INTERNATIONAL
ENERGY
PROGRAM
EVALUATION
CONFERENCE

Transforming a Commercial Boiler Market

K. H. Tiedemann, BC Hydro, Paris, June 2010

Overview

- Program description
- Boiler basics
- Program rationale
- Customer satisfaction
- Free riders
- Program experience
- Gross and net energy and carbon dioxide savings
- Costs
- Lessons learned

Program Description

- The BC Gas Efficient Boiler Program provided customer incentives and technical advice to encourage the installation of mid efficiency and high efficiency boilers in new buildings and retrofit situations
- Goal of the program was to reduce energy bills and increase the efficiency of space heating systems in new construction and retrofits and to reduce peak day energy consumption
- Specifically the program provides the following benefits to BC Gas' commercial customers:
  - (1) lower space heating costs through natural gas savings
  - (2) lower water heating costs if boilers are used for domestic water heating
  - (3) improved operating efficiency through appropriate boiler sizing
  - (4) improved reliability from back-up systems when a multiple boiler system is used.

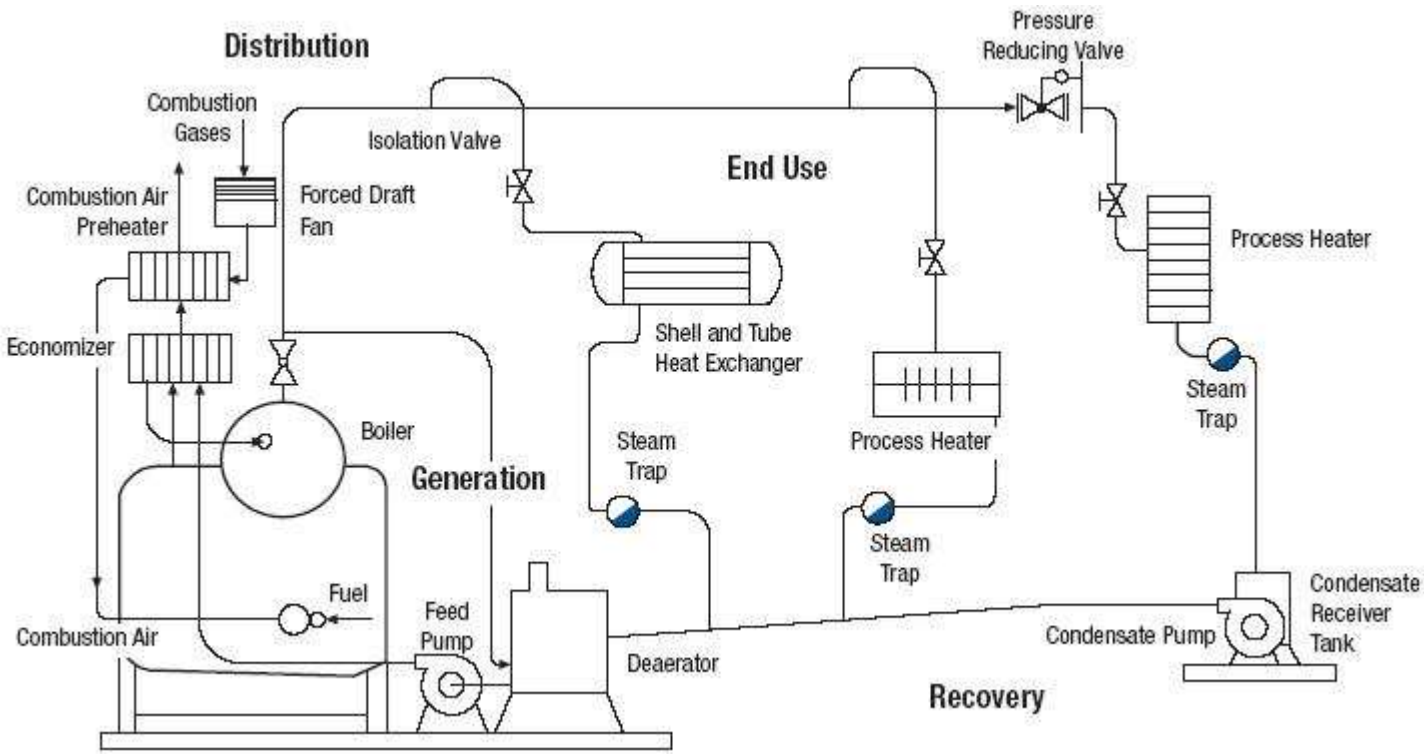
Program Description

- For mid efficiency boilers, BC Gas paid customers up to 75% of the cost difference between a standard versus a mid efficiency boiler system up to a maximum of $2.00 per 1000 Btuh
- For high efficiency boilers, BC Gas paid customers up to 75% of the cost difference between a standard versus a high efficiency boiler system up to a maximum of $15.00 per 1000 Btuh
- The incentives were calculated on space heating loads only, because the space heating load has the greatest implications for natural gas distribution peak, although more efficient boilers would also increase the energy efficiency of other loads on the boiler

Boiler Basics

- A boiler is an enclosed vessel that allows combustion heat to be transferred to water to provide either heated water or steam
- Boiler system consists of a feed water system, a steam system and a fuel system
- Feed water system provides water to the boiler regulates it to meet the steam or hot water demand
- Steam system collects and controls the steam produced in the boiler
- Fuel system includes equipment needed to provide and distribute fuel to the boiler
- Ancillary systems use the hot water or steam for some end use such as space or process heat and also have recovery systems to capture heat which would otherwise be waster

Boiler System Schematic



