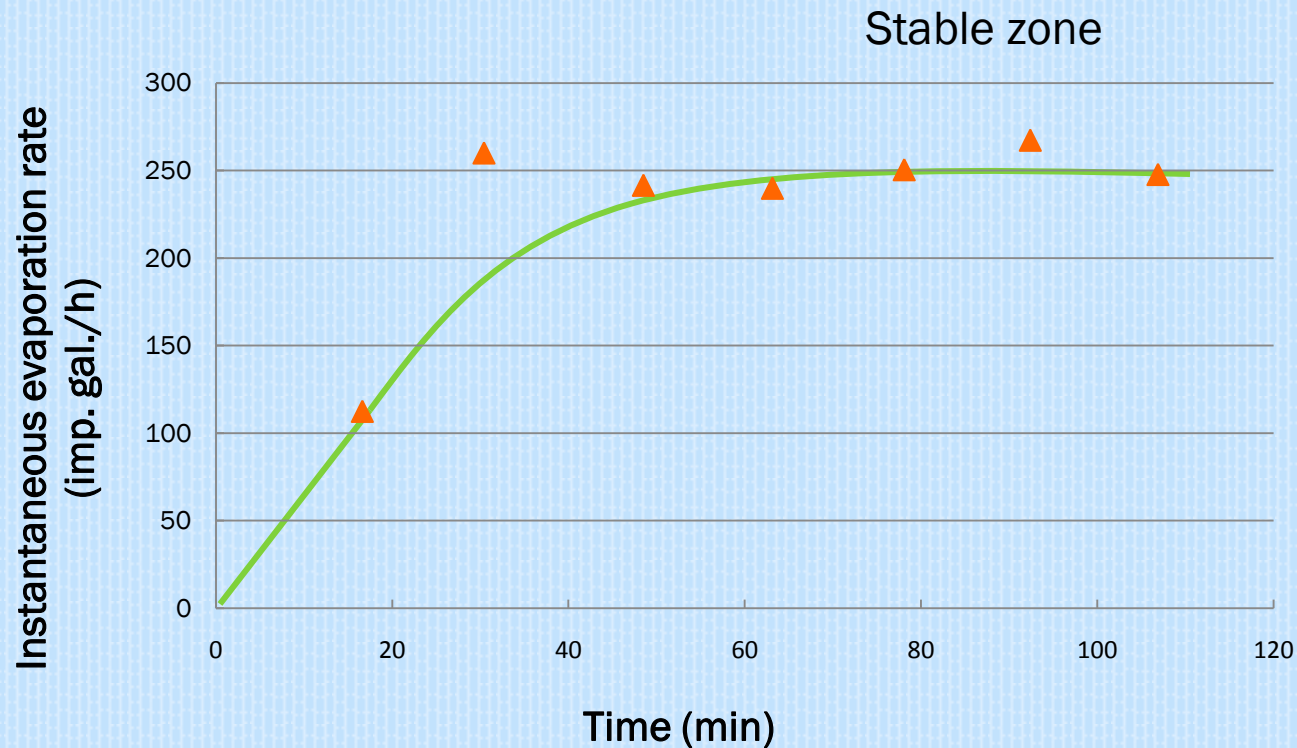
Time interval = 15 minutes

Flowrate calculated for a
time interval



PROTOCOL

- Evaporation rate with pure water



PROTOCOL

- Fuel oil consumption

30.6 US gal./h



PROTOCOL

- Combustion parameters



Smoke test

Draft (inside the combustion chamber)



Stack temperature



CO₂ level

From a sugarhouse in Quebec

CASE STUDY

CASE STUDY

- Performance with pure water (September 2008)

Evaporation parameters	September 2008
Temperature in the tank (°C)	11.4
Feed temperature (°C)	74.7
Evaporation rate with pure water (imp. gal./ h)	251
Fuel oil consumption (US gal./ h)	30.6
Energy efficiency (%)	64.5

