

Chapter 3

Ministry of Energy

Section 3.11

Smart Metering Initiative

Background

In April 2004, the Ontario government announced a plan to reduce energy consumption in the province by creating a culture of conservation. One aspect of the plan was the provincial Smart Metering Initiative (Smart Metering)—the first and the largest smart-meter deployment in Canada—to install new “smart” electricity meters throughout the province to measure both how much and when electricity is used. The new meters would make it possible to introduce time-of-use (TOU) pricing to encourage ratepayers to shift their electricity use to times of lower demand. Smart Metering reflected the intention of the Ministry of Energy (Ministry) to manage demand for electricity in Ontario so as to more efficiently use existing power-generating capacity in the province while reducing reliance on out-of-province power purchases.

The Ministry set aggressive Smart Metering implementation targets, including an interim goal of 800,000 smart-meter installations by 2007 and complete coverage for all residential and small-business ratepayers by 2010. Entities involved in Smart Metering included the Ministry, the Independent Electricity System Operator (IESO), the Ontario Energy Board (OEB) and Ontario’s 73 local electricity distribution companies, including Hydro One.

Key roles and responsibilities of each entity are summarized in **Figure 1**, while **Figure 2** shows key events in implementation of Smart Metering.

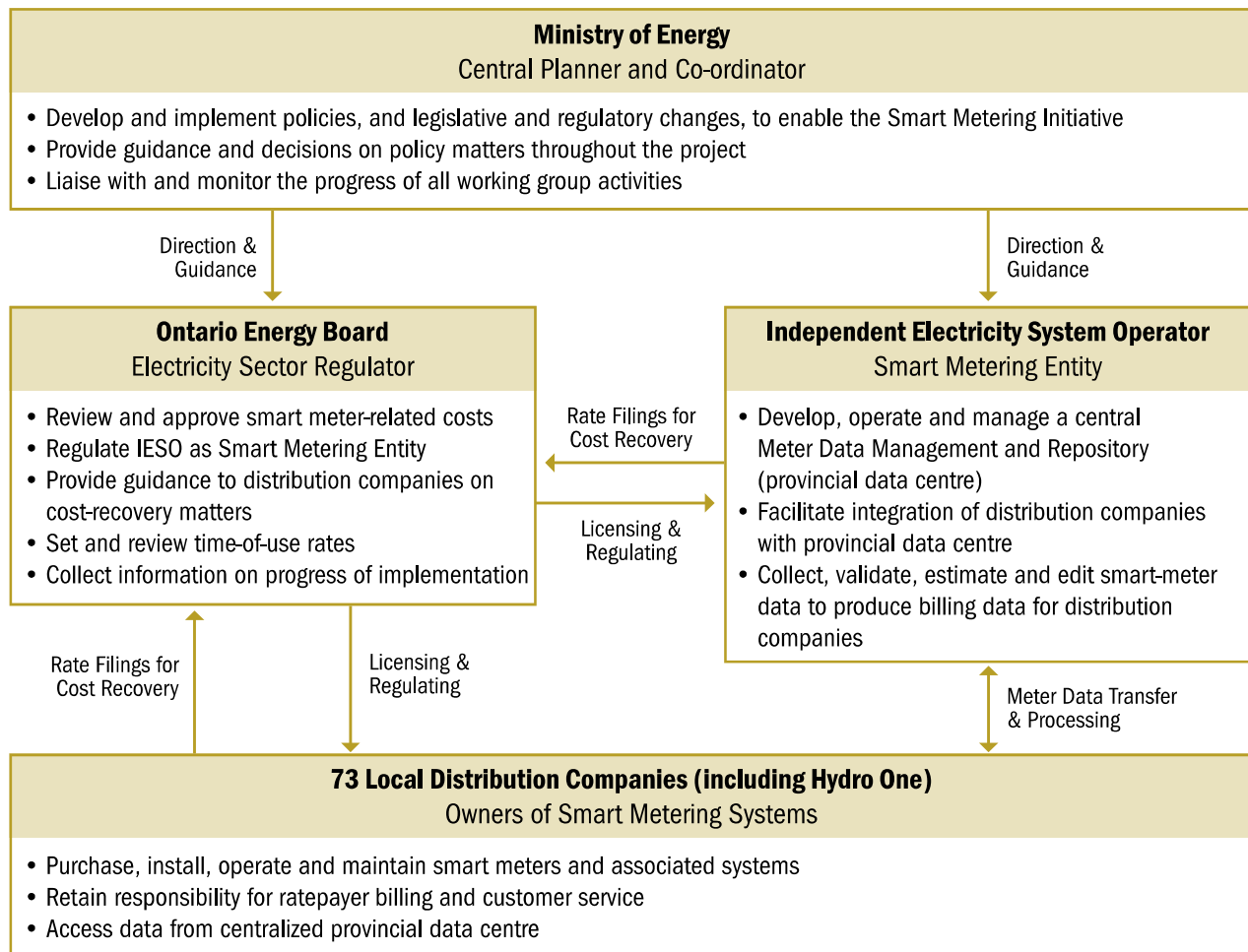
As of May 2014, there were about 4.8 million smart meters installed across Ontario, covering almost all residential and small-business ratepayers, and accounting for 45% of all electricity consumed in the province (large commercial and industrial users account for the remaining 55%). Smart meters resemble conventional meters, but differ with respect to how consumption data is displayed, measured, recorded and communicated, as illustrated in **Figure 3**.

