


ONTARIO POWER AUTHORITY


December 2006

Ontario's Integrated Power System Plan

Discussion Paper 3: Conservation and Demand Management

Revised

Ontario Power Authority™

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December 21, 2006

To Ontario's Electricity Consumers and Stakeholders:

We are pleased to deliver for your consideration "Discussion Paper #3: Conservation and Demand Management". This paper is a revised version of the one issued on September 22, 2006. This revision is, in part, the result of recognizing and considering stakeholder advice and comments made at the workshop on September 27-28, during the subsequent web conference on October 26 and by e-mail. We have also enhanced the paper in a number of ways. We have included regional estimates of conservation, expanded the avoided cost discussion, added end-use estimates by sector and updated the peak demand calculations.

During the September 27-28 workshop, stakeholders expressed – and we acknowledge – the urgent need to implement conservation programs in Ontario. In revising this paper, we have attempted to reflect this sense of urgency.

The OPA welcomes your comments on this revised CDM paper. For details on stakeholder input and participation opportunities (and other IPSP matters), please see the OPA's dedicated IPSP Web site (www.powerauthority.on.ca/IPSP/).

The OPA will continue to work with stakeholders to improve its products and deepen its understanding of all planning issues as we move toward the filing of a recommended IPSP in the spring of 2007. Your participation is greatly appreciated.

Yours sincerely,

Amir Shalaby
Vice President, Power System Planning

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Summary

Ontario urgently needs to reduce its electricity use. The Province has set aggressive targets for reductions in peak electricity demand: 1,350 megawatts (MW) to be achieved by the end of 2007, an additional 1,350 MW to be achieved by the end of 2010 and a further 3,600 MW to be saved by 2025. It has tasked the OPA with leadership in seeing that the targets are met. As the Chief Energy Conservation Officer has reported, solid foundations are being laid and there are grounds for optimism that the goals will be attained[1].

This paper is a component of the Integrated Power System Plan (IPSP) that is being prepared for filing with the Ontario Energy Board (OEB) in the spring of 2007. The IPSP will contain projections about the amount of achievable conservation and demand management (CDM) savings, by different CDM categories, and will outline an action plan for securing them.

The CDM projections developed in this paper were incorporated into the preliminary plan[2] issued in November 2006. They are used as a starting point for developing strategies and plans, with the understanding that they are not ceilings, and will be revised upwards in the future if warranted by experience.

In this paper we:

- Define the CDM resource (all opportunities for reducing electricity demand and consumption that can be achieved more economically than supplying an equivalent amount of energy)
- Discuss Ontario's need to enhance its CDM efforts and outline the OPA's three-pronged approach (procurement of CDM resources, capability building and market transformation)
- Define five categories of CDM (conservation behaviour, energy efficiency, demand management, fuel switching and self generation/cogeneration)
- Present moderate and aggressive estimates of the potential CDM resource achievable in Ontario by each of the categories
- Explain the proposed CDM resource plan that will be used in the IPSP and its costs and benefits
- Indicate the CDM priorities that the OPA will pursue over the next three years
- Outline principles that will inform the design and implementation of specific OPA programs and activities
- Establish the importance of putting in place a robust evaluation, measurement and verification (EM&V) process

This paper is a revised version of one issued on September 22, 2006. The OPA will continue to work with stakeholders to improve its products and deepen its understanding of all planning issues as we move toward the filing of a recommended IPSP in the spring.

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[1] Chief Energy Conservation Officer, *Annual Report 2006*, Ontario Power Authority, November 2006.

[2] Discussion Paper #7- Integrating the Elements – A Preliminary Plan http://www.powerauthority.on.ca/ipsp/Storage/32/2734_DP7_IntegratingTheElements.pdf

The Conservation Challenge

Opportunities to conserve energy that are economic from a societal perspective are not being fully implemented in the Ontario economy for variety of reasons. CDM performance has to improve to ensure electricity reliability, lower costs and improved environmental results from the power system. To secure more of the available CDM resource, it is necessary to:

- Influence customer attitudes and behaviour by providing information and increasing awareness about the importance of electricity conservation
- Utilize various market channels to deploy conservation programs
- Enhance CDM delivery capabilities by improving training, encouraging business networks, supporting research and development, supporting the diffusion of viable new energy saving products and services, and improving sector-wide capability to evaluate projects and target new markets
- Secure improvements in the codes and standards that establish minimum energy efficiency standards for appliances, equipment and buildings
- Reduce or remove legal and economic barriers that unreasonably inhibit the adoption of energy saving practices or unreasonably restrain the expansion of conservation-related businesses
- Achieve continuous improvement in how well we do all of the above through data development and better sharing of information and experiences - through the development of a robust, EM&V process.

The OPA's Role

The OPA has a mandate to play a leadership role in CDM. Ontario Regulation 424/04 on the IPSP requires the OPA to "Identify and develop innovative strategies to accelerate the implementation of conservation, energy efficiency and demand management measures". The OPA has no role in direct program delivery.

Achieving demand and energy savings is a shared responsibility and will require a concerted effort across the board: by governments, utilities, energy service companies, product suppliers, non-governmental organizations and customers. We acknowledge the significant efforts that have been made by many parties over the last several years. In particular, we note the programs launched in the last two years by the local distribution companies (LDCs).

We intend to work closely with the LDCs, program administrators (such as BOMA, SHSC, AMPCO)[3] and market channels (such as HRAI, NGOs)[4] to enhance conservation awareness and delivery capabilities. We will address the targets and meet end user needs by leveraging the

[3] Building Owners and Managers Association (BOMA), Social Housing Services Corporation (SHSC), Association of Major Power Customers in Ontario (AMPCO).

[4] Heating, Refrigeration and Air Conditioning Institute (HRAI), Non Governmental Organizations (NGOs).

capabilities and experience of those already in the field. We will also encourage the development of new partnerships and delivery channels.

The OPA's Approach

The OPA has a three-pronged strategy:

- To procure CDM resources to meet the 2010 targets
- To enhance capabilities across the conservation industry
- To transform the market and build a culture of conservation

As noted, the need for demand reduction is urgent. And we have a great deal of catching up to do in Ontario because programs to support conservation were largely dismantled a decade ago and are only now being rebuilt.

The OPA intends to act immediately and aggressively to secure savings in both electricity consumption and demand. These savings will be achieved through direct procurement programs, such as product rebates, building retrofits and appliance recycling initiatives. This paper discusses some of the principles that will guide the development of the procurement programs to be launched in 2007 and later years.

Our immediate focus is on meeting the 2010 demand reduction target. However, in the mid to long term would involve changes to codes and standards, influencing attitudes, improving knowledge, removing barriers, enhancing delivery capability and introducing new incentives. While procurement programs secure savings almost immediately, changes to codes and standards will play a significant role in achieving energy savings as turn over in capital stock start to take root and the conservation industry develops greater depth and resilience. In the mid to long term we expect there will be less need for procurement of conservation programs because a transformed marketplace will be securing more of the available CDM resource than it does today.

CDM is a cost-effective resource. It has compelling environmental advantages and most CDM gains are sustainable over time. In Ontario, CDM is now looked at as a resource for meeting future customer needs, not simply as an adjustment to the demand forecast. Accordingly, it is being treated strategically as part of the integrated resource plan.

The CDM Resource Plan

We started our estimates with the "National Study" commissioned by the Council of Energy Ministers' working group on demand side management[5]. The National Study focused on potential electricity savings from energy efficiency and cogeneration. We used market scans and information from other jurisdictions to develop estimates for the other CDM categories. Methodologies were developed to convert estimates of potential energy savings (in MWh) to potential reductions in peak demand (in MW).

Moderate and aggressive estimates of the achievable potential were developed, starting with the energy efficiency and cogeneration categories in the National Study. The moderate estimates correspond to a status quo CDM policy environment, while the aggressive estimates correspond to a CDM policy environment that includes subsidies, changes in codes and standards and greater price responsiveness.

By making some judgement calls about the relative success that can be expected in each area, we established targets for each of the five CDM categories, as shown in the "Plan" columns of Table A. This process involved an application of the six sustainability criteria developed for the IPSP: feasibility, reliability, cost, flexibility, environmental impact and societal acceptance.

The estimates of achievable demand reductions are shown in the table below:

Table A – CDM Category Peak Savings (MW)

	2010			2025		
CDM Category	**Aggressive**	**Moderate**	**Plan**	**Aggressive**	**Moderate**	**Plan**
Conservation Behaviour	350	50	60	350	50	226
Energy Efficiency	1,327	452	777	5,598	1,115	2,932
Demand Management	546	199	370	2,384	674	1,411
Fuel Switching	112	112	81	506	506	301
Self Generation (Renewable/Cogeneration)	154	44	69	1,000	115	260
Total	2,490	857	1,356	9,838	2,460	5,131

Note: The plan totals shown are incremental to the 1,350 target for 2007, which is assumed to be met. The low plan savings for fuel switching is explained in the footnote to Table 3.3.
Source: OPA

The category estimates in Table A have not been amended to remove various overlaps and interactions that exist between different categories. Our assumption is that the effect of these overlaps and interactions may be in the range of ten to twenty percent. The estimates confirm that the government demand reduction targets are achievable – they lie between the low and high estimates of achievable potential.

[5] Marbek Resource Consultants Ltd. and M.K.Jaccard and Associates, Inc. *Demand Side Management Potential in Canada: Energy Efficiency Study*, May 2006. The Ontario-specific results were updated to include provincial data for the 2001-2005 period. See OPA, IPSP Discussion Paper #2, Load Forecast, September 2006.

The value, or net benefit, of the overall CDM plan is the difference between the costs of the avoided generation, transmission and distribution and the costs of the CDM, including all customer and program administration costs. Our estimate of the value of the avoided cost is $10-13 billion. The achievable CDM resource would cost approximately $4-5 billion. The difference – the net benefit of the CDM plan as a whole – is thus $5-9 billion.[6]

The individual category targets are not meant to be regarded as hard or fixed. They have been developed for IPSP planning purposes, and will be adjusted as we gain more information about customer needs and program performance.

CDM Implementation

Energy efficiency gains are shown to be the largest source of achievable demand reductions, confirming the importance of changes in energy efficiency standards and codes, especially in the longer run. Gains from demand management are also expected to be large, emphasizing the need for enhanced efforts by those promoting demand management services and technologies, including smart metering.

A key planning challenge for the OPA is to set priorities for its own efforts. Since June 15, 2005, the OPA has received eight ministerial directives totalling 1,300 MW of demand reduction, or almost half of the 2,700 MW to be achieved by the end of 2010. We have already launched a number of initiatives specifically designed to meet the government's targets and will shortly be announcing new ones. There is, however, much more to do to ensure that the 2010 target is met.

Going forward, we intend to focus our program efforts on five high priority end-uses that were identified, in part, through the analysis of end-use potential described above. The five priorities are: lighting, cooling and ventilation in the commercial sector, and lighting and cooling in the residential sector. Reducing and shifting air conditioning load is an obvious target in the quest to reduce peak demand, but improvements in lighting and appliance use are also needed in both the residential and commercial sectors.

We also see significant demand response opportunities in the industrial sector. Demand response occurs when customers install energy management and automated response systems, enabling them to program their energy use in response to price signals, or contract with the system operator, a utility, retailer or other agent to have their energy use automatically adjusted at certain threshold prices or times. Demand response can thus occur for price or reliability reasons.

Estimated achievable energy savings for some of the major end uses (in 2010) are shown below:

[6] Present value over the study period (2008 – 2027) using a 4% real (social) discount rate.

Table B – Energy-Efficiency Savings by End-Use (GWh) 2010 Aggressive Scenario

Residential		
	Room Air Conditioning	10
	Central Air Conditioning	150
	Furnace Fan	150
	Lighting	2,470
	Refrigeration	80
	Freezer	60
	Water Heating	150
	Dish Washer	40
	Clothes Washer / Dryer	80
	Miscellaneous	380
Commercial		
	Space Cooling	280
	Ventilation	600
	Lighting	2,200
	Electric Auxiliary	80
	Water Heating	60
Industrial		
	Process Machine Drive	230
	Heat Production	170

Source: MKJA, OPA

Our proposed principles to guide program selection and design are based on three considerations: our mandate to exercise leadership in the electricity conservation sector, our need and desire to work with our sector partners and leverage their capabilities, and our responsibility to meet the regulatory requirements of economic prudence, safety and environmental sustainability that have been established for the IPSP. These considerations also inform our proposed principles for program implementation.

Among our key principles are the following:

- Leverage: Recognize and build upon successful programs, make use of existing capabilities and delivery channels, and ensure that achievements become part of the industry "knowledge base"
- Best practices: Adopt proven ideas from other jurisdictions
- Flexibility: Design programs to enable quick fixes if necessary
- Customer Responsiveness: Maintain focus on the needs of the final customer
- Transparency: Ensure that processes are open, fair and streamlined
- Continuous Improvement: Implement an EM&V process to track results against objectives and thereby ensure continuous learning and program improvement.