75 %

\$102 per hour

8.2 imp. gal. evaporated/ US gal. of fuel oil

41¢ /imp.gal. evaporated

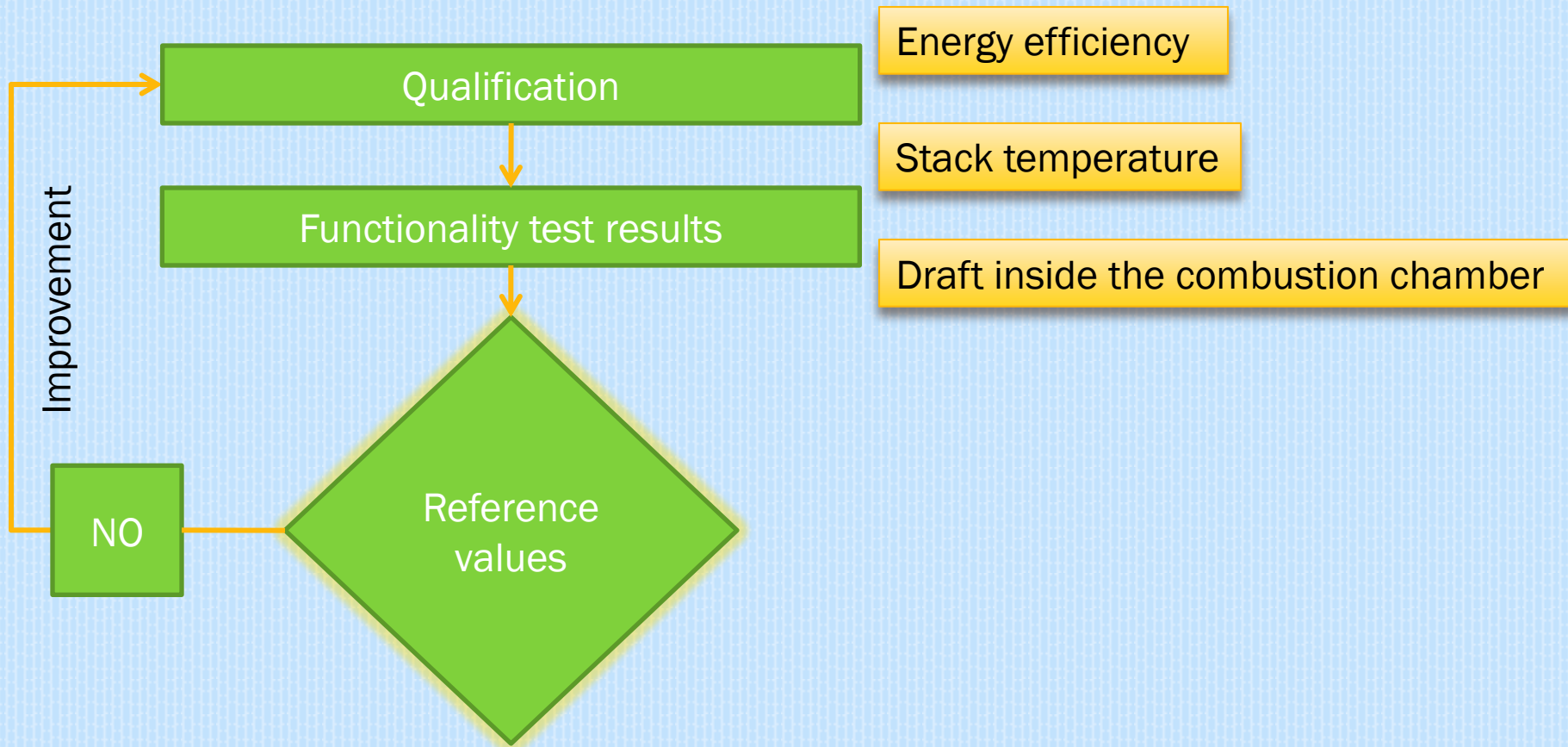
CASE STUDY

- Performance with pure water (September 2008)