Smart meters are the base infrastructure for developing a smart grid, which is the application of information and communications technology to improve the functioning of the electricity system and optimize the use of natural resources to provide electricity. In the *Electricity Act, 1998*, the smart grid and its objectives are set out as the information-exchange systems and equipment used together to improve the flexibility, security, reliability, efficiency and safety of the power system, particularly for the purposes of increasing renewable generation; expanding provision of price information to electricity customers; and enabling innovative energy-saving technologies.

Under TOU pricing, electricity rates charged are highest during the day, but drop at night, on

Figure 1: Key Roles and Responsibilities of Entities Involved in the Provincial Smart Metering Initiative

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weekends and holidays. The combination of smart meters and TOU pricing was expected to encourage electricity conservation and reduce demand during peak times by providing ratepayers with information and incentives to manage their electricity use by:

- moving consumption from peak to off-peak times (for example, running the dishwasher or dryer at night rather than in the afternoon); and
- reducing consumption during peak times (for example, setting the air conditioner a few degrees warmer on summer afternoons).

The Ministry set several targets to reduce peak electricity demand: a 1,350MW reduction by 2007; a further 1,350MW drop by 2010; and an additional 3,600MW reduction by 2025. The

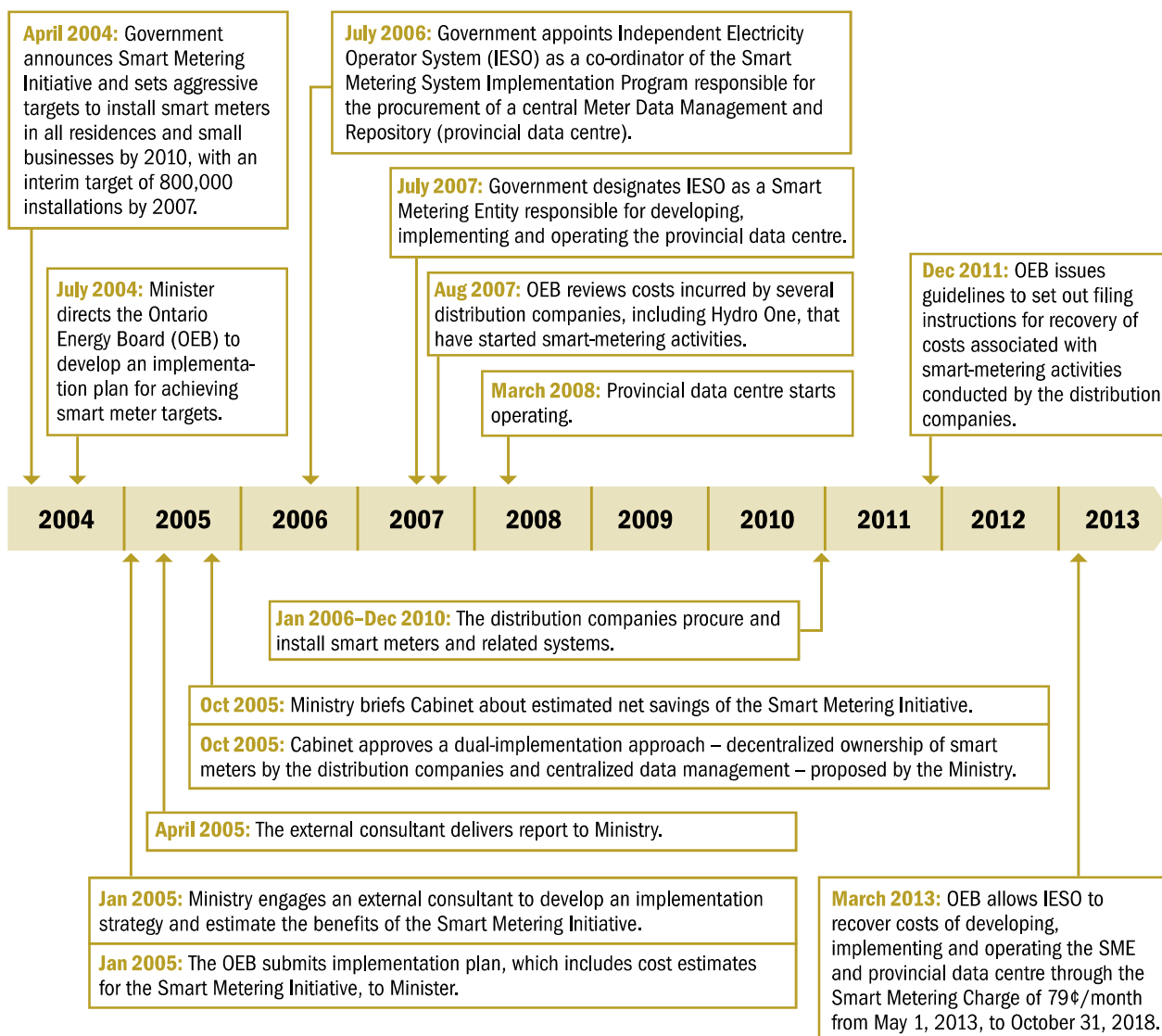
potential reduction in peak demand was intended to lighten the burden on electricity infrastructure, which in turn could reduce the need to build new power plants, expand existing ones, or enter into additional power-purchase agreements. It was also expected to help bring about the closing of coal-fired power plants, which were typically only used during periods of peak demand.