The LDCs are one important partner in the pursuit of CDM opportunities. We are counting on governments and other parties to vigorously address the need to achieve changes to all relevant codes and standards. This is especially important given the extent of the gains that can be achieved through energy efficiency applications. We acknowledge the important advances on standards that have been made in the past year and encourage the proponents to continue their efforts.

We emphasize the importance of EM&V in making conservation a reliable and durable resource. It provides regular feedback about performance and leads to better estimates of CDM potential and more effective programs and activities to secure it. EM&V systems need to be embedded in developing and delivering CDM programs. We will complete an evaluation for all programs we manage, using standardized performance metrics to the extent possible. The reports will track the net energy savings and peak demand savings achieved, consider the impacts on buyers and sellers in the given market, and suggest ways to improve the program design or delivery system.

Reflecting the importance of EM&V in the sector as a whole, the OPA also proposes to develop a standardized reporting format that could potentially be adopted for use throughout the electricity sector, thereby enhancing overall knowledge of what is taking place in the industry.

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1. Introduction

This paper is a revised and updated version of IPSP Discussion Paper #3: Conservation and Demand Management (CDM), originally issued on September 22, 2006. Stakeholders have expressed – and we acknowledge – the urgent need to implement conservation programs in Ontario. The OPA has a role to play in planning and supporting conservation programs for delivery.

Ultimately, the success of all the work currently underway in this area is dependent upon how well the program delivery agents and others, including the OPA, are able to influence customers about the need to adopt practices that reduce their electric energy consumption and that the adoption of these practices will assist in meeting future needs for electricity. It is important for the OPA and others to understand not only the market segments that offer the highest potential to reduce energy use, but also which programs meet customer needs and where the capability gaps are. We acknowledge the need to work with other market players, such as program designers, delivery agents and program administrators, to assess customer needs, design programs that help customers understand the benefits of reducing their demand for electricity, and enhance industry capabilities to deliver these conservation programs.

The Preliminary Plan described in discussion paper #7, posted in November, presents a road map to a sustainable electricity future for Ontario. It is an implementation plan, consisting of:

- actions that need to be taken now to deliver concrete results for conservation, supply and transmission within the next three years; and
- actions that need to be taken now, or soon, to develop the supply and transmission options that will be needed in the mid- to long term and to establish the enabling conditions for conservation from which market transformation can occur over the long term.

In this paper we:

- recognize and consider stakeholder advice and comments made at the workshop on September 27-28,[7] during the subsequent webconference on October 26, and those received by e-mail
- define the CDM resource (identified specific opportunities for reducing peak electricity demand and energy consumption that can be achieved economically)
- discuss the principles that underpin the pursuit of CDM
- define five categories of the CDM resource (conservation, energy efficiency, demand management, fuel switching and self generation/co-generation)
- outline the OPA's approach for procurement of CDM resources, capability building and market transformation

[7] The workshop was attended by 81 stakeholders. For details, please see,
http://www.powerauthority.on.ca/ipsp/Storage/29/2459_CDM_Stakeholder_Workshop_Report.pdf
http://www.powerauthority.on.ca/ipsp/Storage/29/2458_Report_on_Stakeholder_Dialogue_on_CDM__final_.pdf

- explain the approach for choosing specific CDM resources that will meet the 2010 and 2025 targets and our assessment of the costs and net benefits of the plan
- indicate the CDM priorities that the OPA will pursue over the next three years
- outline principles that will inform the design and implementation of specific OPA programs and activities, and
- establish the importance of a robust evaluation, measurement and verification (EM&V) process for CDM programs

The paper consists of this introduction and three sections.

- Section 2 provides a description of our proposed approach to CDM resource planning.
- Section 3 reports on our estimates of the economic and achievable CDM potential in Ontario.
- Section 4 discusses principles and criteria related to the design, implementation, monitoring and evaluation of CDM programs.

In addition, there are four appendices. The first provides more detail on the estimation of achievable potential by CDM category. The second gives details on the calculation of avoided cost and estimated benefit from the proposed CDM implementation plan. The third provides energy and peak savings by end use and sector. The fourth contains legislative and policy initiatives.

Request for Stakeholders' Comments

We request additional feedback and comments on this revised paper. All comments will be considered as we proceed with the development of the IPSP filing documents. The filing with the Ontario Energy Board (OEB) is scheduled for spring 2007.

Comments must be submitted to the OPA through one of the two following channels:

- Electronic submissions can be made through the on-line form at the following Website link, which includes instructions for sending submissions as attachments: http://www/powerauthority.on.c/ipsp/Page.asp?PageID=751SiteNodeID=231&BL_ExpandID=1
- Submissions by regular mail or courier can be sent to: IPSP Submissions, Ontario Power Authority, 120 Adelaide St. W., Suite 1600, Toronto, ON M5H 1T1

Given the volume of correspondence, submissions sent to specific individuals at the OPA cannot be assured of review and consideration.

2. Our Approach and Strategy

2.1 Introduction

In the coming years, conservation and demand management (CDM) will play an increasingly important role in ensuring a secure and environmentally sustainable electricity future in Ontario.

In this section, we provide a brief discussion of our approach and how we intend to meet the conservation challenge. We then define conservation and the five categories of conservation.

2.2 Our Approach

2.2.1 Key Concepts and Commitments

Our approach to conservation starts with a set of principles which will govern the path forward as we build a robust conservation plan. These principles build from our presentation in the October 26 webinar, and we have continued to develop them further in response to stakeholder suggestions. In summary:

- The OPA is committed to the development of conservation as a key resource in the supply mix, a resource that needs to be more effectively harvested to meet the future electricity supply needs of Ontario. CDM can be a reliable, cost-effective resource with many environmental advantages. We are therefore committed to securing as much of it as possible. We view CDM as a system resource, and consider it first in assessing new resources to fill the supply-demand gap.
- The OPA will work closely with its many partners in the conservation sector. We recognize that achieving Ontario's aggressive CDM targets will require a broad-based effort by governments, utilities, energy contractors, retailers, manufacturers, associations, non-governmental organizations, and, of course, customers. We will exercise our leadership responsibility by leveraging the resources that already exist in the market, enhancing competencies and fostering new capability. We appreciate that relationship-building is a long-term process, and that good relationships are built on trust, transparency and respect and accountability.
- The OPA is committed to developing programs that meet customer and delivery partner needs. Programs will be planned strategically and implemented efficiently to meet the goals of economic prudence and cost effectiveness. They will be subject to regular review and evaluation through a comprehensive EM&V process.

These principles presented above are intended to support our strategic approach, the way we do business, and the design and implementation of our programs. As noted, stakeholders have provided many constructive suggestions of how to enhance these principles.

Some of the suggestions are addressed by way of specific improvements we have made in this version of the paper. There were, however, a number of over-arching comments that are best dealt with “up-front”. They have all been addressed, to some extent, in the improved statement of principles given above, but are elaborated below for greater clarity.

We agree with stakeholders that:

- CDM must be pursued with a sense of urgency. Time is of the essence. The 2010 target must be met – success on CDM is critical to the early phase-out of coal-fired generation, and to ensuring system reliability. The OPA has already launched a number of important initiatives. The 2006 Annual Report of the Chief Energy Conservation Officer describes the programs that are underway and in development[8]. As of August 31, 2006, about 800 MW of new CDM had been committed. In addition, we are proceeding with the plan for funding CDM programs that will be offered by the local distribution companies (LDCs) and other delivery partners in 2007. We have a full agenda and are moving ahead aggressively. At the same time, we must ensure that the analytics and design elements are appropriate; our regulator and ratepayers expect no less.
- The CDM targets in the government directive are not caps. The targets are to be exceeded if possible. We have reflected this in our principles. For planning purposes, we require projections that reflect our current best estimates of what is actually achievable. We are using CDM projections, on the understanding that the estimates will be raised if warranted by experience over the next few years, and, conversely, that programming will be intensified if it appears that achieved savings are falling short of what is required to remain on track toward the targets.
- CDM must meet customer needs, interests and priorities. Since the basic point of CDM programming is to convince customers about the benefits of reducing their electricity consumption and demand and focussing on opportunities that will be of interest to customers. We recognize that customers are interested in more than just energy savings; our programs must reflect a range of product dimensions from aesthetics to convenience to price. This customer focus suggests a tilt in favour of market-based solutions and relatively simple, streamlined program designs.
- CDM should promote innovation and flexibility. The OPA should avoid over-engineered solutions. Where feasible, consideration should be given to standard offer-type programs. Flexibility goes hand in hand with the focus on customer needs and partnerships in program design and delivery. And it is supported by continuous improvement through the EM&V process.
- The amount of CDM selected in meeting the future electricity needs should be cost effective. While we recognize the need to act with a sense of urgency, we also recognize that the energy savings and demand reductions achieved by spending ratepayer dollars have to be

[8] Appendix D lists these programs as well as a number of activities by our sector partners.

carefully monitored and verified. There must be confidence that the gains are real and are sustainable over time.

- Strong foundations are necessary. We agree that much work is underway across the province and we support the ongoing efforts of our partners. The government has made important progress in its own energy saving efforts and in stimulating a variety of key developments throughout the public sector. Amendments have been made to the Ontario Building Code. LDCs are making good use of their "third tranche" funding and are committed to continuation of programs in the future.

2.2.2 Five Categories of CDM

The June 13, 2006 ministerial directive regarding the IPSP defined conservation as all encompassing, covering all aspects of CDM, including small scale customer-based electricity generation. The directive states that the IPSP should assume that conservation

> *"includes continued use by the government of vehicles such as energy efficiency standards under the Energy Efficiency Act and the Building Code, and should include load reduction from initiatives such as: geothermal heating and cooling; solar heating; fuel switching; small scale (10MW or less) customer-based electricity generation, including small scale natural gas fired cogeneration and tri-generation, and including generation encouraged by the … net metering regulation".*

For analytical purposes, we have divided conservation into five separate categories of CDM:

- Conservation behaviour occurs when customers reduce their electricity consumption by scaling back the activity which is powered by electricity (e.g. raise their air conditioner set point temperature by a couple of degrees).
- Energy efficiency occurs when customers reduce their electricity consumption but retain at least the same level of end-use service. Energy efficiency is the gain from investing in better appliances, equipment and buildings (e.g. replace household electric appliances and the air conditioner with more efficient models).
- Demand management occurs when customers reduce their electricity demand during peak use hours (peak clipping) or shift some of their demand to off-peak hours. Demand management can occur in a number of ways: for example, when residential customers shift use of their dishwasher and laundry appliances to off-peak hours, when certain industrial customers contractually agree to shut down assembly lines or tools in response to an automatic signal, and when residential and other customers participate in programs allowing their demand to be temporarily reduced by their utility or a demand aggregator.
- Fuel switching occurs when customers elect to use other energy sources in place of electricity (e.g. replace their electric clothes dryer with a gas dryer).
- Self generation/cogeneration occurs when customers elect to install either a generator or a combined heat and power facility to meet all or a portion of their electricity consumption needs (e.g. install solar panels).

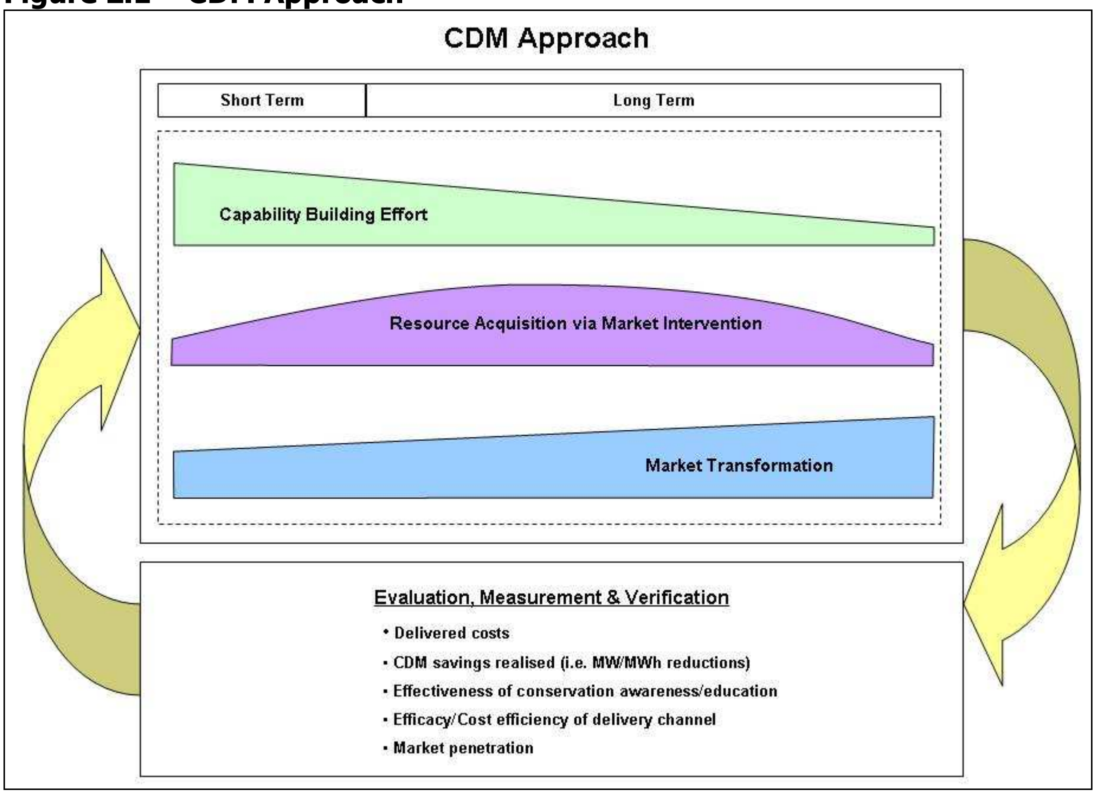
2.2.3 Our CDM Strategy

The OPA's strategic approach has been articulated in a number of documents, most recently the *2006 Annual Report of the Chief Energy Conservation Officer*[9]. It consists of three basic components:

- Procurement of CDM resources. Specifically meet the short term demand reduction target by 2010 mainly through procurement;
- Capability building. Enhance market capability for the medium and longer term, and
- Market transformation. Transform the market through structural changes, such as improvements in relevant codes and standards, taxation measures and the introduction of price-based incentives.