Program Rationale – Logic Model

	Program development	Program marketing	Technical advice and support	Financial incentives
Inputs	Assess barriers and opportunities	Advertising and promotions	Specifications and technical advice	Financial incentives paid
Outputs	Program addresses customer needs	Customer/trade ally awareness	Knowledge of EE boilers	EE boiler payback period reduced
Purpose	Increase the installation and efficient use of mid-efficiency and high-efficiency natural gas boiler systems in new buildings and retrofits			
Goal	Reduce energy bills, reduce energy consumption and reduce greenhouse gas emissions in new buildings and retrofits			

- We reviewed documents and conducted interviews with program staff and trade allies to understand the program/build Logic Model
- Rationale for program is that providing potential boiler purchasers with: (1) information; (2) technical advice; (3) incentives will increase market penetration of energy efficient boilers
- Logic Model suggest there are valid and plausible linkages between inputs, outputs, purpose and goal so program rationale is sound

Customer Satisfaction

	Participants	Dropouts	Controls	Trade allies	Manufacturers
Program information	3.9	3.2	4.4	3.8	3.9
Technical advice	3.4	3.2	4.0	2.8	2.2
Incentives mid-efficiency	3.6	2.2	3.0	3.0	1.6
Incentives high-efficiency	3.8	3.2	4.0	3.5	4.1
Eligible equipment range	3.4	2.4	3.6	3.3	3.5
Application procedures	3.6	2.6	3.9	3.3	2.6
Overall program	3.8	3.0	3.6	3.4	2.9

- Survey respondents were asked how satisfied they were with program components on a scale from 1 (not at all satisfied) to 5 (very satisfied)
- Satisfaction with information, incentives for high efficiency furnaces and overall program were high
- Satisfaction with incentives for mid-efficiency furnaces, range of eligible equipment, application procedures were lower, but still good

Free Rider Analysis

	(5)	(4)	(3)	(2)	(1)	1 - FRR
Weight	1.0	0.75	0.50	0.25	0.00	
Share	0.57	0.18	0.19	0.03	0.03	
Product	0.57	0.14	0.10	0.01	0.00	0.82

- Free riders are customers who received a financial incentive through the program but would have installed a mid efficiency or high efficiency boiler in the absence of the program
- If the respondent had received a financial incentive through the Efficient Boiler Program, the respondent was asked how important the incentive was in the decision to install an efficient boiler (where 5 was very important and 1 very unimportant), and a weighted score was then calculated to produce a free rider rate of 0.18