Audit Objective and Scope

Our audit objective was to assess whether effective systems and procedures were in place to:

Figure 2: Timeline of Key Events Relating to Implementation of the Provincial Smart Metering Initiative

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- ensure that the Smart Metering Initiative (Smart Metering) was planned, implemented and managed economically and efficiently, and in compliance with applicable policies and requirements; and
- measure and report on whether the objectives of Smart Metering were met in a cost-effective way.

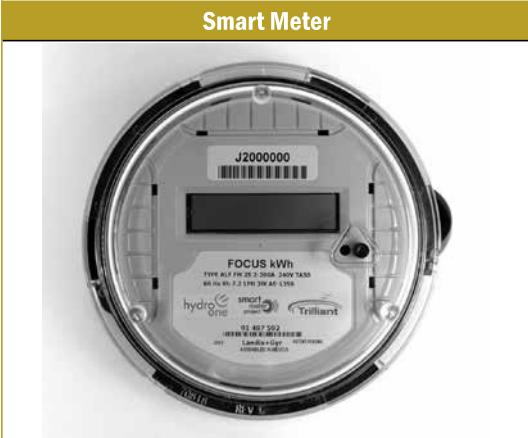
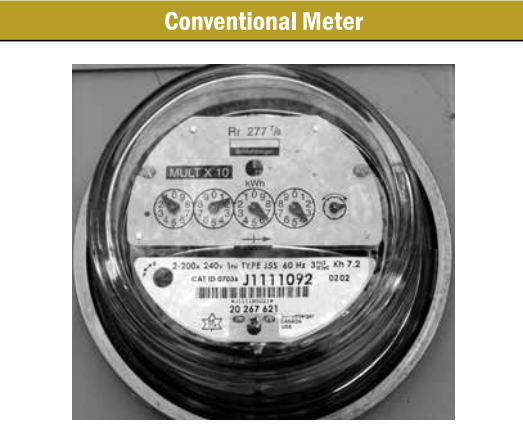
Senior management at the Ministry of Energy (Ministry), the Independent Electricity System Operator (IESO) and the Ontario Energy Board (OEB) reviewed and agreed to our objective and

associated audit criteria. We conducted this audit from October 2013 to May 2014.