Successful implementation of this strategy will result in an enduring culture of conservation in the province. The approach is illustrated in Figure 2.1.

Figure 2.1 – CDM Approach



Source: OPA

OPA procurement of CDM resources is required in the short term to ensure that the 2010 peak demand reduction target is met. Key examples of procurement are industrial demand response programs, product rebate programs, building retrofit programs and appliance recycling

[9] Conservation Bureau, *2006 Annual Report of the Chief Energy Conservation Officer*, Ontario Power Authority, November 1, 2006.

programs. A number of these programs have already been started, and more are in the planning stage.

The OPA will work in partnership with many other participants in the sector and leverage existing capabilities to ensure the 2010 targets are met.

Capability building refers to strengthening and building the conservation competencies of the players in the market including the internal competencies of the OPA. A recent study for the OPA concluded that the conservation industry in Ontario appears to be in the early stages of development. There are many opportunities to support and encourage it. Potential activities include: the provision of general information to customers and suppliers; support for the training of building operators, contractors and service suppliers; support for the formation of industry associations and networks; support for research and development in relation to products, technologies, program delivery options and customer needs and behaviour; and assistance toward development of improved project assessment capability and the diffusion of evaluation reports.

As a subset of capability building, it will also be necessary for the OPA and other program providers to increase our data and analytical capabilities. CDM programming was essentially non-existent for about a decade, and capacity in this area has to be rebuilt.

Market transformation is about achieving a substantial and sustainable increase in the market share of the most energy efficient technologies, buildings and production processes. In addition to capability building, a number of interventions are needed to establish the enabling conditions from which market transformation can begin to take place, including:

- Working with the manufacturers and supply chains to ensure availability and choice of better performing equipment.
- Changing codes and standards to ensure that the most energy-efficient products and services gain early market dominance and that the least efficient technologies are forced off the market.
- Addressing other non-technical barriers to CDM. For instance, eliminating outdated legal and accounting “barriers” can increase competition and drive innovation and productivity.
- Sending customers the right price signals reflecting the true cost of supply on a time-differentiated basis. This will help customers make choices that are socially beneficial – less energy consumption and less on-peak usage.
- Improving awareness and understanding among customers of “the value proposition” for CDM.

Procurement activities will deliver megawatt (MW) reductions almost immediately; that is their purpose. Activities aimed at building capability and transforming the market are intended to have payoffs that build through time as new attitudes and behaviours take hold. For example, Ontario has recently adopted changes to its building code that will take effect at various points over the 2007-2015 period.

Over time, the need for procurement of CDM is expected to moderate. A culture of conservation will emerge on the demand side; CDM delivery capabilities will be built up on the supply side of the conservation marketplace; and various structural changes will occur in and around the market itself. In the longer term, the transformed market will be securing a larger portion of the available CDM resource than it does today, and most of the achieved CDM will occur through market-based transactions, without significant ratepayer support.

Figure 2.1 also depicts the critical role of program EM&V. These activities ensure that CDM programs remain on track, that energy savings are being realized and that the intended transformation is indeed taking place.

3. The CDM Resource Plan

3.1 Introduction

This section describes the short and long term CDM resource plan within the IPSP. Estimation of the CDM resource involved the following steps:

- Estimation of economic potential for CDM in all sectors of the Ontario economy. Economic potential is an estimate of the energy demand that would occur if all equipment and building envelope energy management actions that pass a Total Resource Cost (TRC) test[10] were implemented in the target markets. These actions are applied at either natural stock turn-over or retrofit rates. Economic opportunities are individual CDM projects which would pass the TRC test, i.e., deliver energy savings at less cost than supplying an equivalent amount of energy. The National Study[11] was used as a starting point, as it examines the costs of implementing known energy savings technologies on an end-use basis.
- Estimation of achievable potential. Achievable potential is an estimate of the energy demand that would occur as a result of market intervention to influence the take up of energy management actions. Achievable CDM is a subset of economic CDM. Achievable CDM is estimated under two scenarios. The first assumes that relatively moderate policy instruments are in place to stimulate and support CDM; the second assumes a relatively aggressive policy environment. The energy efficiency and cogeneration estimates were developed using the same approach and model as used for the estimate of economic potential. The other CDM categories namely: demand management and self-generation were estimated using a number of separate approaches, including use of market surveys, internal studies and information from other jurisdictions.

[10] The Total Resource Cost test is discussed in Appendix B.

[11] Marbek Resource Consultants Ltd. and M.K.Jaccard and Associates, Inc. *Demand Side Management Potential in Canada: Energy Efficiency Study*, May 2006. The Ontario-specific results were updated to include provincial data for the 2001-2005 period. See OPA, IPSP Discussion Paper #2, Load Forecast, September 2006.

- Conversion of the foregoing estimates of economic and achievable potential from MWh of energy to MW of peak demand. This involves the use of load profiles.
- Determination of a CDM resource plan. This involves a professional judgement about how much of the achievable potential to include in the IPSP, by each of the CDM categories. The OPA has embarked on a detailed program screening exercise which will firm up the savings estimates. The OPA is committed to achieving as much CDM as possible, but we need to recognize that it may not be easy or realistic to implement all the policy instruments that are assumed in the aggressive CDM scenario. In this regard, our treatment of CDM is similar to our treatment of renewable generation in the IPSP; for example, we do not include all the cost-effective wind potential because we know there are issues related to transmission and local acceptability. We have assessed the achievable potential in each CDM category using the sustainability framework and criteria suggested in IPSP Discussion Papers #6 and #7, namely: feasibility, reliability, cost, flexibility, environmental performance and social acceptability.
- Application of the Total Resource Cost (TRC) test to assess the economic viability of the CDM resource plan. The TRC calculates the net benefits of the CDM measures on the basis of the stream of costs and benefits generated from each measure. The cost stream of a CDM program measure is the full or incremental cost of installation plus the program overhead costs, which include marketing, training, administration and measurement and verification. The benefits stream of the CDM program measure is the value of the supply costs "avoided" over the useful life of the measures implemented in a program.
- Disaggregation of the proposed CDM resource plan to the regional level. We need to do this in order to better target our future CDM activities and programs. The regional CDM estimates are also needed to produce an integrated regional transmission and supply plan.

There was considerable stakeholder interest in the steps described above. We have attempted to address stakeholder comments in this revision by:

- Clarifying that the OPA will pursue as much cost-effective CDM as possible. The goals for CDM set out in the Minister of Energy's June 13, 2006 directive are targets, not caps. We see the targets as challenging but achievable. The CDM resource plan will be adjusted in future IPSPs if circumstances warrant.
- Providing a clearer statement of the methodologies used, including a more careful definition and explanation of terms.
- Clarifying the estimate for the conservation category.
- Explaining some of the limitations of the models used for estimating the CDM potential.

3.2 Estimating the Economic Potential from Energy Efficiency

Considerable effort was put into developing the estimates of economic (and achievable) potential for energy efficiency. Energy efficiency is generally known to account for a significant part of the CDM potential and it seemed prudent and cost-effective to focus our analytic efforts on this area.

The economic potential from energy efficiency improvements and cogeneration was estimated using the approach developed in the National Study, with the Canadian Integrated Modelling System (CIMS) model as the analytical platform for the exercise.

The CIMS model is an integrated energy-economy model that simulates the technological evolution of fixed capital stocks (mostly equipment and buildings) and the resulting effect on costs and energy use. The evolution of this fixed capital stock encompasses changes in type and performance of the technologies and equipment used to provide energy services to the market (e.g., heating, cooling, lighting services). CIMS comprises several sector specific sub-models in which technologies and equipment are specified to meet demands for given levels of energy service in the residential, commercial, transportation, and electricity supply and industry sectors[12].

The take-up of CDM technologies in CIMS is driven by a model construct that tries to reflect the financial and non-financial considerations affecting energy user decisions and choices. CIMS is a platform for a competition among various CDM technologies. While the engine for this competition is the minimization of annualized life cycle technology costs, customer decisions depend not only on recognised financial costs (capital, energy and other operating and maintenance costs), but also respond to:

- Identified differences in non-financial preferences (e.g. differences in the quality of lighting from different light bulbs).
- The preferences of firms and households with respect to the risk of newness and risk of irreversible investments. Thus the lifecycle cost is calculated with effective 'private' discount rates that are revealed from market data.[13]
- The non-deterministic nature of market behaviour. Market shares are allocated among technolgoies probabilistically according to a *variance parameter*.[14]

A base case is derived within the CIMS modelling platform, using a bottom-up construct in which technologies are prescribed to all energy end-uses. From this base, the reference case projection and additional scenarios are developed. It is therefore possible to specifically represent the evolution of a technology, or group of technologies, in a reference case forecast and to alter model inputs to simulate alternative forecasts and policy scenarios.

The CDM technologies considered in the National Study are listed in Section 5.2 of the Modelling and Scenario Documentation publication[15]. They include improvements in space cooling, reduced standby power for minor appliances, building envelope upgrades, compact fluorescent and T8 use in commercial lighting and greater use of ground source heat pumps.

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[12] Only the residential, commercial (including institutional) and industrial sectors were explicitly modeled for the OPA.

[13] Revealed discount rates cover both of these factors because the new technologies of interest to energy-economy modelers are those that increase energy efficiency through irreversible, long payback investments.

[14] In contrast, the optimizing models will tend to produce outcomes in which a single technology gains 100% market share of the new stocks.

[15] See: http://www.powerauthority.on.ca/ipsp/Storage/26/2144_Jaccard_Documentation_Report_Final_Sept_22_2006.pdf

Deep water lake cooling was not included in the present analysis, but could be examined in future work.

As noted, the derivation of the Ontario CDM estimates is built on the modeling construct and approach of the National Study. The national study was conceived as a high level, policy oriented exercise to be used as the foundation for future dialogue. Therefore, the outcomes of the Jaccard and Associates derivation to the Ontario market needs to be seen as the beginning, not the end, of the process needed to bring full defensibility and rigour to the resulting metrics. That is why we supplemented the analysis with several "market scans" in which further elaboration of potential was identified. Moreover, as noted, we are now embarking on detailed CDM program designs which will generate more precise estimates through the EM&V process.

As a high level policy exercise, the CIMS modelling construct was not set up to fully explore all industrial CDM possibilities. Nor was the analysis set up to derive a detailed factoring out of the effect of each type of CDM measure. Consequently, there are some aspects of the CDM resource that might be understated. For example, the CIMS analysis does not fully represent industrial process changes and operational improvements that occur alongside the introduction of more energy efficient technologies. This has resulted in a lower estimate for CDM potential in the industrial sector than we would expect on the basis of recently completed market scans. The potential underestimate of industrial CDM is an important issue when considering the results presented later in the paper. This issue will need to be addressed as analytic capability is built up over the coming months and years.

Further details on CIMS are available in Section 3.1 of the Modelling and Scenario Documentation publication.[16]

3.3 Estimating Achievable Potential

For a variety of reasons, only a portion of the economic potential is achievable. Not all barriers can be removed; not all standards can be pushed as hard as needed; not all programs can succeed every time.

It is necessary, therefore, to estimate a subset within the economic potential, representing what is actually attainable. Different methods were used to estimate the achievable potential for the different categories of CDM. The approaches are detailed in Appendix A. Briefly:

Energy Efficiency/Cogeneration: Our estimates of achievable potential for energy efficiency and cogeneration use the same approach and model we used in estimating economic potential for these categories. Two scenarios were used to estimate the achievable potential:

- **Achievable Potential, Scenario 1: Status Quo.** The CIMS model was used to estimate the achievable potential for energy efficiency and cogeneration over the next 20 years assuming a continuation of approximately the current levels and types of policy instruments and

[16] See: http://www.powerauthority.on.ca/ipsp/Storage/26/2144_Jaccard_Documentation_Report_Final_Sept_22_2006.pdf

associated market interventions by government, utilities and others. This scenario is driven by two types of policy instruments: subsidies and information programs. In this regard, the Status Quo scenario can be considered to be somewhat conservative. Although equipment and building standards are important part of today's CDM landscape, they were not included in this scenario.