Combustion parameters		September 2008
Draft inside the combustion chamber (water column inches)		- 0.06
Stack temperature (°F)	Reference values	720 – 730
CO ₂ level (%)	- 0.01 to - 0.02	9
Combustion efficiency (%)	400 to 575	68 ¾ - 70 ¾
Smoke test (-)	12	1 – 2 (Excellent to good)
	To be established	
	1	

CASE STUDY

■ Diagnostic formulation



AFTER THE DIAGNOSTIC

Once the diagnostic is completed and the values obtained are compared with reference values, steps can be taken iteratively to modify the evaporator current parameters (eg. size oil burner and nozzle, combustion chamber characteristics, stack, steam hood, preheater, instrumentation, etc.) in order to improve its energy efficiency.

CASE STUDY

■ Improvement strategy

Nozzles

- Decrease the fuel oil flowrate

Burner

- Adjust combustion air
- Adjust burner

- Installation of nozzles 5.5 et 5.0 45° H, therefore 16 % less fuel oil
- Optimal position

CASE STUDY

- Improvement strategy (October 2008)

Combustion parameters	September 2008	October 2008
Temperature in the tank (°C)	11.4	n.a.
Feed temperature (°C)	74.7	78.8
Evaporation rate with pure water (imp. gal./h)	251	245
Fuel oil consumption (US gal./h)	30.6	25.2
Energy efficiency (%)	64.5	75.2

18.9 % more water evaporated/ US gal. fuel oil

9.75 imp. gal. evaporated/US gal. of fuel oil

\$84 per hour

34¢/imp. gal. evaporated

CASE STUDY

- Improvement strategy (October 2008)

Combustion parameters	September 2008	October 2008
Draft inside the combustion chamber (water column inches)	- 0.06	- 0.03
Stack temperature (°F)	720 – 730	~ 640
CO ₂ level (%)	9	unmeasured
Combustion efficiency (%)	70 ³ / ₄ - 68 ³ / ₄	unmeasured
Smoke test (-)	1 – 2 (Excellent to good)	unmeasured

CASE STUDY

- Performance with maple sap (2009)

Sap concentrate at 14 °Brix

Evaporation parameters	2009
Temperature in the tank (°C)	6
Feed temperature (°C)	56
Treatment rate (imp. gal./h)	275
Fuel oil consumption (US gal./h)	25.2
Energy efficiency (%)	74

\$84 per hour

10.9 imp. gal. treated/US gal. of fuel oil

30¢/imp. gal. treated

Production history

CASE STUDY

- Performance with maple sap (2009)

Combustion parameters	Spring 2009
Draft inside the combustion chamber (water column inches)	- 0.03
Stack temperature (° F)	635
CO ₂ level (%)	10
Combustion efficiency (%)	74 ¾
Smoke test (-)	unmeasured