In conducting our audit, we reviewed applicable legislation, regulations, policies, studies and other documents; analyzed electricity consumption and billing data; and interviewed appropriate staff at the Ministry, the IESO and the OEB. We surveyed 60 of Ontario's 73 distribution companies, with a response rate of over 70%, and interviewed staff from the remaining 13 distribution companies, including Hydro One, the only distribution company owned by the province. **Appendix 1** contains the

Figure 3: Comparison of Smart Meter and Conventional Meter

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	Smart Meter	Conventional Meter
		
Display	Digital meter with numerical display	Analog meter with spinning dials
Measure	How much and when electricity is used (typically hourly with date and time stamp)	How much electricity is used over a billing period (typically one or two months)
Recording	Automated meter reading: meters send data electronically to distribution companies through a wireless network*	Manual meter reading: distribution company staff physically visit ratepayer premises to record data
Communication	Two-way communication between meters and distribution companies*	No communication capability
Pricing	Time-of-use pricing (a three-tiered rate structure: on-peak, mid-peak, and off-peak) to reflect changing electricity costs throughout the day	Two-tiered pricing, with one rate applied to consumption up to a threshold and a second rate for electricity consumed in excess of this threshold

* See Figure 11 for data flow between the distribution company's smart-metering system and the IESO's provincial data centre.

questions posed to the distribution companies we interviewed and surveyed, and summarizes their responses. We also reviewed data and studies from the Ontario Power Authority, which has been involved in co-ordinating and assessing province-wide energy conservation efforts, including time-of-use (TOU) pricing enabled by smart meters. As well, we met with the Electricity Distributors Association, which represents all distribution companies across the province. In addition, we conducted research on smart-metering programs in other jurisdictions to identify best practices, and we engaged on an advisory basis the services of an independent expert with knowledge of smart metering.

Summary

The Ontario government's Smart Metering Initiative (Smart Metering) is a large and complex project that required the involvement of the Ministry of Energy (Ministry), the Ontario Energy Board (OEB), the Independent Electricity System Operator (IESO), and 73 distribution companies, including Hydro One. Our audit found that Smart Metering was rolled out with aggressive targets and tight timelines, without sufficient planning and monitoring by the Ministry, which had the ultimate responsibility to ensure that effective governance and project-management structures were in place to oversee planning and implementation. As yet, many of the anticipated benefits of Smart Metering

have not been achieved and its implementation has been much more costly than projected.

Our report highlights the difficulties that have been experienced in rolling out Smart Metering, which represents an initial step towards creating a smart grid—using information and communications technology to improve the functioning of the electricity system and optimize the use of natural resources to provide electricity. We hope that lessons learned from implementing smart meters can be applied to the government’s ongoing efforts to develop a smart grid in Ontario.

Some of our key observations related to Smart Metering are as follows:

Decision to Mandate Smart Metering Not Supported by Appropriate Cost-benefit Study

The government announced Smart Metering in April 2004, and shortly thereafter the Minister of Energy issued a directive to the OEB under the *Ontario Energy Board Act, 1998*. The directive required the OEB to develop an implementation plan to achieve the government’s targets of 800,000 smart-meter installations by 2007 and complete coverage for all residential and small-business ratepayers by 2010. The Ministry did not complete any cost-benefit analysis or business case prior to making the decision to mandate the installation of smart meters. This is in contrast to other jurisdictions, including British Columbia, Germany, Britain and Australia, which all assessed the cost-effectiveness and feasibility of their smart-metering programs. As well, even though the electricity market in Ontario continued to change, the Ministry never adjusted the smart-meter implementation plan.

Subsequent Cost-benefit Study Flawed

After the government announced the rollout of Smart Metering in April 2004, the Ministry prepared a cost-benefit analysis of Smart Metering, and submitted it to Cabinet in October 2005. However, the analysis was flawed; its projected net benefits of approximately \$600 million over 15 years were significantly overstated by at least \$512 million because it excluded an annual net

increase in the projected operating costs of distribution companies. In other words, the projected net benefits should have been reflected as only \$88 million over 15 years.

