ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS

BEHIND EVERY GREAT ENGINEER.

Retail Electricity Price Reform:

Path to Lower Energy Bills and Economy-Wide CO_2 Emission Reductions

Summary Report

April 9, 2019

About OSPE

The Ontario Society of Professional Engineers (OSPE) is the voice of the engineering profession in Ontario. OSPE represents the entire engineering community, including professional engineers, engineering graduates and students.

Executive Summary

Objective

This report identifies the need for Ontario to reform its retail electricity price plans to enable consumers to purchase surplus emission-free electrical energy at its low wholesale market energy price. A key component of this reform is to eliminate the legal requirement in the Electricity Act and its regulations to recover the fixed cost of generating electricity from the consumer's energy consumption. Fixed costs should be recovered based on the consumer's share of the fixed cost of generation which is more appropriately determined based on the consumer's peak power demand. That change will make surplus emission-free electricity cheaper than fossil fuels on an incremental kilowatt-hour (kWh) consumption basis.

OSPE has prepared this report to demonstrate to government policy makers, regulators and the public that more innovative approaches to retail price plan design can substantially reduce consumers' total energy bills and greenhouse gas (GHG) emissions, without imposing additional costs on the electricity system.

Context

Ontario's electricity system has been transformed into a low emission system. All low emission electricity systems are capable of producing significant amounts of emission-free electricity that is surplus to domestic electricity needs. Ontario currently exports most of that surplus to other Canadian provinces and the United States at low wholesale market energy prices and curtails (discards) the amounts it cannot export.

Unfortunately, Ontario consumers cannot get access to that low-cost surplus electricity because Ontario's retail price plans are not designed to make surplus electricity available at its low wholesale market energy price.

Ontario consumers should be able to purchase this surplus electricity at the same wholesale market energy price as utilities of other jurisdictions.

Recommendations

This report recommends that:

1. The Ministry of Energy, Northern Development and Mines revise current legislation and regulations which prevent consumers from purchasing surplus emission-free electricity at its wholesale market energy price.

2. The Ministry of Energy, Northern Development and Mines, in collaboration with the Ontario Energy Board (OEB) and Local Distribution Companies (LDCs), deploy voluntary smart price plans that will allow Ontario consumers to purchase surplus emission-free electrical energy at its low wholesale market energy price.

This report presents three smart price plans for consideration by the Ontario government, OEB and LDCs. These smart price plans will reduce consumers' total energy costs and GHG emissions in the heating & transportation sectors.

The historical amounts of the total surplus and curtailed amounts of emission-free electricity in Ontario are summarized below in Table 1.

Table 1
Amount of Surplus Emission-Free Electricity in Ontario

Year	Curtailed Amounts TWh	Number of Homes Equivalent for Curtailed Amounts	Total Surplus TWh	Number of Homes Equivalent for Total Surplus
2014	3.6	380,000	10.0	1,040,000
2015	4.8	500,000	13.3	1,390,000
2016	7.6	840,000	15.9	1,770,000
2017	10.2	1,130,000	23.9	2,660,000

Making the surplus quantities above available to Ontario consumers at the wholesale market energy price would effectively lower the average cost of energy to consumers. However, to do so, Ontario's retail electricity rates must be redesigned to create what OSPE calls smart price plans.

OSPE recommends that these smart price plans be made **voluntary**. The smart price plans can capture a portion of the surplus emission-free electricity with relatively simple and low-cost heaters, switches and timers. A consumer with a fully automatic energy management system can capture a larger portion of the surplus electricity and enjoy larger energy savings albeit at an additional upfront cost for the additional control equipment.

This report analyzed several cost reduction strategies for comparison purposes among the various price plans designed for residential consumers. The analysis considered the OEB's standard Time-Of-Use (TOU) price plan, the OEB's recently approved TOU-style price plan pilots and OSPE's three proposed smart price plans. In OSPE's view, the three smart price plans are more effective at lowering consumers' annual energy bills. They can also accommodate the different metering and communication equipment capabilities of the LDCs and the different level of consumer familiarity with electricity billing parameters.