- **Achievable Potential, Scenario 2: Aggressive.** Under this scenario, the CIMS model was used to estimate the achievable potential for energy efficiency and cogeneration assuming implementation of new and expanded policy instruments by all levels of government and resulting heightened levels of activity by utilities and the private sector. The scenario is driven by four main factors: subsidies targeted to energy efficiency measures, marginal cost pricing for electricity, an aggressive schedule of legislatively backed advanced minimum energy performance targets for equipment and buildings and an aggressive schedule of subsidies targeted to accelerate the market penetration of on-site renewable energy technologies (which count as CDM).

Demand Management: The achievable potential from demand management was estimated through consideration of the various types of measures that could be deployed in the various target markets in Ontario.

The demand management options considered in the analysis were based on time-differentiated pricing supplemented by technologies with which users are able to see their electricity supply costs in real time and, therefore, make decisions to manage their demand.

To estimate time-of-use potential, we made a variety of assumptions related to the rate of penetration of smart meters and their use by residential and small business customers. Assumptions were also required about the structure, such as the spread between on- and off-peak prices.

We also developed estimates for demand response by all customer classes. Demand response occurs when customers install energy management and automated response systems, enabling them to program their energy use in response to price signals, or contract with the system operator, a utility, retailer or other agent to have their energy use automatically adjusted at certain threshold prices or times. Demand response can thus occur for price or reliability reasons. We made assumptions about the uptake of the various types of demand response programs.

To parallel the work on energy efficiency, we built a similar modest/aggressive distinction into our estimates of achievable demand management by varying some of the key assumptions. For example, we introduced alternative assumptions about metering and prices.

The assumptions we made were based largely on our understanding of the results from demand management initiatives in other jurisdictions, notably California.

Fuel Switching: The OPA commissioned a study to explore the potential of fuel switching as a CDM initiative to reduce Ontario's peak electricity demand. The study examined the fuel substitution potential in all market sectors and followed a similar methodology to that used for the estimation of energy efficiency potential. Contextually, the results should be interpreted as falling somewhere in the mid range of the modest and aggressive scenarios suggested above.

Self Generation: A variety of assumptions and information sources were used. Readers are referred to Appendix A.

Conservation: We have assumed that the potential from general education and information programming is relatively small, recognizing that general conservation programs affect the savings in other CDM categories.

3.4 Converting Potential Energy Savings to Potential Demand Reductions: The Use of Load Profiling

In estimating economic potential (and, later, achievable potential), we first determine the megawatt hours (MWh) of energy that would be saved by introducing the new technology or business practice. It is then necessary to convert the MWh of energy saved into estimates of peak demand reduction, i.e., MW saved. We do this using a set of load profiles developed specifically for the purpose. Some CDM categories were converted using end-use profiles and a "bottom-up" aggregation methodology, as described in the Load Forecast Supplemental Information document[17]. Other CDM categories were converted using more aggregative assumptions. Our methods are briefly described below.

Conservation: Savings are assumed to occur during the top 15 summer peak days for 10 hours per day.

Energy Efficiency: Energy savings were converted to peak using the end-use load profiles developed to build the reference load forecast. A "bottom-up" methodology was used to aggregate the end-uses for total energy efficiency savings. For further details, please see the Load Forecast Supplemental Information document. Detailed peak results by end-use for the aggressive scenario are provided in Appendix C of this paper.

Demand Management (Time-of-Use): The time-of-use profile[18] developed for the supply mix advice served as the starting point for the analysis. Some adjustments were made to reflect more up-to-date information. It was also recognized that in addition to peak shifting, some energy savings could be expected in response to the new price structure. An additional adjustment was made to yield a net energy savings (equivalent to one percent of the residential energy use). All time-of-use savings are assumed to occur in the residential sector.

Demand Management (Demand Response): Savings are assumed to be in effect during the top 15 summer peak days for six hours per day spanning the peak. For purposes of translating

[17] See: http://www.powerauthority.on.ca/ipsp/Storage/33/2849_Load_Forecast_Supplemental_Information.pdf

[18] Navigant Consulting. Overview of the Portfolio Screening Model. December 2005. Available at: http://www.powerauthority.on.ca/Storage/15/1105_Part_4.1_Navigant_Consulting_PSM_Report_Final.pdf.

energy to peak demand, a simplifying assumption was made that all demand response occurs in the industrial sector.

Fuel Switching: Energy estimates were based on the fuel switching report[19] completed for the OPA. For those end-uses analyzed in the fuel switching report, the technique for conversion to peak followed that used for the energy efficiency analysis.

Self generation (Renewable resources): Self-generated wind energy was converted to peak using wind profiles developed for capacity planning. Self-generated bioenergy was assumed to operate at available capacity during each hour of the year, except for one hour a week for maintenance. Solar was assumed to operate at available capacity for six hours per day during each day of the year. The relative capacity mix between renewable resources was assumed to remain constant.

Self generation (Cogeneration): Energy savings arising from cogeneration were translated to peak using the end-use load profiles developed to build the reference load forecast.

3.5 The CDM Resource: Achievable Potential by Category

The estimated CDM resource in Ontario, based on the achievable potential is presented below according to each category of CDM. Additional details are provided in Appendix A. Table 3.1 and Table 3.2 summarize the potential for savings in energy (TWh/year) and peak demand reduction (MW) by each CDM category and for each of the moderate and aggressive scenarios. A graphical representation of the data provided in these tables is presented in Figure 3.1and Figure 3.2

It is important to note that the savings from each CDM category may not add up due to interaction effects if the same customer chooses to participate in more than one category. For example, the peak savings from a customer who chooses to purchase a more efficient clothes dryer and shift their usage to off-peak will be slightly smaller than the sum of the peak savings attributed to each program in isolation. Another example of potential interactive effect occurs if efficiency programs are successful in reducing the energy usage in a small commercial facility, making it less attractive for this facility to proceed with a self generation project, because the potential load displaced would be less. Similar issues may exist between impacts estimated for time-of-use pricing and economic demand response programs.

Our initial analysis suggests this interactive effect is probably less than 10 percent of the overall savings total in the early years but would be larger in later years. We will recognize this in the design and delivery of our programs, and seek to substantiate the estimate through the EM&V process.

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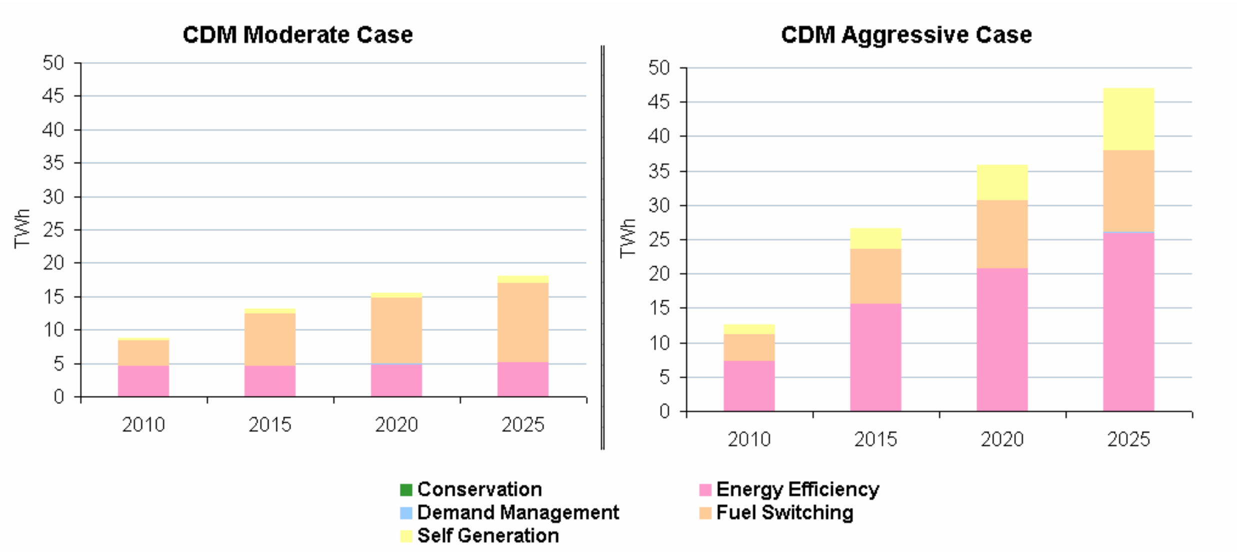
[19] Marbek Resource Consultants, Ltd. in association with ALTECH Environmental Consulting. *Potential for Fuel Switching to Reduce Ontario's Peak Electricity Demand*. September 2006. http://www.powerauthority.on.ca/Storage/26/2175_Final_Draft_Report_Sept_25.pdf

Table 3.1 – Achievable Potential (TWh Savings)[20]

	CDM Category	2010	2015	2020	2025
Moderate	Conservation	0.01	0.01	0.01	0.01
	Energy Efficiency	4.56	4.47	4.82	5.07
	Demand Management	0.02	0.02	0.04	0.05
	Fuel Switching[21]	3.89	7.87	9.85	11.86
	Summer	*0.39*	*0.86*	*1.16*	*1.46*
	Off-summer	*3.50*	*7.01*	*8.69*	*10.40*
	Self Generation (Renewable & Cogeneration)	0.36	0.75	0.81	0.99
Aggressive	Conservation	0.05	0.05	0.05	0.05
	Energy Efficiency	7.15	15.52	20.62	25.82
	Demand Management	0.02	0.05	0.09	0.14
	Fuel Switching[21]	3.89	7.87	9.85	11.86
	Summer	*0.39*	*0.86*	*1.16*	*1.46*
	Off-summer	*3.50*	*7.01*	*8.69*	*10.40*
	Self Generation (Renewable & Cogeneration)	1.40	3.08	5.17	9.18

Source: MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

Figure 3.1 – Projected Energy Savings (TWh) - Moderate & Aggressive Case - 2010 to 2025



Source: : MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

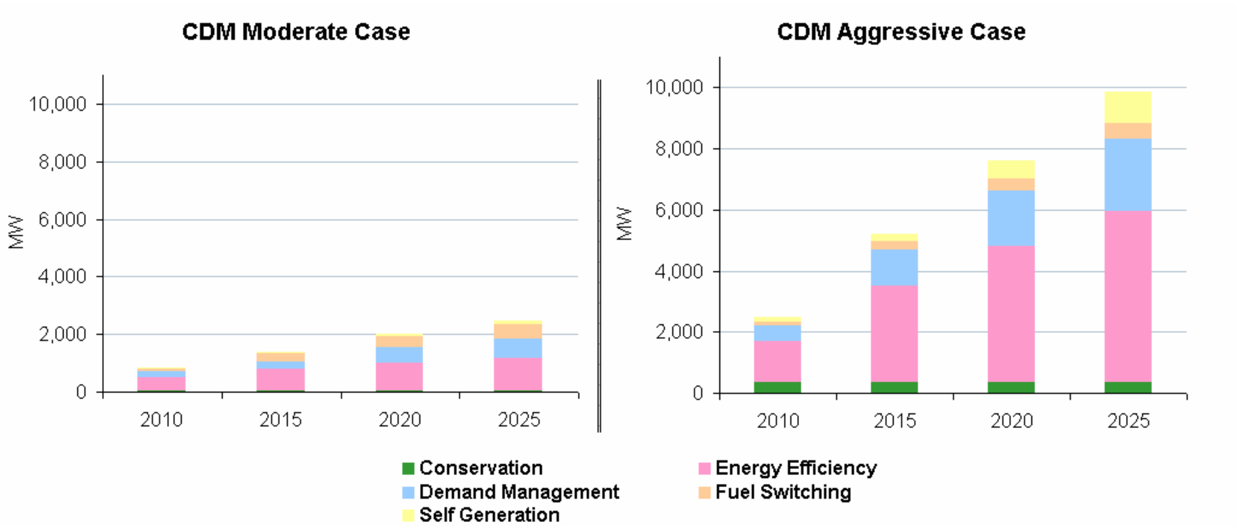
[20] At the generator.
[21] These fuel switching numbers were developed by Marbek Resource Consultants. The explanation for why the moderate and aggressive estimates are identical is provided in Appendix A.

Table 3.2 – Achievable Potential (MW Savings)[22]

	CDM Category	2010	2015	2020	2025
Moderate	Conservation	50	50	50	50
	Energy Efficiency	452	727	971	1115
	Demand Management	199	287	520	674
	Fuel Switching[21]	112	263	384	506
	Self Generation (Renewable & Cogeneration)	44	63	95	115
Aggressive	Conservation	350	350	350	350
	Energy Efficiency	1327	3161	4464	5598
	Demand Management	546	1,192	1,822	2,384
	Fuel Switching[21]	112	263	384	506
	Self Generation (Renewable & Cogeneration)	154	243	574	1,000

Source: : MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

Figure 3.2 – Projected Peak Demand Savings (MW) - Moderate & Aggressive CDM case - 2010 to 2025



Source: : MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

3.6 Considerations in Developing a CDM Resource Plan

The analysis has confirmed that there is significant CDM potential in Ontario, and that it is concentrated in the energy efficiency and demand management categories. A CDM resource

[22] At the generator.

plan is presented in this subsection. The plan sets notional targets for each of the CDM categories, as a way of guiding the design and deployment of the CDM program portfolio.