Smart Metering Costs to Date Exceed Projected Costs and Benefits

The Ministry has neither updated the projected costs and benefits of Smart Metering, nor tracked its actual costs and benefits, to determine the actual net benefits being realized. Up to the end of 2013, our analysis shows that total smart metering-related costs incurred only by the distribution companies had already reached \$1.4 billion—well in excess of the Ministry’s initial total projected costs of \$1 billion. When costs of the Ministry, the OEB and the IESO are included, we noted that total costs relating to implementation of Smart Metering had reached almost \$2 billion at the time of our audit. Additional costs are expected in the future because some distribution companies had not yet incorporated all of their implementation costs into their charges to ratepayers (these additional costs will be subject to OEB review and approval). As well, the benefits of Smart Metering in reducing distribution companies’ operating costs and reducing electricity bills to ratepayers were so far limited: Of the distribution companies we consulted, 95% said they realized no savings and their operating costs actually rose, and over half said they received a high volume of ratepayer complaints about “increased bills with no savings.”

Significant Smart Metering System Development and Integration Challenges Encountered

In other jurisdictions, mass deployment of smart meters was carried out by only a few distribution companies, or even just one. The challenge in Ontario was that 73 distribution companies were each separately responsible to purchase, install, operate and maintain smart meters, as well as to bill ratepayers. This made it difficult to ensure a cost-effective implementation of Smart Metering. Three-quarters of the distribution companies we consulted ranked data management and system

integration as one of the top three challenges of Smart Metering, and 83% said it was difficult and costly to integrate their systems with the provincial data centre. There have been many system upgrades, including changes made in order for Ontario to comply with Measurement Canada's billing disclosure requirements after smart meters were installed.

Peak-demand Reduction Targets Not Met

The purpose of Smart Metering was to enable time-of-use (TOU) pricing, which was expected to reduce electricity demand during peak periods. The Ministry set several targets to reduce peak electricity demand (a 1,350MW reduction by 2007, a further 1,350MW drop by 2010, and an additional 3,600MW reduction by 2025). However, the initial target of reducing peak demand by 1,350MW was irrelevant to Smart Metering anyway because it was supposed to be achieved by 2007, three years before full installation of smart meters was to be completed. With respect to the second target of an additional 1,350MW reduction by 2010, peak electricity demand did not fall, but actually rose slightly by about 100MW between 2004 and 2010.

Ontario's Surplus Power Exported to Other Jurisdictions at Less than Cost

The reduction of electricity demand during peak times was intended to delay the need to expand power-generating capacity in Ontario, along with the related costs. In the decade since the Ontario government announced Smart Metering, peak demand has remained essentially unchanged, but the Ministry has approved significant increases in new power generation, such as renewable energy, creating power surpluses in Ontario. The overall financial impact has been that other jurisdictions are able to buy this surplus power from Ontario at a price considerably lower than what it actually cost Ontario to produce this power. The total cost of producing the exported power was about \$2.6 billion more than the revenue Ontario received from exporting that power between 2006 and 2013.

Electricity Billing Amounts Varied by Distribution Company

Ratepayers pay different amounts for the same power usage depending on where they live in Ontario, mainly due to different delivery costs of the 73 distribution companies. For example, a typical residential electricity bill could vary anywhere between \$108 and \$196 a month, mainly due to the variation in delivery costs ranging from \$25 to \$111 a month charged by different distribution companies to ratepayers. Implementation of Smart Metering significantly impacted the costs for each of the distribution companies, which chose different smart meters and IT solutions for their in-house systems. The cost per meter therefore varied with each distribution company, ranging from \$81 per meter to \$544 per meter, depending mainly on geography and the amount of upfront costs. For example, Hydro One, the only distribution company owned by the province, incurred significant costs to implement its smart-metering project. By the end of 2013, Hydro One accounted for \$660 million, or almost 50%, of the \$1.4-billion implementation costs incurred by all 73 distribution companies. However, it installed 1.2 million smart meters, which represented only about 25% of the 4.8 million smart meters installed in Ontario.

Of the \$660 million spent by Hydro One, more than \$125 million went to a private-sector vendor with whom it signed multiple contracts for services, such as system integration and project management, and approved a number of change orders. Hydro One selected this vendor based on several criteria, including price. However, pricing evaluation was not based on the overall contract cost. Hydro One explained the contract cost could not be fixed due to the "unknown nature of all the business requirements at the time of the Request for Proposal (RFP)." Granting a contract through the RFP process without acquiring enough knowledge about the business requirements would lead to risks of significant cost increases due to change orders.