Table 2 below summarizes OSPE's estimate of the annual total energy bill savings that a typical residential consumer can expect using the OSPE Energy Plus Peak Demand Smart Price Plan with a fully automatic energy management system. These different scenarios take into consideration the current federal carbon tax and its proposed increases throughout the years[1].

OSPE estimates there will be sufficient surplus emission-free electricity in the long term (after the nuclear reactor refurbishment program is finished) to displace 36% of the fossil fuel used by 1.3 million homes. The fossil displacement only reaches 36% for each home because three conditions have to occur simultaneously in each hour:

(1) there is a need for heat;
(2) there is surplus electricity available; and
(3) there is power capacity available between the home's normal hourly electricity consumption and the home's monthly average peak power demand.

The 1.3 million represents the number of homes that can be supplied using 70% of the annual average amount of surplus emission-free electricity at the 36% fossil fuel displacement rate for each home.

Table 2
Annual Net Energy Cost Savings by Residential Fossil Fuel Consumers
(Without Creating a Higher Peak Power Demand)

	Fossil Fuel Displaced	Nat. Gas Consumer Savings $/yr.	Propane Consumer Savings $/yr.	Fuel Oil Consumer Savings $/yr.
$0 /tonne CO_2 Price	36%	$64	$395	$721
$20 /tonne CO_2 Price	36%	$86	$423	$754
$50 /tonne CO_2 Price	36%	$118	$461	$803

[1] The Government of Canada's carbon pricing plan comes into effect in April 2019. This carbon tax is $20 per tonne of CO_2 emissions for 2019 and will increase at a rate of $10 per tonne per year until 2022, when the price will reach $50 per tonne.

Table 3 below summarizes OSPE's estimate of the GHG emission reductions that are achievable if all the surplus emission-free electricity was used in Ontario to displace natural gas for water and space heating. Other applications such as propane and fuel oil displacement, electric car charging and industrial hydrogen production will result in larger emission reductions per unit of electricity.

Table 3
Potential GHG Emission Reductions from Natural Gas Displacement
By Surplus Emission-Free Electricity

	Surplus Emission-Free Electricity Available TWh	Reduction if Natural Gas is Displaced tonnes CO_2
2020-2035 Annual Average	9.8	2,100,000
2020-2035 Total	157.0	33,400,000

OSPE's proposed rate reform will make surplus emission-free electricity affordable for fossil fuel displacement. The consumer who subscribes to the new smart price plan will have a slightly higher electricity bill but will have a much lower fossil fuel bill. Fossil fuels are imported to Ontario so the economic impact of fossil fuel displacement on the local Ontario economy will be positive. The environmental benefits are obtained at no cost to the electricity system.

As Ontario increases the emission-free generation capacity of the electricity system to supply a growing population, the surpluses will increase. The annual energy savings from fossil fuel displacement and the associated emission reductions will also be larger if smart price plans are deployed to allow consumers to take advantage of those surpluses.