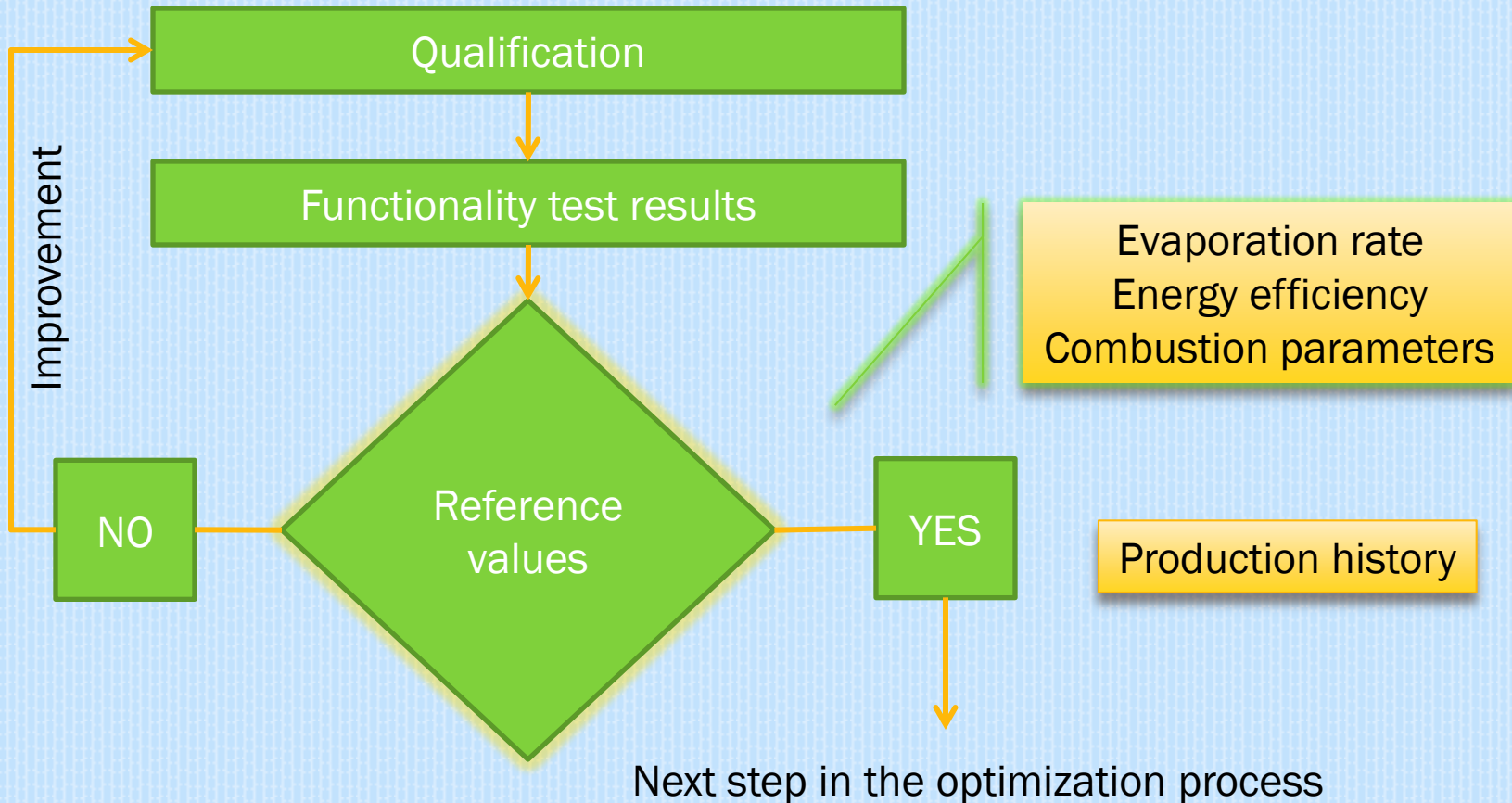
CASE STUDY

The modifications carried out on the equipment did not have any known repercussions on the maple syrup's commercial characteristics

AFTER IMPROVEMENTS

If the harmonization of the evaporation system components allows *good heat distribution and heat transfer to the maple sap during evaporation*, it will contribute to the flavour and colour development which defines the commercial value of maple syrup.

ENERGY OPTIMIZATION STRATEGY



ACKNOWLEDGEMENTS

Funding: from the "*Programme d'appui financier aux regroupements et aux associations de producteurs désignés*" of the "Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec"

(MAPAQ – Quebec ministry of agriculture, fisheries, and food)

Case study: the producer that participated in the case study exercise.

Team: ACER Center technical team at the experimental station

ACER CENTER



Head office and experimental station
142, Rang Lainesse
Saint-Norbert d'Arthabaska
Québec, Canada G0P 1B0
Telephone : 819 369-4000
Fax : 819 369-9589



Research laboratory
3600, boulevard Casavant Ouest
Saint-Hyacinthe
Québec, Canada J2S 8E3
Telephone : 450 773-1105
Fax : 450 773-8461

alfaarzate@centreacer.qc.ca

**Protocol, videos and Excel worksheet
are available in our website:
www.centreacer.qc.ca**