Time-of-use (TOU) Pricing Model Has Had Minor Impact on Reducing Peak Demand

Smart Metering was undertaken to enable the introduction of time-of-use (TOU) rates to encourage people to shift power use to Off-Peak periods. However, TOU rates and periods may not be designed effectively to reduce peak demand as intended. Specifically:

- The difference between the On-Peak and Off-Peak rates has not been significant enough to encourage a change in consumption patterns. When TOU rates were introduced in 2006, the On-Peak rate was three times higher than Off-Peak; by the time of our audit, that differential had fallen to 1.8 times, due to significant increases in the Global Adjustment, another component of electricity bills in Ontario. In particular, the Off-Peak rate increased the most, by 114%, while On-Peak increased the least, by 29%. As a result, the difference between On-Peak and Off-Peak rates has narrowed, thus undermining TOU pricing as an incentive for ratepayers to shift power use to Off-Peak periods.
- The distribution of On-Peak, Mid-Peak and Off-Peak periods does not fully reflect actual patterns of electricity demand. In particular, in response to amendments to Ontario Regulation 95/05, the OEB moved the start of Off-Peak in 2010 from 9 p.m. to 7 p.m. on weeknights, making the early evening hours of 7 p.m. to 9 p.m. Off-Peak, even though demand at those times is high.

In 2013, separate studies released by the Ontario Power Authority and the OEB indicated that TOU pricing had a modest impact on residential ratepayers, reducing their peak demand by only about 3%, but a limited or unclear effect on small businesses, and none at all on energy conservation. Our review also found that:

- Of about 1.8 million ratepayers on TOU rates that we reviewed, only 35% of residential ratepayers and 19% of small businesses reduced their consumption during On-Peak periods,

while a majority of them (65% of residential and 81% of small businesses) did not.

- About 77,000 ratepayers with smart meters paid set rather than TOU rates because they signed fixed-price contracts with electricity retailers, who do not charge based on time of use. Consumption patterns of retail and TOU ratepayers were about the same, suggesting that TOU pricing provided no more incentive to change usage behaviour than retail contracts.

Significant Impact of Global Adjustment on TOU Rates Not Transparent to Ratepayers

The Electricity Charge on ratepayer electricity bills is composed of two parts: the electricity market price and the Global Adjustment, added to the market price mainly to cover the guaranteed prices paid to contracted power generators in Ontario. From 2006 to 2013, the Global Adjustment increased almost 1,200%, while the average market price actually dropped 46%. The impact of the Global Adjustment has been significant on ratepayer electricity bills as follows:

- The total Global Adjustment paid by Ontario ratepayers has grown from \$654 million in 2006 to \$7.7 billion in 2013. More contracted generators, especially producers of higher-priced renewable power, will soon be coming online, so the total Global Adjustment is expected to increase even more. Between 2006 and 2015, the 10-year cumulative actual and projected Global Adjustment stands at about \$50 billion, equivalent to almost five times the 2014 provincial deficit of \$10.5 billion. In essence, the \$50 billion is an extra payment covered by ratepayers over and above the actual market price of electricity.
- The vast majority of residential and small-business ratepayers pay for electricity based on the three TOU rates—Off-Peak, Mid-Peak and On-Peak—which were seen as critical in encouraging ratepayers to shift power use to times of lower demand. The Global Adjustment now accounts for about 70% of each of

the three TOU rates. While the Global Adjustment has increased significantly and accounts for a substantial proportion of TOU rates, its impact is not transparent to ratepayers because it is embedded in TOU rates and does not appear as a separate line on most electricity bills (the Global Adjustment appears separately only on bills of those ratepayers who have signed contracts with electricity retailers, who do not offer TOU rates).

Ratepayer Complaints Stemmed from Time-of-use (TOU) Rates and Billing Errors

Many distribution companies did not track or log the nature or type of complaints they received. They were therefore unable to quantify the volume of complaints they received before and after smart-meter implementation; nor could they separate smart meter-related concerns from billing-system issues. Without proper tracking and monitoring of ratepayer concerns, key information could not be collated to identify and resolve common or recurring problems on a timely basis. Those distribution companies that did track complaints found that most ratepayers were upset about TOU pricing, which they believed resulted in higher electricity bills than previously. Our work at Hydro One also noted complaints from ratepayers about estimated bills or no bills for extended periods due to Hydro One's billing-system problems and connectivity issues between smart meters and associated communication systems; and about bills based on errors arising from smart meters connected to incorrect addresses.

Duplication of Services by Provincial Data Centre and Local Distribution Companies' In-house Systems

Under Smart Metering, the IESO is recovering the cost of its \$249-million provincial data centre, called the Meter Data Management and Repository (provincial data centre), from all residential and small-business ratepayers through a Smart Metering Charge of 79¢ per month that began in May 2013 and was set to end in October 2018. These costs were not included in the initial cost

projection of \$1 billion made by the OEB for implementing Smart Metering.