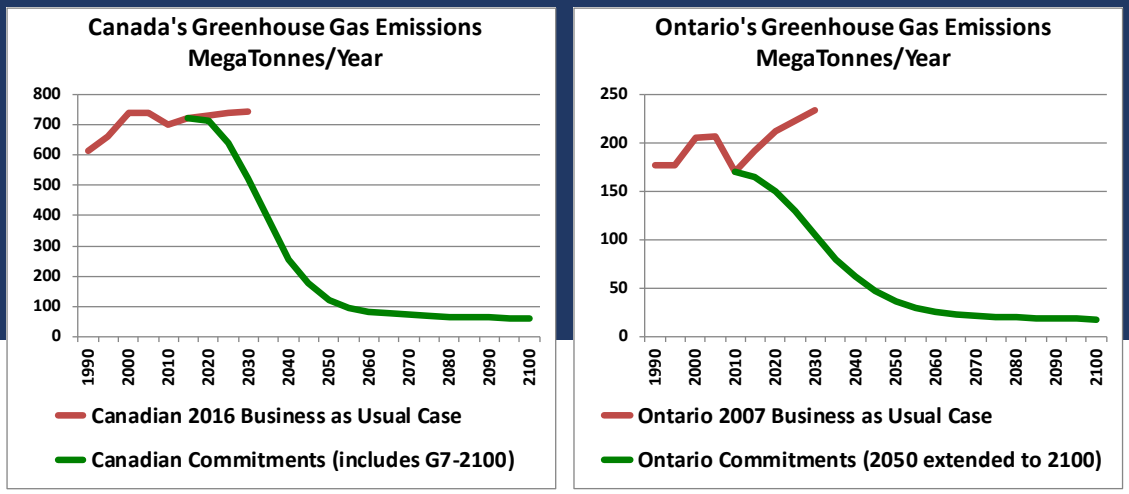
Making use of surplus electricity for fossil fuel displacement is an effective way to offset annual increases in electricity bills with lower fossil fuel bills. Addressing consumers' total energy needs creates opportunities for cost and emission reductions through more effective integration of Ontario's electrical and fossil-fueled energy systems.

Ontario energy policy makers and regulators need to engage closely with engineers and other experts who design and operate our energy systems. Energy systems are among the most technically complex systems in society. A deeper understanding of the fundamental drivers of higher energy costs and emissions is essential in order to find affordable permanent solutions to reduce emissions across the entire economy. Knowing how to leverage Ontario's low emission electricity system with its high fixed costs and low variable costs is key to achieving low emissions at an affordable cost. Ontario's professional engineers look forward to working with the government to achieve its economic and environmental goals.

Ontario's Current Electricity Retail Price Plans

Ontario banned coal-fired generation and reduced GHG emissions in the electrical sector by over 80% from 2005 to 2015. Despite Ontario's success in the electrical sector, Figure 1 below shows Canada's poor overall progress over the past three decades.

Figure 1 – Canada's and Ontario's GHG Emissions and Commitments[2]



Ontario's current retail electricity price plans charge consumers too much for energy consumption in an effort to recover the fixed cost of the electricity system installed capacity. Ontario's current retail price plans have made surplus emission-free electricity too expensive to use to displace fossil fuels. As a result, Ontario consumers continue to pay for fossil fuels for their hot water, space heating and steam requirements, while surplus emission-free electricity is exported at low prices or curtailed. Effectively, Ontario consumers are:

- needlessly spending money on imported fossil fuels;
- are wasting money on the fixed costs for surplus electricity; and
- are contributing to higher than necessary GHG emissions.

Ontario's Regulated Price Plans

Ontario's regulated price plans apply to two consumer groups: residential consumers and small commercial/industrial consumers under 50 kWh/average monthly peak power demand.

Most residential consumers pay for their electricity based on standard province-wide Time-Of Use (TOU) commodity rates designed to be used with Ontario's smart meters. Prices per kWh vary depending on the time of day during working days. There are three rates defined as "on-peak", "mid-peak" and "off-peak". Holidays and

[2] Government of Canada, historical and projected future GHG emissions to 2030 on a business as usual case, accessed on July 16, 2018 at: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html and https://www.canada.ca/en/environment-climate-change/services/climate-change/publications/2016-greenhouse-gas-emissions-case.html
Government of Ontario, historical and projected future GHG emissions to 2030 on a business as usual case, accessed on March 20, 2018 at: https://www.ontario.ca/page/ontarios-climate-change-update-2014

weekends are treated as “off-peak” hours. These rates are then further marked up by delivery and regulatory charges.

The OEB approved several alternative TOU-style price plans for pilot testing with a limited number of consumers by several LDCs. Results are expected to be published later in 2019. OSPE also performed comparative analysis on those pilot plans as well.

This report presents analysis for a residential consumer who has a working smart meter. Milton Hydro delivery charges have been used for the analysis for this report, which are typical for urban consumers in Ontario.