The category targets were derived using the same evaluation criteria applied in assessing the sustainability of the OPA's supply and transmission plans: feasibility, reliability, cost, flexibility, environmental performance and societal acceptance. Hence, there is consistency and symmetry of approach between the demand- and supply-side elements of the plan.

The approach represents a change from that first tabled in the original version of this CDM paper, in which we developed a set of "weights" to transition from the high and low estimates of potential to our preferred CDM resource plan. Stakeholders felt, by and large, that this approach was too academic and formulaic. We were also challenged on the choice of weights, and, to a lesser extent, on the four factors that we used.

While we acknowledge these points, the challenge remains: the moderate and aggressive scenarios were constructed to establish a range for the amount of CDM that is achievable, and we need to define a plan that is comfortably within the range. The OPA is committed to achieving as much CDM as possible, subject to application of the criteria presented below. At this point in time, we do not consider it prudent to plan on the basis of the aggressive estimates, especially in regard to the near-term. As our knowledge and experience grows, we may gain more confidence in the aggressive estimates.

The criteria and their application are as follows:

3.6.1 Feasibility

Feasibility refers mainly to the availability of human and material resources to execute CDM programs and projects on a timely basis. In applying feasibility from this standpoint, feasibility encompasses such responsibilities as completing the multi-party agreements necessary to implement projects, steering relevant legislation or code changes through the approvals processes, and deriving accurate and reliable market information to support decision making.

We have carefully considered the feasibility of achieving the energy efficiency potential identified in the aggressive scenario. Energy efficiency is the largest source of potential gain and needs to be carefully assessed. The aggressive scenario made certain assumptions about the dates when code changes and other elements would be in place. The schedule for the implementation of these changes has a significant impact on the long-term potential savings. Considerable momentum is building. For example, important amendments have been made to the building code, there have been amendments to Ontario and federal regulations related to energy efficiency, and the Province has passed the Energy Conservation Leadership Act to drive efficiencies throughout the public sector for this time period.

Nevertheless, it is our assessment that, at least for the period to 2010, policy changes are not going to be as beneficial as assumed in the aggressive scenario and that we should therefore significantly discount the aggressive 2010 target for energy efficiency. We have assumed a target equal to about 60 percent of the high scenario.

There are similar feasibility considerations in respect of demand management. For example, the aggressive scenario assumes major policy initiatives to heighten customer exposure to higher on-peak prices for electricity. This assumption may be on the optimistic in the short term.

3.6.2 Reliability

Reliability for CDM refers to system adequacy, availability and durability. The CDM resource clearly contributes to reliability in that it lowers the demand on the system. As further elaborated in section 4, we are building an effective EM&V system with which the availability and durability of CDM savings can be assessed. Typically, there are many factors that can affect availability and durability:

- Technical performance of the CDM measures,
- User behaviour, and
- Operating practices in the facilities.

The EM&V framework will ensure that all of these factors are addressed. Pending the evaluation results that will start flowing in 2007, we do not expect reliability to be an issue for all of the components of CDM, with the exception of conservation. At the moment, we do not have solid information proving that general information and conservation programs will yield significant savings. We have therefore chosen an estimate for our plan that is close to the low scenario estimate for conservation gains

3.6.3 Cost

The achievable CDM resource is determined using the TRC test and, by definition, is cost effective. The Total Resource Cost Test and the concept of avoided cost are explained briefly in section 3.8.1, and in more detail in Appendix B. Cost will, of course, be a consideration in the sequencing of CDM measures to be deployed, particularly in the short-term. For example, we consider it easier, and more cost effective, to obtain near-term CDM resources from energy efficiency than from investments in renewable on-site generation. Cost will clearly be an important consideration in determining specific end uses to target within the energy efficiency category and specific demand management activities to support.

3.6.4 Flexibility

Flexibility refers to the ability to deploy the estimated CDM resource from among a basket of choices, i.e., conservation versus efficiency and so on. CDM in general scores high on flexibility and, in this way, adds to the robustness of the overall IPSP.

Operationally, CDM design and deployment can be shifted from one category of CDM to another, pending feedback from the E,M&V system and changing market circumstances. If one category does not deliver the savings expected, the program designer can adopt a more aggressive stance in the other categories to make up the shortfall. Flexibility is also provided by the fact that there are multiple policy instruments, channels and paths available within each of the categories. There is ample flexibility to adjust to unanticipated changes in demand, technology, and other factors. The relative flexibility of the CDM categories was not a significant factor in determining the resource plan.

3.6.5 Environmental Performance

Environmental performance is a complex issue for CDM. Intuitively, using less electricity should be good for the environment. Given that energy saved through CDM is energy that would not be produced by generation technologies, CDM should result in fewer emissions to land, air and water. However, the environmental scorecard also has to consider outcomes of CDM programs, such as the disposal of old appliances and the environmental impacts associated with production of new ones. Disposal and similar considerations need to be integrated into the design of CDM programs to ensure good environmental performance. This said, it is clear that energy efficiency is beneficial for the economy and the environment. We have considered the individual categories of CDM to be more-or-less equal in terms of their environmental impacts, but this is a question that warrants further consideration during the program design phase.

3.6.6 Societal Acceptance

CDM as a whole has public support. Society has generally been supportive of environmentally friendly programs, such as recycling programs. The keys to societal acceptability include starting early, investing in education, designing initiatives that meet real customer needs and administering programs in an efficient, yet customer friendly way.

Societal acceptability, along with feasibility and reliability, has been a factor in the setting of the resource plan. The criterion of acceptability touches upon many complicated questions about intra-generational and inter-generational equity: CDM activities create benefits for some people and possible costs for others. For example, aggressively raising energy efficiency standards is beneficial overall, but can create a problem for some segments of society by raising the cost of equipment and appliances. It can also benefit certain suppliers and regions to the detriment of others. In short, it is difficult to achieve change, even when there is general agreement on the direction in which to go.

Such considerations have again suggested that, for forecasting and planning purposes, we should use estimates that are considerably short of those in the aggressive scenario.

We have used the six IPSP sustainability criteria to guide us in establishing the resource plan proposed below, but have done so in a general, non-mechanical way, recognizing the considerable uncertainty of the potential estimates with which we began and the sensitivities in converting between energy savings estimates and demand reduction estimates. We will continue to refine the CDM resource plan as new information becomes available.

3.7 The Proposed Resource Plan for 2010 and 2025

Table 3.3 and Table 3.4 present our proposed CDM resource plan for achieving the 2010 demand reduction target and the associated energy savings, respectively.

The plan composition was derived by starting with the estimates from the aggressive potential scenario, and scaling them by considering how each CDM category fared in terms of the six IPSP sustainability criteria. For example, feasibility, reliability and societal acceptability considerations led us to take about 60 per cent of the high side estimate for energy efficiency and about 67 per cent of the high side estimate for demand management. We took estimates for conservation and self generation that are closer to the low side, reflecting data uncertainties in the case of conservation and longer implementation timelines in the case of self generation.

Table 3.3 – CDM Category Peak Savings for 2010 (MW)

CDM Category	Aggressive	Moderate	Proposed Plan
Conservation	350	50	60
Energy Efficiency	1,327	452	777
Demand Management	546	199	370
Fuel Switching	112	112	81
Self Generation (Renewable & Cogeneration)	154	44	69
Total	2,490	857	1,356

Note 1: The proposed plan savings estimate for fuel switching was scaled down from the results of the single achievable potential scenario as a result of applying the six IPSP sustainability criteria described in the preceding section of the paper.
Note2: The plan estimates differ from our September paper as a result of the use of improved load profiles. See the Load Forecast Supplementary Information document referred to earlier.
Source: MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

Ontario Power Authority

Table 3.4 – CDM Category Energy Savings for 2010 (TWh)

CDM Category	Aggressive	Moderate	Proposed Plan
Conservation	0.05	0.01	0.01
Energy Efficiency	7.15	4.56	4.19
Demand Management	0.02	0.02	0.02
Fuel Switching	3.89	3.89	2.79
Self Generation (Renewable & Cogeneration)	1.40	0.36	0.60
Total	12.52	8.83	7.61

Note: Energy savings in the proposed plan are lower than in the moderate scenario because the proposed plan emphasizes high-peak, low-energy end uses similar to those of the aggressive scenario.
Source: MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

As shown, energy efficiency represents about 60 per cent of the total demand reduction in 2010, with demand management accounting for an additional 25 per cent. The basic message is clear: energy efficiency is the top priority for CDM design and deployment, followed by demand management. As discussed in section 4, we have already embarked on activities consistent with this finding. The process of detailed program planning, coupled with the feedback from the EM&V process, will help bring greater granularity and certainty to this resource plan.

Table 3.5 and Table 3.6 present our proposed CDM plan for achieving the remaining 3,600 MW of peak reduction and the corresponding energy savings for 2025. As discussed earlier, these projections have been developed for policy planning purposes. The OPA is committed to achieving as much CDM as possible, and to flexibility with regard to the composition of the portfolio. The portfolio will be adjusted in response to the observed pace of market transformation, emerging opportunities and the experience gained through the EM&V process. In short, the portfolio is both scalable and adaptable.

Table 3.5 – CDM Category Peak Savings for 2025 (MW)

CDM category	Aggressive	Moderate	Proposed Plan
Conservation	350	50	226
Energy Efficiency	5,598	1,115	2,932
Demand Management	2,384	674	1,411
Fuel Switching	506	506	301
Self Generation (Renewable & Cogeneration)	1,000	115	260
Total	9,838	2,460	5,131

Source: MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

Table 3.6 – CDM Category Energy Savings for 2025 (TWh)

CDM Category	Aggressive	Moderate	Proposed Plan
Conservation	0.05	0.01	0.03
Energy Efficiency	25.82	5.07	13.52
Demand Management	0.14	0.05	0.06
Fuel Switching	11.86	11.86	7.06
Self Generation (Renewable & Cogeneration)	9.18	0.99	2.33
Total	47.05	17.98	23.01

Source: MKJaccard and Associates (MKJA), Marbek Resource Consultants Ltd, OPA

The tables provide data for 2010 and 2025. Annual savings for each of the moderate, high and proposed cases for each CDM category for each year from 2005 through 2025 are posted on the OPA website.

The proposed CDM plan results in about 23 TWh of savings in the year 2025, corresponding to a peak saving of 5,131 MW. This does not include the 1,350 MW government target for the end of 2007, which is incremental to the 5,131 MW savings.

Energy efficiency is the main contributor to CDM savings in terms of both energy and peak, accounting for almost 60 percent of the energy and peak savings in 2025. Fuel switching is the next largest contributor to energy savings, constituting approximately 31 percent of the total in 2025.

Fuel switching contributes approximately six percent of the total peak savings, which is significantly less than its energy contribution. This stems from the fact that many of the end-uses for which fuel-switching is an option use electricity for space heating purposes and the use is therefore concentrated in the winter months. Because Ontario's system peak occurs during the summer, the contribution of fuel-switching to peak savings is therefore less.

Following energy efficiency, demand management is the main source of peak savings, accounting for 28 percent of total peak savings in 2025. At the same time, demand management contributes less than one percent to total energy savings. This result is to be expected, given the implementation of demand management measures at times of high peak demand.

The differences between energy and peak contributions among the CDM categories illustrate the importance of proceeding with a variety of programs. A varied approach will allow for the achievement of goals relating to both saving energy and reducing peak demand.

3.8 Costs and Benefits of the Plan

3.8.1 Economic Evaluation

There are three main concepts that underpin the economic evaluation of CDM initiatives: avoided cost, implementation cost and total resource cost.

The first concept is avoided cost. It is defined as the future cost that would otherwise be incurred if it were not for MWh and MW savings from CDM initiatives. Decreased demand results in cost savings due to the decreased use of facilities and from building fewer new facilities. Avoided costs thus include reduced generation, transmission and distribution capacity investments, reduced energy production costs and reduced transmission and distribution losses. The valuation of avoided costs is the key variable in the determination of the benefits stream under the TRC test. We also consider the reduced financial uncertainty as a benefit.

The second concept is CDM implementation costs. They include costs for program design, delivery and EM&V and capital and operating (C&O) costs. The C&O costs are measured on an incremental basis - the difference between the C&O cost related to the implementation of the CDM initiative and the baseline cost. For example, consider a customer contemplating an air-conditioner purchase who is faced with making a choice between a regular model and a higher cost but higher efficiency model. In this case, the regular model is the baseline and the relevant C&O cost is the difference in costs between the regular and high efficiency models. In other instances, where the baseline cost is a sunk cost, the relevant C&O cost will be the entire cost of the CDM initiative.

The third concept is the Total Resource Cost (TRC) test to determine the cost-effectiveness of the CDM resource. It is common practice, as exemplified by California standard practice, and as directed by the OEB, to evaluate CDM initiatives on the basis of the TRC. The TRC test measures the benefits and costs of CDM efforts from a societal perspective. Under the TRC test, benefits are essentially the supply costs that have been avoided. Costs are the costs of equipment and all program support costs associated with delivering that equipment to the marketplace. The net benefit is a societal gain.