Of the 4.8 million smart meters installed across the province, approximately 812,000 have not transmitted any data to the provincial data centre for processing. Although these ratepayers have never benefited from the provincial data centre, they still have to pay the monthly Smart Metering Charge of 79¢, totalling about \$42.1 million up to October 2018.

The IESO has exclusive authority to develop and operate a provincial data centre in which to process smart-meter data for the province. However, the goal of operating the provincial data centre as a central system to ensure standard and cost-effective data processing has not been met because most distribution companies have used their own systems to process smart-meter data (before transmitting it to, or after receiving it from, the provincial data centre) for billing purposes. The provincial data centre was not available when some distribution companies started to roll out smart meters. Of the distribution companies we consulted, 88% indicated that the provincial data centre and their own systems have similar functions, resulting in redundancy. The costs of this duplication—one system at the provincial level and another locally—are passed on to ratepayers. The monthly operating cost for the local systems is, on average, about 21¢ per meter, which is being borne by ratepayers on top of the 79¢-a-month Smart Metering Charge.

Limitations of Provincial Data Centre and Distribution Companies in Processing Smart-Meter Data

Several limitations in processing smart-meter data by the provincial data centre and the business processes at the distribution companies have affected the quality and usefulness of smart-meter data, which in turn can affect billings to ratepayers. These limitations were associated with situations such as meter replacements and power blackouts. Also, half the distribution companies we consulted indicated that the provincial data centre has limited capabilities for data retrieval and querying. In

August 2013, the IESO reported to its board that the provincial data centre was able to manage data queries during its early stage of implementation, but it was not designed to support the expected increases in volume of data-retrieval requests from distribution companies.

Contract Terms for Operating Fee of Provincial Data Centre Not Clear

The IESO and a private-sector vendor signed a five-year contract in 2006, with an option to extend for another two years, for developing, implementing and operating the provincial data centre. The IESO paid the vendor \$81.7 million for services up to March 2013. However, the \$13.4-million-a-year contract fee for the two-year extension period was almost double the \$6.8-million-a-year cost of the previous five years. The IESO attributed a portion of the fee increase to the additional costs associated with changes made to the provincial data centre and the higher number of meters being put in service during the two-year extension period. We found that the fee increase was due mainly to an error stemming from a contract amendment that did not clarify the fee for the two-year extension period. The IESO noted that this was an oversight on the part of the vendor, the IESO and their counsels, and that since the vendor incurred losses on the contract, the error offered the vendor an opportunity to improve its commercial position.

Monitoring of Smart Metering-related Fire Safety Risk Not Sufficient

There have been cases of fires arising from smart meters in Ontario and in other jurisdictions. However, no accurate and complete information on smart meter-related fires was available in Ontario to determine and monitor the scope and extent of the problem across the province. Only anecdotal evidence was available, which indicated three possible root causes for the fires: improper installation of smart meters, defective smart meters and problems with old meter bases where smart meters are mounted.

OVERALL MINISTRY RESPONSE

Electricity systems around the world are adapting to meet the new and complex demands of technology advances and customer expectations. In 2004, the province took a critical step towards modernizing Ontario's electricity grid with the announcement of the Smart Metering Initiative.

The Ministry acknowledges that given the ambitious timeline to install smart meters by 2010 and the inherent structure of the distribution industry, with over 70 local distribution companies, that the initiative was both complex and challenging.

Faced with these challenges, the Ministry, the IESO, the OEB and local distribution companies worked collaboratively to make Ontario one of the first jurisdictions in North America to roll out smart meters.

The deployment of 4.8 million smart meters has brought a number of benefits to the province, including the ability of consumers to respond to price signals. Going forward, smart meters, as the base technology for a modern grid that enables emerging technologies and applications like electric vehicles, electricity storage and innovations to make Ontario homes smarter, will continue to deliver value to Ontario.

The Ministry will incorporate the recommendations of the Auditor General's report when working in partnership with our agencies and the broader sector to deliver future smart meter initiatives and related investments.

Detailed Audit Observations

Governance and Oversight of Planning and Implementation

In April 2004, the Ontario government announced the Smart Metering Initiative (Smart Metering)—the first and the largest smart-meter deployment in