Impact Method

- Normalized weather-adjusted billing data was used to estimate the gross impact of higher efficiency boilers on natural gas consumption
- For retrofits, gross savings were defined as pre-retrofit consumption minus post–retrofit consumption
- For new buildings, there is no pre-retrofit building to serve as a baseline, so we calculated gross annual savings as control group consumption minus new building participant consumption

Impact Results

	Unit savings (GJ)	Number of buildings	Gross savings (TJ)	1 – FRR	Net savings (TJ)	CO_2 (ktonnes)
Retrofit (same fuel)	1,964.7	80	157.18	0.82	128.88	4.30
Retrofit (new fuel)	18,515.3	3	55.55	0.82	45.55	1.52
New buildings	404.3	48	19.41	0.82	15.91	0.53
All installations	1,764.4	131	232.14		190.34	6.35

- Gross energy savings were 232 TJ per year (1 GJ = 278 kWh)
- Net savings were defined as gross savings times one minus the free rider rate and were 190 TJ per year
- Carbon dioxide savings were then estimated using an emissions factor of 33.35 tonnes of carbon dioxide per terajoule, which yields an emissions reduction for carbon dioxide savings total 6.35 kilotonnes

Capital Costs

	Participants (n =62)	Drop outs (n = 7)	Controls (n = 25)
Total boiler costs installed ($)	$482,00	$422,00	$321,00
Unit costs ($ per square foot)	$3.98	$4.85	$2.18
Incremental costs ($ per square foot)	$1.80	$2.67	-

- Survey data was used to collect information on total and unit capital costs for new boiler systems with results as shown above
- Incremental capital costs were $1.80 per square foot for participants and $2.67 for program drop outs

Annual Maintenance Costs

	Participants (n =62)	Drop outs (n = 7)	Controls (n = 25)
Total annual maintenance ($)	$5,900	$4,600	$6,400
Unit costs ($ per square foot)	$0.049	$0.053	$0.044
Incremental costs ($ per square foot)	$0.005	$0.009	-

- Survey data was also used to collect information on annual total and unit maintenance costs for new boiler systems with results as shown above
- Incremental maintenance costs were $0.005 per square foot for participants and $0.053 for program drop outs

Lessons: Providing Value to Customers

- Natural gas markets have experienced a high degree of price volatility over the past several years, and some experts believe that this price volatility may be an ongoing characteristic of the natural gas market in North America
- A high degree of price volatility has negative impacts on many commercial and institutional customers, particularly those who have limited ability to hedge against higher prices
- Since natural gas prices tend to be particularly high during the space heating season, measures to reduce space heating loads of commercial and institutional customers can be particularly useful in helping to shield these customers from the adverse impacts of natural gas price fluctuations

Lessons: Benefits to Gas Utilities

- From a utility perspective, demand side management programs have two potential benefits
- First, if the marginal cost of increased supply is greater than the marginal benefit of increased sales, the utility is financially better off if it can postpone or avoid increased sales. This situation is most likely to apply for an end use such as space heating that has a high degree of coincidence with system peak, since meeting a highly peak coincident marginal load requires costly distribution investments
- Second, many customers have diversified loads such as water heating, drying and cooking that have different load profiles over the day and over the year. Supporting customers with diversified loads helps to keep load factors up and rates down

Lessons: Role of Trade Allies

- This study has found that trade allies play a key role in determining the choice of boiler system in both new buildings and retrofits
- Consulting engineers, manufacturers representatives and architects are important sources of knowledge and expertise for developers, property owners and building managers who often lack detailed knowledge of the advantages and disadvantages of alternative boiler systems
- Although many trade allies have good knowledge and extensive experience with mid efficiency and high efficiency boiler systems, other trade allies lack adequate familiarity with, and knowledge of, these efficient technologies
- This is a significant barrier to the widespread technology of higher efficiency boiler systems, especially for condensing boilers, and additional efforts with trade allies can strengthen promotional efforts, increase program awareness and improve participation rates