The results of the TRC test are usually expressed as a net present value of the streams of benefits and costs. Alternative discount rates may be used to determine the present value (i.e., express the future streams of benefits and costs as a single "current year" value). If the present value of the benefits is greater than the costs, the program is considered to be cost effective.

The TRC test has been used in the estimation of the economic potential of energy efficiency, cogeneration and fuel switching. These calculations have been done using the OEB approved estimates of avoided costs.

3.8.2 Application of the TRC Test to the CDM Resource Plan

To check that the aggregate CDM resource plan program is economic, the TRC of the whole plan has been determined. This study was described in brief in Discussion Paper # 7. It was a three step exercise as follows:

Step 1-Determine avoided cost of the deferred or avoided supply:

The avoided cost of the aggregate CDM program was calculated by comparing the operating and capital cost of two generation and transmission expansion plans, one with and one without the proposed CDM initiatives. The plan without the CDM initiatives required extra generation resources to reliably meet the demand. The extra generation resources required were:

- A firm import of 2000 MW starting in 2015, costing $4500/kW[23]
- Simple cycle natural gas capacity - 600 MW in 2015 and an additional 900 MW in 2027 - costing $750/kW
- Two extra nuclear units of 700 MW each, coming in service in 2016 and 2017 respectively, costing $3,400/kW.
- Advancing 500 MW of Pumped Generating Station (PGS) from 2020 to 2016 and adding another 1000 MW of PGS in 2016, each costing $1500/kW

Additional reliance on the interconnections in the short term has also been assumed and costed at the price on imports from the interconnected market.

This study has been repeated with the revised load forecast and CDM estimates, a slightly modified preliminary plan, and a modified set of extra resources. The results obtained are essentially the same as reported in discussion paper #7. The OPA's latest analysis indicates that the present value of the costs avoided by undertaking CDM for the 20 year study period, using a 4% discount rate, is in the range of $10 to $13 billion[24] dollars. All costs are in 2006 and in Canadian dollars. The increase of the estimate from the $10 billion reported in discussion paper #7 is primarily due to the larger amounts of energy from fuel switching that have been assumed.

It is important to note that these estimates of avoided costs are subject to uncertainties. They are dependent on assumptions as to how the future system expansion plan would change if the CDM program delivers less or more demand reduction than expected. Other uncertainties include forecasts of fuel costs, generation capital costs and generation plant performance.

Step 2: Calculate the CDM Program Costs

The CDM program costs are shown in Table B.12 and Table B.13 in Appendix B. The present value of the program costs (administration and incremental capital and operating costs) is in the range of $4 to $5 billion.

Step 3: Calculate Net Benefit of the CDM Resource Plan

The net benefit of CDM programs was calculated based on the above avoided costs and the CDM program implementation costs shown in Table B.12 and Table B.13 in Appendix B. The present value of the net TRC benefit of the CDM plan for the 20-year period is estimated to be approximately $7 billion.[25] The main contributors are energy efficiency and demand management programs. Including allowance for the uncertainty in the avoided costs and the program costs, the net TRC benefit over the study period is in the order of $5 to $9 billion.

The benefit of the CDM plan is clearly substantial.

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[23] The capital costs quoted include interest during construction

[24] The earlier preliminary $4 to $8 billion cost represented the estimated value of the energy efficiency portion of the CDM portfolio. We have refined our analysis to account for other CDM categories.

[25] Present value at 4 percent discount rate.

Appendix B provides further details on the methodology used to calculate the avoided costs and the resulting values of the net benefit.

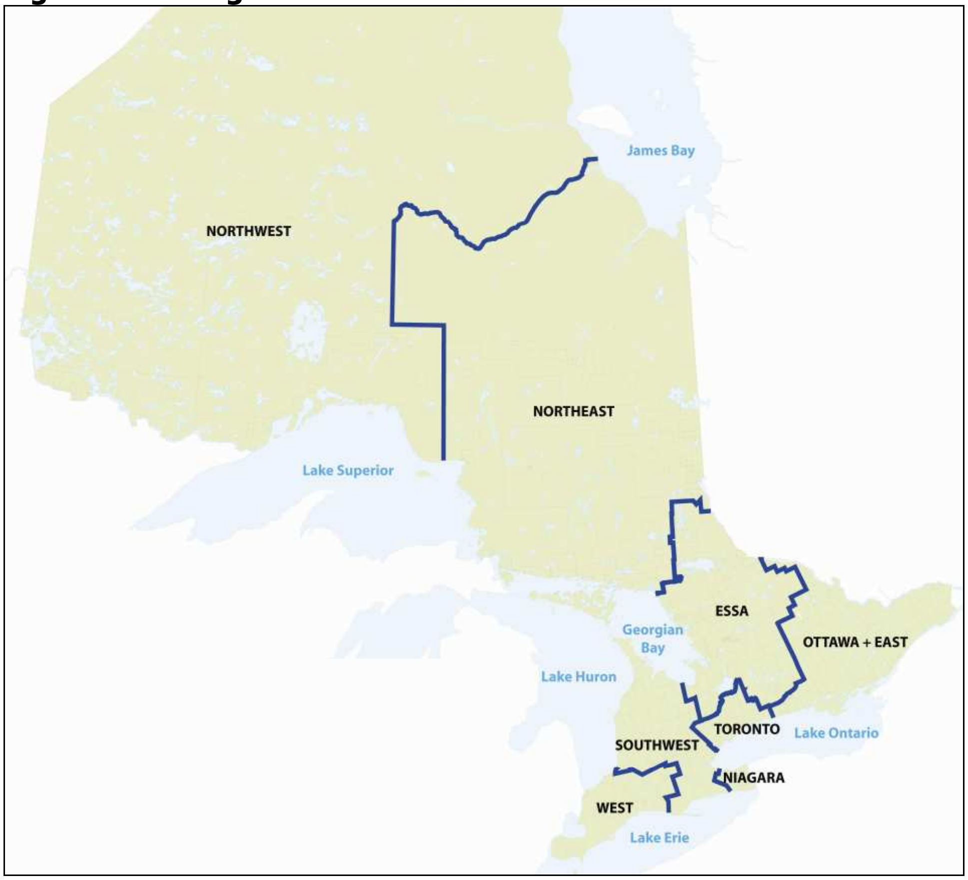
3.9 Regional Disaggregation

The purpose of this subsection is to share with stakeholders the results of the regional disaggregation of the proposed CDM resource plan. Details of the regional disaggregation of the CDM portfolio had not yet been completed at the time of publication of the original CDM discussion paper in September 2006. The OPA informed stakeholders during the September 26/27 workshop that the results of our ongoing analysis would be shared as soon as practically possible. This subsection provides the energy and peak results of the regional CDM disaggregation.

The methodology used to disaggregate the proposed CDM portfolio follows that used for disaggregating the load forecast (please see Load Forecast Supplemental Information document[26]). The province was divided into nine geographical zones corresponding to the electrical zones delineated by the IESO. Each zone was ascribed a share of the provincial load forecast based on population, commercial employment and floor space, growth rates of industrial sub-sectors and an adjustment for climate differences. The total share was determined by first establishing the appropriate residential, commercial and industrial shares for each zone.

[26] OPA, Load Forecast Supplemental Information, ibid

Figure 3.3 – Regional Zones



Source: OPA

The same shares were used to disaggregate the CDM estimates by category. For each zone, the sectoral share of the load forecast was taken as the sectoral share for each CDM category.[27] For example, if the northwest was ascribed a certain percentage of the provincial residential load forecast, it would be ascribed the same percentage of the residential energy efficiency savings. The sectoral shares for each category for each zone were then aggregated to provide an overall zonal share for each category.

The results are given in Table 3.7 and Table 3.8.

[27] For some CDM categories, savings are assumed to occur only in certain sectors. For instance, all demand response savings are assumed to occur in the industrial sector.

Table 3.7 – Regional CDM Savings: Energy (GWh)

	2005	2010	2015	2020	2025
Northwest	0	173	336	454	505
West	0	699	1,403	1,771	1,944
Northeast	0	631	1,321	1,702	1,799
Essa	0	527	1,426	1,535	1,736
Ottawa+East	0	961	2,159	2,671	3,011
Toronto	0	2,941	6,124	8,227	8,955
Niagara	0	228	449	580	621
Southwest	0	1,446	3,137	3,977	4,440
TOTAL	0	7,605	16,355	20,917	23,012

Source: OPA

Table 3.8 – Regional CDM Savings: Peak (MW)

	2005	2010	2015	2020	2025
Northwest	0	42	86	118	127
West	0	147	317	452	509
Northeast	0	66	131	179	192
Essa	0	100	218	319	363
Ottawa+East	0	162	381	556	632
Toronto	0	530	1,255	1,870	2,149
Niagara	0	41	90	128	143
Southwest	0	268	599	882	1,014
TOTAL	0	1,356	3,078	4,505	5,131

Source: OPA

CDM savings are concentrated in the Toronto and southwest zones, which together account for 62 percent of total provincial peak savings in 2025. The opportunities for savings are greatest in these areas as these zones are forecast to experience the highest growth over the study period. By 2025, CDM is able to supply 59 percent and 72 percent of new peak demand in the Toronto and southwest zones, respectively. In the west and Niagara regions, CDM contributes to a lower peak in 2025 than in 2005.

4. CDM Program Design and Implementation

Given the analysis of CDM potential and the broad CDM resource plan described in the previous section, the challenge for the OPA is to design and implement programs and other activities to meet the Ontario peak load targets for 2010 and beyond. The OPA has been assigned a leadership role on electricity conservation and is committed to working closely with its many partners in the electricity conservation sector to ensure the targets are achieved. We intend to leverage the delivery capabilities that currently exist, and to build new capabilities in the medium and longer term.

The need for electricity conservation is urgent. That is why the OPA has been given the mandate to manage and co-ordinate CDM program development and deployment: to ensure success and manage risk.

In this section, we review the current status of CDM programming in Ontario. The OPA has received specific ministerial directives and has responded by developing a series of programs. At this time, we have 19 program initiatives in the mass markets and business markets pipeline; ten are operational and the other nine are planned for launch in 2007. Much has been accomplished already in terms of setting a course for meeting the 2010 targets, but further effort and focus are needed, particularly with regard to laying solid foundations for longer term market transformation.

We then consider a number of factors that will influence how the CDM program portfolio will be developed and deployed to meet the provincial peak load reduction targets. For example, we consider how program objectives are set and how the OPA program development and implementation strategy will leverage the opportunities and delivery channels of our partners. CDM program design and deployment will be refined over time, based on results, to maximize cost effectiveness. We elaborate in this section on the planned approach to EM&V, which will guide such refinements.

4.1.1 The CDM Challenge

CDM investments and activities are constantly taking place in Ontario, but only a portion of the economically attainable[28] CDM resource is being secured. Anecdotal evidence suggests that individual, corporate and institutional customers frequently do not invest in CDM projects even though the value of the resulting energy savings would exceed the capital and operating costs. In short, investments which appear to be “socially desirable” are not being made. There are many reasons for this, some of which are identified in the following table.

[28] The term “economically attainable” is defined by the Total Resource Cost test, as discussed in Appendix B.

Table 4.1 – A Selection of Reasons for Lower than Expected CDM Investment

Category	Explanation
Institutional and Regulatory	Codes or standards that prohibit implementation of innovative CDM technologies. Disconnect between longevity of infrastructure and short-term horizons on crucial decisions, such as budget allocations for maintenance and rehabilitation and rate structures.
Customer Awareness and Preferences	Customers unaware of the "value proposition"—don't know that energy efficiency opportunities & products exist. Or have poor understanding of CDM programs/products, and the associated benefits and costs. Customers have "offsetting preferences" (e.g., large single detached homes with many energy-using characteristics)
Product and Service Availability	Products may not be available locally (or even nationally). Manufacturers/Vendors may not be fully aware of all efficiency options or have good understanding of the technical issues.
Delivery Channel Capability	Both of Ontario's private CDM industry and publicly funded CDM programs were dismantled during the period of 1992-2002, resulting in lost capability to quickly design, launch and deliver cost effective initiatives targeted at areas of greatest CDM potential.
Technology and Innovation	Lack of enabling tools and techniques (e.g., lack of appropriate sub-metering in industrial operations may make it difficult to identify and measure CDM opportunities).
Perceived Risk/Reward	Perceived (i.e., exaggerated) risk that the energy efficient product may not perform as promised.
Split Incentive/Motivation	Imbalance in the distribution of the costs and benefits of a given investment (e.g. as between landlords and tenants).
Financing	Competition for scarce capital in corporate budgeting Lack of access to effective project financing mechanisms. energy users appear to discount future savings of energy at rates well in excess of market rates for borrowing or saving
Transaction Costs	Too much effort required to become informed, select products, choose contractor(s) and install.
Price Signals	Energy prices do not reflect real-time costs.