OSPE Smart Price Plans

OSPE’s smart price plans have been specifically designed to allow consumers to use surplus emission-free electricity when it is available to displace fossil fuels. This report presents analysis of three smart price plans that OSPE has designed. The smart price plans lower consumers’ annual total energy bills (electricity plus fossil fuels) and reduce GHG emissions.

The three OSPE smart price plans that are presented in this report are:

- OSPE Modified Low Overnight Smart Price Plan (see Table 4 below)
- OSPE Energy Plus Peak Demand Smart Price Plan (see Table 5 below)
- OSPE Energy Only Smart Price Plan (see Table 6 below)

The annual electricity bill amount for the standard TOU price plan and each of the three smart plans in Table 4, 5 and 6 are the same. The tables demonstrate that the three OSPE smart price plans are designed to be revenue-neutral to the LDC if the consumer makes no changes to their energy use. Revenue neutrality is currently a requirement by the OEB for approval of any new price plans. However, once consumers begin to shift their loads and displace their fossil fuels, the smart price plans will provide significant savings in consumers’ annual energy bills (electricity plus fossil fuels). The savings are summarized later in this report.

Table 4
Comparison of Standard TOU Price Plan with the
OSPE Modified Low Overnight Smart Price Plan (Milton Hydro)
May 1, 2018 Rates (All Components Included – Typical Home)

Electricity Charges	Standard TOU Price Plan	OSPE Modified Low Overnight Smart Price Plan	Billing Units
Fixed Monthly Charge	25.56	28.34	$/month
Energy: TOU On-peak Rate	0.1541	0.2064	$/kWh
TOU Mid-peak Rate	0.1161	0.1141	$/kWh
TOU Off-peak Rate	0.0871	0.0871	$/kWh
TOU Overnight Rate	-	0.0122	$/kWh
Surplus Energy Rate	-	0.0062 (4)	$/kWh
Sales Tax Rate	5	5	%
Annual Total Bill	**1,247 (3)**	**1,247 (3)**	**$/yr**

Table 5
Comparison of Standard TOU Price Plan with the
OSPE Energy Plus Peak Demand Smart Price Plan (Milton Hydro)
May 1, 2018 Rates (All Components Included – Typical Home)

Electricity Charges	Standard TOU Price Plan	OSPE Energy Plus Peak Demand Smart Price Plan	Billing Units
Fixed Monthly Charge	25.56	28.34	$/month
Energy: TOU On-peak Rate	0.1541	-	$/kWh
TOU Mid-peak Rate	0.1161	-	$/kWh
TOU Off-peak Rate	0.0871	-	$/kWh
Monthly Peak Demand Rate	-	22.78	$/kW/month
Energy Rate (all except surplus)	-	0.0243	$/kWh
Surplus Energy Rate	-	0.0062 (4)	$/kWh
Sales Tax Rate	5	5	%
Annual Total Bill	**1,247 (3)**	**1,247 (3)**	**$/yr**

Table 6
Standard TOU Price Plan versus
OSPE Energy Only Smart Price Plan (Milton Hydro)
May 1, 2018 Rates (All Components Included – Typical Home)

Summary	Standard TOU Price Plan	OSPE Energy Only Smart Price Plan	Billing Units
Fixed Monthly Charge	25.56	28.34	$/month
Energy: TOU On-peak Rate	0.1541	-	$/kWh
TOU Mid-peak Rate	0.1161	-	$/kWh
TOU Off-peak Rate	0.0871	-	$/kWh
Energy: Peak-load Rate	-	0.2120 (8)	$/kWh
Intermediate Load Rate	-	0.1422 (7)	$/kWh
Base-load Rate	-	0.0724 (6)	$/kWh
Surplus Energy Rate	-	0.0062 (4)	$/kWh
Sales Tax Rate	5	5	%
Annual Total Bill	**1,247 (3)**	**1,247 (3)**	**$/yr**

Notes for Tables 4, 5 and 6:

1. The tables assume the same hourly load profile for both plans.
2. The tables include the Fair Hydro Plan rate reduction until Dec 2021.
3. The annual "total bill" above does not include taxes, load shifting or energy for fossil fuel displacement.
4. The Surplus Energy Rate applies to surplus emission-free electricity for fossil fuel displacement. However, that rate requires communication capability at the LDC.
5. All rates are subject to regular review (typically semi-annually).
6. The Base-load Rate in Table 6 is charged only on the first 0.79 kWh of energy each hour.
7. The Intermediate Load Rate is charged only on hourly demand between 0.79 kWh and 2.37 kWh each hour.
8. Peak-load Rate applies to energy use above 2.37 kWh each hour.

Using Surplus Electricity to Replace Fossil Fuels

Surplus emission-free electricity could be used by residential consumers to displace the fossil fuels they use for water and space heating at very low electricity prices. To do that consumers need either dual electricity-fossil fuel heating devices or a separate set of electrical devices and a means to switch between the two energy sources. Any electrical heating solution should be assessed beforehand and installed by qualified personnel to ensure both electrical and fire safety.

When surplus emission-free electricity is available, the residential consumer would use electricity rather than fossil fuels for the required thermal energy. The consumer uses less fossil fuels and produces less emissions for the same total thermal energy consumption. Surplus emission-free electricity is considered "interruptible" because the supply cannot be guaranteed and can be interrupted at any time. Interruptible electricity imposes no additional installed capacity demands on the overall electricity system. The fossil fuels rather than the electricity provide consumers the dependability for the thermal loads. This means the electricity can be legitimately purchased only at its marginal cost of production, without any fixed capacity charges. Surplus emission-free electricity has a very low marginal price in the wholesale energy market. In 2018, the average volume weighted price was 0.62 ¢/kWh. Residential consumers emit less carbon dioxide (CO_2) when surplus emission-free electricity is used to displace fossil fuels. The emission savings when fossil fueled heating equipment operating at 85% lifetime efficiency with emission-free electricity and resistance heaters is displaced is:

- 213 grams CO_2 per kWh for reduced natural gas use;
- 253 grams CO_2 per kWh for reduced propane use; and
- 293 grams CO_2 per kWh for reduced fuel oil use.

Industrial hydrogen suppliers can also use surplus emission-free electricity in electrolysers to make hydrogen for oil refineries rather than making hydrogen from natural gas using the steam methane reforming (SMR) process. The SMR process emits about 12 grams of carbon dioxide into the atmosphere for each gram of hydrogen that is produced.

The resulting reduction in atmospheric carbon dioxide emissions depends on how the hydrogen is used. Due to the differences in conversion efficiencies of different end uses for hydrogen, the reduction in atmospheric emissions are:

- **Displacing gasoline in hydrogen fuel cell cars:** 350 grams CO_2 /kWh of electricity
- **Displacing SMR hydrogen at refineries:** 210 grams CO_2 /kWh of electricity
- **Displacing natural gas in pipelines:** 110 grams CO_2 /kWh of electricity

However, to make all of these options economically viable, the marginal price of each additional unit of emission-free electrical energy (kWh) at the retail level must be less than the marginal price of the same amount of useful energy from fossil fuels at the retail level. Fortunately, the marginal price of surplus emission-free electricity at 0.62 ¢/kWh is less than the marginal price of fossil fuels like gasoline, diesel fuel, propane, fuel oil and natural gas. Table 7 on the next page shows the marginal retail price of common fossil fuels used for heating, with the respective federal carbon tax until 2022.