Source: OPA

Our job is to reduce as many of these barriers to CDM implementation as possible in the short term through: the provision of information on programs and enabling technologies; the provision of incentives to overcome capital barriers; and, the development of delivery channels. In short, our challenge is to find ways to encourage customers to increase the proportion of the economically feasible CDM that is achievable. To do this, we believe there is a need to:

- Encourage and incent customers to take action to conserve - by providing information and increasing awareness about the importance of electricity conservation

- Enhance and support successful CDM delivery channels – by providing market product research to our delivery partners, by improving training, encouraging business networks, supporting research and development, supporting the diffusion of viable new energy saving products and services, and improving sector-wide capability to evaluate projects , target new markets, and deliver CDM products and information. This will support the re-building of the Ontario CDM delivery industry so that intervention by the OPA can decline can decline over time.
- Secure improvements to codes and standards that establish minimum energy efficiency standards for appliances, equipment and buildings
- Work with agencies and others to reduce or remove barriers (e.g. legal and economic) that inhibit adoption of energy saving practices or unreasonably restrain the expansion of conservation-related businesses
- Expand incentives for customers to save energy and shift their peak electricity use by promoting the installation/adoption of equipment and process changes that allow for better energy use, particularly in a time-of-use pricing environment, and by introducing demand response contractual arrangements.
- Support, and if necessary, build upon local member associations that support energy awareness or conservation activities with their various constituencies (e.g. partnerships with local business associations, faith and community groups, etc.)
- Achieve continuous improvement through data collection and sharing of information and experiences, i.e., promote development of a robust, sector-wide EM&V process.
- Recognize that the conservation industry in Ontario will need support and intervention to be able to deliver the targeted amount of demand reduction. Ontario's capability was lost during the decade 1992-2002 as electricity conservation programs in the province were dismantled.

4.2 The Current Status of CDM in Ontario

CDM programming capabilities in Ontario were substantially eroded in the 1992-2002 period. Since 2004, there has been renewed interest in promoting and delivering electricity conservation. Delivery capability has begun to improve and new activities have been launched. Key developments included the establishment of the OPA and its Conservation Bureau, the approval of LDC funding for CDM initiatives, the issuance of government demand reduction targets and specific directives relating to markets and regions, the government's adoption of conservation targets for its own operations, amendments to the Ontario Building Code, passage of the Energy Conservation Leadership Act, and the revision of various energy efficiency standards for appliances.

The OPA has also contracted with certain key institutions and organizations which, because they have unique capabilities, have management control over important energy-using assets with CDM potential (e.g. City of Toronto), or unique relationships with end users (e.g. Ontario Mining Association, Building Owners and Managers' Association)—have the ability to identify customer needs and then enable the delivery of CDM programs. In addition, the OPA—through the Conservation Fund—has funded parties who have CDM programs (e.g. Conservation Council of Ontario), information gathering systems (e.g. Enerlife Consulting initiative with the Ontario Hospital Association) and education initiatives (e.g. Reduce the Juice). In essence, these pilots provide important research to the OPA and its delivery partners about CDM initiatives which have the potential to be scaled up to deliver CDM more widely to other end-users. Appendix D gives a brief description of some of these developments.

The CDM work of the OPA has largely been shaped by the government directives focussed on specific markets and regions. Table 4.2 lists the implementation directives that have been issued to-date.

Table 4.2 – Ministerial CDM Directives

Targets	Focus	Date Direction was Received
250 MW	Demand side management and demand response programs across Ontario	June 15, 2005
100 MW	Residential – low income/social housing demand side management programs	October 6, 2005
100 MW	Appliance exchange and efficient lighting demand side management programs	October 20, 2005
300 MW	Toronto demand side management programs	February 10, 2006
250 MW	Demand side management and demand response programs across Ontario	February 2006. Amendment to increase the June 15, 2005 directive to 500 MW
150MW	Commercial buildings and municipalities, universities, schools and hospitals (MUSH) demand side management programs	March 10, 2006
150 MW	Electrically heated houses and other residential upgrades demand side management programs	March 10, 2006
Not Specified	Develop CDM programs to be delivered through LDC's, and provide funding mechanisms for up to $400 M over three years	July 13, 2006

Source: OPA, 2006 Annual Report of the Chief Energy Conservation Officer, Page 13

As suggested in the 2006 Annual Report of the Chief Energy Conservation Officer, the OPA is deploying CDM programs that respond to these directives. Indeed, we have been actively working with key delivery agents, allies and stakeholders to explore program offerings that would contribute toward meeting the targets. The critical challenge is that, in all cases, delivery channel capability has to be sourced, contracted for, and then developed so as to effectively bring these programs to market to optimize savings in the most cost-effective manner.

Appendix D lists current and planned OPA initiatives.

Given the activities related to meeting targets defined in directives, and the findings of the IPSP, we are finalizing a comprehensive, focussed CDM program portfolio to meet the peak load reduction targets set out by the Province. The plan is to deploy an initial program portfolio in 2007 designed to mine peak load reduction opportunities while, at the same time, begin development of the conditions necessary for durable CDM performance and market transformation over the longer term. As the experience base grows and initial measurement and verification metrics are assessed, this initial CDM portfolio will be further refined for 2008 and beyond. This anticipated evolution in programming is particularly important given the intent to promote and support emerging technologies to ensure future savings.

In addition to procuring short term peak load reduction and energy savings, the OPA's approach is to simultaneously build a conservation culture in the mass market and to work with channel partners to increase the overall delivery capability of retailers, contractors, manufacturers and the service professions to market and sell more efficient designs and products.

We are also working with our key market partners to develop a comprehensive CDM program portfolio to accomplish the 2010 peak load reduction targets and to establish the conditions for successful CDM beyond 2010. Our basic strategy was discussed in Section 2: to "accelerate" CDM activity through a three-pronged strategy involving resource acquisition to ensure the 2010 target is met, capability building across the delivery chain, and market transformation through structural changes that support the introduction of more energy efficient products and services. Recognizing the urgency, we have already begun to develop programs to implement this approach. From a planning perspective, the objective now is to be somewhat more systematic and strategic in terms of program development, and more focussed on the longer term.

Our stakeholders remind us that programs have to be designed to meet the real needs of customers. They need to be relatively simple and user friendly. They need to be efficiently administered. We are committed to these basic principles.

In addition to these important criteria, our program development will be shaped by a number of other considerations.

- The CDM portfolio will need to be “balanced” across a number of sectors and programs and initiatives. The OPA will work with its allies to consider the best approaches for dealing with short versus medium term priorities, and the relative weight to be given to procurement, capability building and market transformation. The composition of the portfolio will be adjusted through time, based in part on what we learn from market assessments and future stakeholder consultations.

  It will also be important to ensure a balance between programs targeted at peak load reduction and those targeted at energy savings. The targets have been expressed in terms of demand reduction, and it will be a priority to develop programs that address the summer peak load. However, energy saving programs are also important for customers in that they can deliver cost savings, even when they may not have a significant impact on peak load.

- Careful consideration will be given to the marketing and communication of our strategy and our programs. Well targeted sector specific marketing and communications activities are being developed to support CDM programs, helping to ensure that all electricity users are provided with the information they need to make maximum use of program opportunities. The marketing and communications strategy will be deployed more broadly, to help ensure that the conditions for a long-term transition to a conservation culture are also attained.
- More aggressive training, awareness and procurement programs may be necessary, because, in the short term, the capability gap in the marketplace may make it difficult to achieve as much as we hope. There are limitations on how much can be achieved; many of our initiatives will take time to deliver the needed energy savings and demand reductions.
- At the wholesale level, we will have to work with manufacturers and wholesalers to ensure that products are in place before we establish programs that increase customer demand for them. At the retail level, retail suppliers, equipment deliverers/installers, home builders and others all need information about, and access to, energy efficient technologies. At the customer level, it will take time to understand the implications of energy usage on energy savings and costs.
- Another planning consideration is the need to ensure that the portfolio is cost effective, and delivers on the directives. Through the IPSP analysis, we have identified achievable potential, by end use (in the case of energy efficiency) and different types of opportunities (in the case of demand management). In so doing, we have established clear priorities and targets for our programs. This, combined with effective EM&V, should help guide program development and refinement over time, so as to ensure cost-effective achievement of our targets.

  We will design our short term programs with a view to creating the necessary enabling conditions from which a market transformation will take place, in the longer term. While resource acquisition prompts immediate market investment in CDM, achieving market transformation will require deployment of a wide range of information, instruments and measures designed to create certain enabling conditions.

4.3 Our CDM Deployment Strategy

Our deployment strategy is largely based on utilization of outsourced delivery channels, i.e. working in partnership with retailers, contractors and other energy product and service providers to benefit from their hands-on experience and detailed knowledge of customers and the CDM industry. One of the greatest opportunities we have for rapid implementation is to build on existing programs like those currently run by the Toronto Region Conservation Authority, Toronto Atmospheric Fund, and various NGOs and municipal governments.

The following Table 4.3 outlines principles that will guide CDM deployment into 2007 and beyond.

Table 4.3 – Suggested Principles to Guide CDM Deployment

- Open and transparent process for inviting and evaluating bids.
- Requests for Expression of Interest and RFPs and other solicitation documents will state requirements, conditions and timeframes clearly, completely and reliably.
- Ensure widespread participation in CDM procurements, and will actively solicit participation by new delivery organizations as a way of deepening the market.
- Ensure timely resolution of all competitions.
- Use standardized contracts, as far as is practical, identifying responsibility for: monitoring and verification; result reporting; payment terms, based on performance, and; definition and use of communication materials.

Source: OPA

For illustration purposes, Figure 4.1provides an example of how the OPA is working with the LDCs, as program administrators[29]. As shown, the range of business models include OPA design and third party administration at one end and LDC design and administration at the other end of the continuum. As is the case with other delivery partners, the LDCs will apply for and obtain varying levels of OPA funding for CDM program administration. In some cases, the OPA may choose to fund LDC customer programs as 'pilot projects' to determine whether CDM programs designed and delivered in one LDC territory are 'scalable' and can be successfully replicated elsewhere in the province. This is akin to funding pilots underway in other sectors with other customer representative organizations (e.g. AMPCO, Ontario Mining Association, Community College Secretariat Ontario Hospital Association). See: http://www.energy.gov.on.ca/english/pdf/conservation/CAT_Report.pdf

[29] In October 2006, we established two related Advisory Groups to help advance the design and operating framework for the standard programs. The "program design advisory group" (PDAG), is comprised of representatives of the LDCs, customer and environmental interests and the provincial government. The PDAG was tasked to identify, characterize and recommend as many as five standard CDM programs for roll-out in Ontario by LDCs. The desired outcome is selection by the OPA of a final group of standard programs and development of contracts, rules and guidelines for the program funding framework.

Figure 4.1 – Continuum of Program Deployment for LDC CDM Activities

		Standard Programs aka "Programs in a Box"	
OPA Design	OPA Design	OPA Design	LDC Design
Third Party Administration	Third Party Administration	Third Party Administration	Third Party Administration
Reactive LDC support such as responding to customer queries	Proactive LDC support such as local promotion, marketing and awareness building	Focus of Program Design Advisory Group	"Custom" Programs Pilots Market Research
Demand Response Program for Wholesale Customers	Refrigerator Retirement (if not included in Standard Program portfolio)	Residential Demand Response (based on recommended Standard Program portfolio)	Residential New Construction

Source: OPA

When choosing the most appropriate delivery partner, the OPA must consider:

- The partner's unique customer knowledge, relationship and delivery capabilities—including billing and customer care infrastructure/skills;
- Knowledge and skill with existing programs that can be leveraged, built upon or expanded
- Breadth, size and depth of the channel's network, so as to access a significant number of customers, for potential roll-out across the province
- Proven results and cost-effectiveness based on experience in Ontario and elsewhere to limit risk to OPA and increase confidence of successful CDM deployment.

In addition to the standard program offering for LDC CDM activities, the OPA is using and will continue to use other market channel delivery platforms. For example, the OPA has reached agreements with the Building Owners and Managers Association (BOMA),as well as with the City of Toronto and Toronto Hydro, to support the delivery of the 300 MW of CDM identified in the February 2006 directive.

4.4 Evaluation, Measurement and Verification

Earlier sections of this paper have stressed the importance of EM&V process. EM&V is essential because:

- It provides the data for determining whether the CDM targets are being met, and how well the OPA is succeeding in its mandate to accelerate CDM activity across the province
- It provides assurance that the CDM resource is real, and can be counted on in the context of electricity system planning as a whole
- It provides the data for determining the cost-effectiveness of CDM programs and reporting
- It provides data and qualitative information about program successes and failures, leading to a process of continuous improvement in program design and implementation.

The OPA is developing an EM&V system that will provide OPA staff, the OEB, policy and decision makers and the electricity customers of Ontario with accurate information on CDM program performance

All successful CDM experience documented in other North American jurisdictions is backstopped by effective EM&V reporting systems and requirements for periodic evaluations. The OPA is learning from the best practice EM&V experience to develop a world class system. Development of the EM&V system comes at a time when there is a high level of uncertainty about the projected peak and energy impacts of CDM programs in Ontario

The balance of this section elaborates the EM&V goals and principles that are guiding development of the system, as well as the near-term actions being undertaken to ensure it is operational in time to track the performance of the emerging CDM program portfolio.