Table 7
Marginal 2018 Retail Price of an Additional kWh of Fossil Fuels

$0 per Tonne CO_2 Price				
Fuel Type	**Units**	**Residential**	**Commercial**	**Industrial**
Fuel Oil	¢/kWh	13.9	12.3	8.0
Propane	¢/kWh	7.9	5.7	7.8
Natural Gas	¢/kWh	1.8	1.8	1.7
$20 per Tonne CO_2 Price				
Fuel Type	**Units**	**Residential**	**Commercial**	**Industrial**
Fuel Oil	¢/kWh	14.5	12.9	8.6
Propane	¢/kWh	8.4	6.2	8.3
Natural Gas	¢/kWh	2.2	2.2	2.1
$50 per Tonne CO_2 Price				
Fuel Type	**Units**	**Residential**	**Commercial**	**Industrial**
Fuel Oil	¢/kWh	15.4	13.8	9.5
Propane	¢/kWh	9.1	7.0	9.1
Natural Gas	¢/kWh	2.8	2.8	2.8

Notes for Table 7:
- Prices are based on the 2018 year forecast in the Ontario Fuels Technical Report except for residential natural gas price which is the actual 2018 Union Gas marginal price in Milton, Ontario. Prices have been adjusted up to reflect a lifetime higher heating value combustion efficiency of 85%. The propane price for industrial consumers is based on a blend of propane and natural gas liquids from the Ontario Fuels Technical Report. A pure industrial propane price was not available.
- Marginal costs represent the cost of the next kWh of energy and excludes fixed monthly costs.
- All prices including the carbon price are expressed in Canadian currency.

The current Ontario retail price plan marginal prices for each additional kWh of surplus emission-free electrical energy are summarized in Table 8 below, showing that even during off-peak periods, it is much higher than the actual marginal cost of that electricity (0.62 ¢/kWh) for all consumer groups.

Ontario's current retail electricity price plans, with their excessively high energy rates for electricity, are making the federal carbon price ineffective in getting consumers to reduce their GHG emissions for their heating needs.

Table 8
Marginal Price of an Additional kWh of Surplus Emission-Free Electricity
For Different Consumer Groups

Description	Billing Units	Residential	< 50 kW	< 1,000 kW	< 5,000 kW	>= 5,000 kW
Present retail price plans minimum off-peak price	¢/kWh	8.71	9.99	7.05	7.05	7.05
Present retail price plans maximum on-peak price	¢/kWh	15.41	16.69	11.94	11.94	7.05

Notes:
1. Marginal prices represent the next kWh of energy and excludes fixed monthly charges and peak kW demand charges for larger industrial and commercial consumers.
2. Retail Price Plan prices are based on Milton Hydro rates effective April 1, 2018. Milton Hydro rates are similar to rates in most urban communities. The residential and <50 kW columns represent prices for consumers on TOU rate plans.
3. Ontario also has surplus emission-free electricity available during on-peak periods typically in the spring and fall when the day is both windy and sunny.

Analysis and Results

The 2017 Long Term Energy Plan (LTEP) identified the 2016 typical residential electricity consumption as 750 kWh/month or 9,000 kWh/year. OSPE's analysis was done using the hourly load profile of a residential consumer whose annual electricity consumption was the same as the LTEP-defined typical residential consumer.

The total amount of surplus emission-free electricity in Ontario is becoming significant. Table 9 on the next page summarizes past actual amounts of total surpluses and curtailed amounts of electricity. The difference in the two columns is the exported amounts, which are typically larger than the curtailed amounts.

Table 9 Amount of Surplus Emission-Free Electricity in Ontario				
Year	Curtailed Amounts TWh	Number of Homes Equivalent for Curtailed Amounts	Total Surplus TWh	Number of Homes Equivalent for Total Surplus
2014	3.6	380,000	10.0	1,040,000
2015	4.8	500,000	13.3	1,390,000
2016	7.6	840,000	15.9	1,770,000
2017	10.2	1,130,000	23.9	2,660,000

Note for Table 9:
Curtailment data was accessed November 1, 2018. Data for nuclear, solar and wind was from the IESO's year-end electricity production reports at: http://www.ieso.ca/en/Corporate-IESO/Media/Year-End-Data and hydroelectric data was from OPG's annual reports at: https://www.opg.com/about/finance/pages/financial-reports.aspx

To evaluate the effectiveness of the various price plans to reduce the typical consumer's energy bills, OSPE analyzed four different cost reduction strategies separately:

- Manual load shifting from on-peak to off-peak hours (e.g. electric vehicle charging and delaying use of appliances to off-peak periods)
- Energy conservation (reduced consumption by any means)
- Automatic load leveling using electrical storage
- Fossil fuel displacement using surplus electricity for hot water and space heating

The OSPE analysis shows that manual load shifts are an effective way to reduce electricity bills when the difference between on-peak and off-peak rates are large. However, it is difficult for a residential consumer to find enough high-power, long-running loads that can be manually shifted to save a significant amount of money. Most consumers find that manual load shifts produce modest bill reductions even with the best rate plans. The exception is electric cars. Electric car batteries can be charged during off-peak periods. Substantial bill savings are achievable because the cars have high power demand for a significant period of time and consume significant amounts of electricity. The price plans with the lowest off-peak rates produce the highest bill savings for electric car owners. The standard TOU rate plan provides savings of $268 per year if the consumer charges their electric car during off-peak periods instead of on-peak periods.

All rate plans provide savings to consumers when they reduce their loads through conservation or by purchasing high efficiency appliances. The plans with the highest rates during periods when consumers use the most electricity typically produce the largest bill reductions. But as in the case of manual load shifts, reducing power demand for a long enough period of time to achieve a significant reduction in energy consumption is difficult for most residential consumers. Most conservation efforts produce modest bill reductions even with the best rate plans.

Automatic load leveling can theoretically produce annual bill savings of up to 30% with the best rate plans. Unfortunately, the electrical storage required is prohibitively expensive. It does not make economic sense to purchase automatic load leveling equipment.

OSPE's analysis shows that displacing fossil fuels like heating oil and propane by adopting smart price plans is both practical and economically attractive. Smart price plans allow consumers to purchase surplus emission-free electricity at very-low wholesale market prices (at 0.62 ¢/kWh in 2018). The fuel-switching equipment is reasonably priced (at less than $200 /kW) and the savings are significant. A fuel oil consumer can save the equivalent of 60% of their total annual electricity bill by displacing fuel oil with surplus emission-free electricity. A propane consumer can save the equivalent of 30% of their total annual electricity bill by displacing propane with surplus emission-free electricity. Displacing natural gas economically is more challenging because urban consumers in Ontario have access to natural gas at a very low price. A natural gas consumer can only save about 2% of their total annual electricity bill by displacing natural gas with surplus emission-free electricity. However, when a carbon price of $50 per tonne carbon dioxide is applied in 2022 to natural gas, that same consumer would save almost 10% of their total annual electricity bill by displacing natural gas with surplus emission-free electricity. Carbon prices will have to reach much higher levels to justify the fuel switching equipment to displace natural gas for most urban consumers. The annual energy savings are summarized in Table 10 below.

The OSPE analysis was done separately for each cost reduction strategy. However, consumers willing to practice two or more of the cost reduction strategies can improve their overall annual savings. Those urban consumers who are environmentally conscious can choose to use their accumulated savings to purchase modestly priced fuel switching equipment to also displace some of their natural gas. That would allow urban consumers to participate effectively in Canada's GHG emissions reduction program. As carbon prices rise in the future, urban consumers will benefit even more from those earlier investments, or they can upgrade to a fully automatic energy management system to further reduce their energy bills and GHG emissions.

Savings using a Fossil Fuel Displacement Strategy

Table 10 below shows the 2018 maximum annual energy cost savings available using a fossil fuel displacement strategy. The amounts of surplus electricity that can be used was limited in the analysis so as not to exceed the consumer's normal monthly average peak power demand in order to avoid creating higher electricity system peak demands. The greatest savings will accrue to consumers that use the most expensive fossil fuels: fuel oil and propane. Consumers with fuel oil and propane heating furnaces will likely volunteer first for the new smart price plans. Propane and heating oil are used primarily in rural Ontario. Urban consumers in Ontario typically use natural gas for water heating and space heating. Consumers with electric cars will also be early subscribers because they will enjoy a larger savings compared to the standard TOU price plan if they charge their cars during periods when surplus electricity is available.

Table 10
Annual Net Cost Savings by Typical Residential Fossil Fuel Consumer Using a Fossil Fuel Displacement Cost Reduction Strategy (Limited by the Monthly Average Peak Power Demand)

Month	Power Limit kW	Fossil Fuel Displacement	Nat. Gas Savings $/yr.	Propane Savings $/yr.	Fuel Oil Savings $/yr.
$0/t CO_2 Price	2.53	36%	$64.10	$395.44	$721.36
$20/t CO_2 Price	2.53	36%	$85.82	$422.60	$753.95
$50/t CO_2 Price	2.53	36%	$118.42	$460.62	$802.83

An electric car owner will see an additional saving of about $239/year if they subscribe to the OSPE Energy Plus Peak Demand Smart Price Plan instead of the standard TOU price plan and if they charge their car off-peak and use surplus emission-free electricity 50% of the time.

Implementation Considerations

Deploying new smart price plans involves a number of implementation choices that have to be evaluated and selected. Those choices impact both the consumer and LDC, so some compromises may have to be made to keep costs affordable for both.

The OSPE Modified Low Overnight Smart Price Plan is the easiest and cheapest for the LDCs and consumers to implement because it is similar to the existing TOU price plans and its basic implementation does not require communication capability. This plan is also easy for residential consumers to understand because they only need to know energy consumption units (kWh) and the time of day. Fossil fuel displacement can be accomplished with thermostat-controlled heaters and timers. The cost per home should not exceed $1,000 for space heating but the savings will be more modest than the amounts shown in Table 10 by about half. The price plan does not need the residential consumer to know about power demand units (kW). However, to capture the maximum amount of low-cost surplus emission-free electricity any time during the day, the consumer will need a more complex implementation with an energy management system and communication capability with the LDC.

The OSPE Energy Plus Peak Demand Smart Price Plan provides the greatest savings for the residential consumer if all its features are made available. This plan has the strongest price signals to help improve overall electricity system performance, however, it is more difficult for consumers because they need to understand both energy and power parameters. If the LDC does not have communication capability, the plan still provides consumers with cost effective displacement of propane and fuel oil with electricity during low demand hours.The consumer needs to purchase an automatic energy management system to maximize savings and to avoid inadvertently creating a higher monthly average peak power demand, which will increase the consumer's monthly bill with this plan.

The OSPE Energy Only Smart Price Plan allows the consumer to be billed in energy only units. However, to use the plan to maximize fossil fuel displacement, the consumer will need to purchase an energy management system with communication capability with the LDC. The LDC will also have to modify its billing algorithms with this plan.

Conclusion

Smart price plans should be deployed using a voluntary program. Consumers who can benefit most from the new smart price plans will subscribe first and become early adopters. They will establish a market for the fossil fuel displacement equipment. That should help reduce equipment costs over time and make it possible for more consumers to subscribe. The smart price plans will significantly reduce a consumer's total annual energy cost (electricity plus fossil fuels) and also reduce carbon dioxide emissions through reduced fossil fuel use.

As Ontario increases the emission-free generation capacity of the electricity system to supply a growing population, the surpluses will increase. The annual energy savings from fossil fuel displacement and the associated emission reductions will also become larger in future if smart price plans are deployed to allow consumers to take advantage of those surpluses.

Making use of surplus emission-free electricity to displace fossil fuels and lower consumers' fossil fuel bills is an effective way to offset the forecasted electricity bill increases in the future.

Readers who are interested in reviewing the more detailed analysis and discussion related to retail electricity price reform can access the detailed OSPE report at www.ospe.on.ca

For more information or to book a meeting with OSPE, please contact advocacy@ospe.on.ca

ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS

BEHIND EVERY GREAT ENGINEER.