4.4.1 EM&V Definition and Goals

Evaluation, measurement and verification are three interrelated functions to support estimation of program effectiveness, savings impacts, and fiduciary accountability. These functions are defined as follows:

Verification: Refers to activities which verify that the equipment installations or behavior changes reported by the program delivery agent(s) have occurred and that the equipment is working.

Measurement: Refers to activities that measure the pre- and post-CDM program conditions. Measurement techniques that include surveys and on site measurement are used to confirm that the assumptions used to estimate the baseline conditions affecting energy usage were accurate and also measure the conditions after CDM measures have been deployed.

Evaluation: Refers to activities in which the information obtained through measurement and verification are used to evaluate the value (energy and demand savings primarily) produced by the existing CDM program(s) from which the results are compared to expectations. Evaluations can be used to decide if program modifications are needed, or funding increases or decreases are justified.

When operational, the EM&V system will enable the OPA to address four fundamental questions:

- What was happening in the market before a program was launched?
- What happened as a result of the program's activities? (installations, energy savings, market impacts)
- Why did the energy use of program participants change (up or down)?
- How can program effectiveness be improved? How can program objectives be met at lower cost?

In this context, the objectives of the EM&V system are to:

- Produce a standardized process for evaluating all CDM programs, reporting their results and identifying follow-up actions.
- Ensure that funds are prudently spent.
- Provide accurate information on the performance (load impacts, cost effectiveness, and customer participation levels) of CDM programs and how the load impacts will affect future power needs and resource procurement. This includes verification of the key assumptions driving the estimates of peak load reduction and energy savings, such as baseline energy use, hours of operation, expected baseline energy use in the absence of programs and/or considerations of the potential for free riders or free drivers resulting from the program.
- Provide accurate information on the dollar value created by each group of programs for use in compensating CDM program delivery agents and, potentially, CDM implementers, for their services.
- Suggest useful and creative ways to improve CDM program design, and ultimately the program's cost effectiveness, both during the implementation stage and at the start of each planning cycle.
- Produce an accurate assessment of future opportunities to save energy through new or different programs to meet the information needs of the IESO and OPA resource planners in order to develop more accurate estimates of the range of future demands.
- Establish protocols to guide the frequency of evaluations. All programs must be periodically evaluated in terms of their load impacts (energy and peak savings). The frequency of these evaluations should be geared to the importance of the program in meeting overall savings goals, the uncertainty in the existing estimates and the estimated cost of the evaluation.
- Establish protocols to guide the application of both process and impact evaluations. Process evaluations should be focused on documenting the results of program operations and developing recommendations to improve the effectiveness of the program design. Conversely, impact evaluations should be focused on estimating the net energy and peak savings from a program based on collecting data from a representative sample of participants (and non participants that can serve as the control group).

These goals are broader than simply evaluating the level of energy savings achieved by programs because they explicitly recognize that there are other important customers of evaluation results and other objectives for CDM programs besides achieving resource savings. In particular, this includes documenting the evolution towards a culture of conservation - how customer attitudes and behaviour are changing as a result of CDM program initiatives, and how, relatedly, increased customer awareness is itself helping to improve the targeting and effectiveness of CDM programs.

At the same time, the EM&V system will help to document the degree to which capacity building is actually occurring, examining whether targeted competencies, both management and technical, are being met. Ultimately, the EM&V system is about information. The OPA is committed to sharing the quantitative and qualitative results among all stakeholders and organizations with specialized evaluation needs. We recognize that our evaluation plans must meet the needs of all stakeholders if they are to be adopted on a widespread basis.

4.4.2 Near Term Actions

In the last three months, we have made progress in achieving the EM&V milestones discussed in our October paper. In this section, we describe that progress and highlight actions to be taken in the next six months for each of the three action items listed in our first paper,

- Program Tracking Systems
- Program Progress Reporting
- Protocol Development.

With regard to program tracking systems, we have, in the past three months:

- developed an internal tracking system that includes success and progress metrics for all of our programs
- developed the specification for a CDM analysis tool that can analyze the costs and benefits of programs in the field.

Next Steps: We plan to ask our delivery agents and/or LDC program administrators to use the format and content of this internal tracking system to help us keep the Ministry of Energy and stakeholders informed. This data will feed into the next part of the structure: program progress reporting.

In addition, we are committed to developing a clear and consistent progress reporting system to document CDM progress in a timely fashion. In the past three months, we have:

- Agreed on a vision of how the evaluation framework will evolve to meet the needs of various constituencies
- Developed a process for ensuring evaluation plans are part of the program launch contract
- Developed a schedule for the release of interim and final evaluation products.

Next Steps: We are in the process of drafting evaluation plans for each of the current and future programs we plan to launch in 2007. These plans will require the hiring of independent contractors to review data being collected by program delivery agents, verify reported cost and installation data, and track performance against the metrics specified in the program contract.

With regard to CDM evaluation protocols, we have, in the past three months, working on protocols for:

- Financial Audits of Program Expenditures
- On-Site Audits to Verify Measure Installation and Operation
- Process Evaluations of Program Delivery
- Program Load Impact (energy and peak) Evaluations
- The Persistence or Effective Useful Life of measures installed by programs

The purpose of the financial and on-site audit protocols is to ensure ratepayer funds are being effectively spent on achieving CDM savings. We will audit a sample of program invoices and visit a sample of sites to ensure ratepayers gets what they paid for. The purpose of the process evaluations is to identify ways to reduce program costs and/or improve program delivery. The purpose of the program load impact protocols and related persistence protocol is to ensure that the load impact results from evaluations funded by the OPA are based on a sound statistical sampling approach and that the underlying assumptions used to support current estimates of energy and peak savings from these programs have been verified.

All of these evaluation protocols will provide a “how to evaluate” manual for program managers and planners and will include lists of decision menus and/or steps to plan and implement a high quality, rigorous evaluation of specific types of programs. The protocols will guide the activities of OPA program staff and, more broadly, could be attached to all CDM program delivery contracts and adopted as requirements for all LDCs or third party program managers who wish to apply to design and deliver CDM programs.

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Appendix A: Details of Achievable Potential by CDM Category

The purpose of this appendix is to provide additional detail on the five CDM categories and the methods used to estimate the achievable potential from each one.

Conservation

Programs in this category are aimed at influencing customer behaviour to reduce the amount of electricity consumed over time using technology already in place. They provide customers with tools and information to reduce their electricity use. These programs are primarily targeted at residential and small volume customers but conservation suggestions can also be made during energy audits of large industrial and commercial facilities. Turning lights off, keeping the air conditioning temperature higher and using power bars to limit power loss while appliances are off are all examples. In an industrial context, a conservation program may involve changing business processes.

Conservation programs can be used to raise general awareness of more energy efficient purchase options and to encourage public participation in specific CDM programs.

Estimating the level of permanent peak savings to include in the forecast from programs that promote conservation actions or influence behaviour is very difficult and uncertain. Research has shown that at least some conservation behaviours are likely to be transient and subject to environmental factors outside of the control of a CDM program framework. For example the California Energy Commission forecasting office has estimated that roughly 75% of the residential population made specific changes in their consumption patterns in response to the electricity crisis in 2001 and 2002 but that roughly half of this conservation effect had disappeared by the summer of 2005.

There may be some conservation behaviours that can be introduced by programs and become permanent as a result of building a conservation culture. Anecdotal evidence suggests that certain segments of society are more amenable to learning how to program and use a programmable thermostat than others. Similarly, campaigns to convince customers to do their laundry during off-peak periods appear to have lasting results.

In general, conservation programs are good at generating leads for energy efficiency programs and in raising customer awareness of the consequences of energy investments and energy brands such as Energy Star® and PowerWISE®. We hope that the energy savings achieved by these campaigns will be captured by the program evaluations. We think it is reasonable to count on public appeals for curtailment during times of system stress. A large component of this expected level of peak reduction during peak times is a transitory resource that may not be sustainable in the long run. There may be residual long term savings; however, it is difficult to estimate their potential. We have assigned a nominal estimate of 50 MW for the moderate scenario and 350 MW for the aggressive scenario for each of the five milestone years for peak savings. TWh and MW savings for the milestone years are tabulated in Table A.1 and Table A.2.

Table A.1 – Achievable Conservation Potential (TWh Savings)

	2010	2015	2020	2025
Moderate	0.01	0.01	0.01	0.01
Aggressive	0.05	0.05	0.05	0.05

Source: OPA

Table A.2 – Achievable Conservation Potential (MW Savings)

	2010	2015	2020	2025
Moderate	50	50	50	50
Aggressive	350	350	350	350

Source: OPA

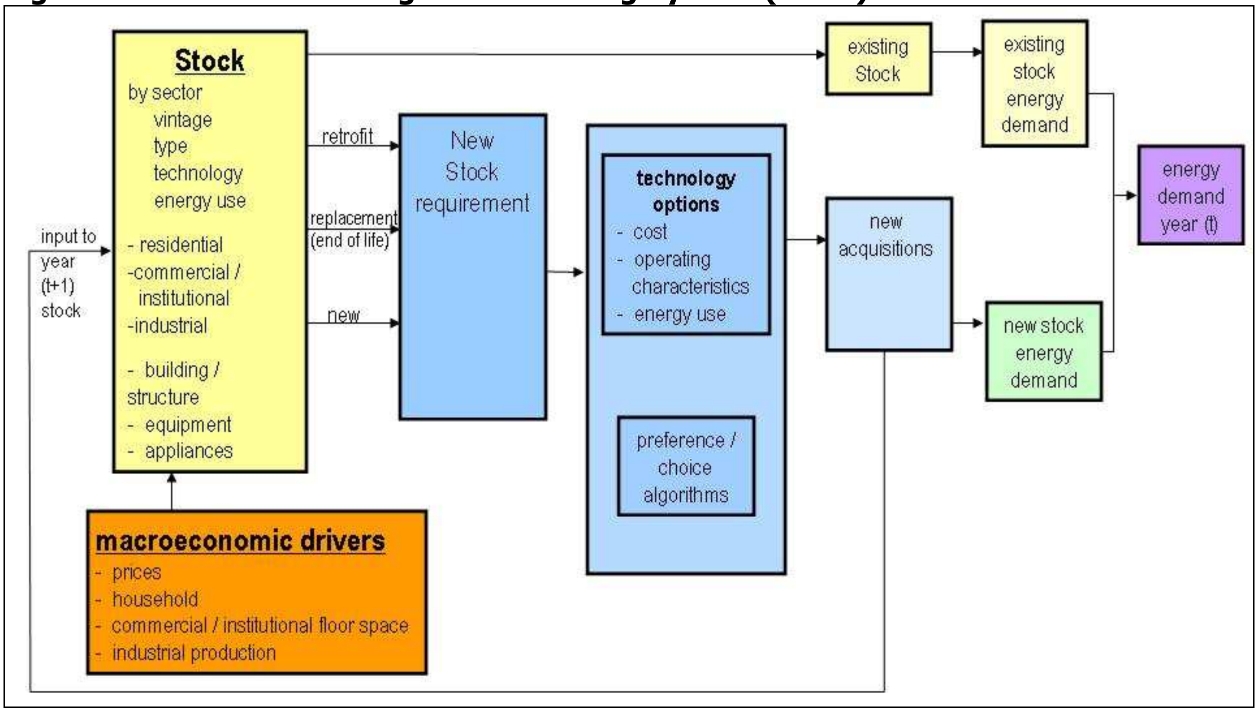
Energy Efficiency

Energy efficiency refers to programs, technologies and measures that reduce the energy used by specific end-use devices and systems without reducing the quality of services provided, i.e., the same or improved service for less energy. Energy efficiency programs are different than generalized conservation measures in that they seek to get customers to invest in more efficient infrastructure, process and building designs and equipment rather than reducing their demand for the service through a reduction or shift in operating hours. Overall electricity consumption is reduced often without explicit consideration for the timing of program-induced savings.

To estimate the CDM potential from this category, the OPA built on a 2005 study commissioned by the Council of Energy Ministers Demand Side Management Working Group to estimate the achievable demand-side management potential in Canada (The National Study). The DSM Working Group was comprised of representatives from the federal government (Natural Resources Canada), provincial governments, the Canadian Gas Association (CGA) and the Canadian Electricity Association (CEA). Marbek Resource Consultants Ltd. (Marbek) and M.K. Jaccard and Associates (MKJA) completed the study jointly. The analysis was conducted using the CIMS model, supported by Marbek DSM tools and databases.

The CIMS model is depicted below. It is a technology choice model that produces results in terms of energy reductions that can be achieved.

Figure A.1 – Canadian Integrated Modeling System (CIMS)



Source: OPA

The OPA decided to leverage the considerable effort that went into the National Study in developing the IPSP. We contracted with M.K. Jaccard & Associates to extract and update the National Study estimate of CDM potential in Ontario. The CIMS model was used to investigate the potential from energy efficiency, fuel mix changes and cogeneration. The National Study model assumes that customers will make decisions in a market based environment defined by two different policy regimes: a status quo scenario and an aggressive scenario. These scenarios used the reference load forecast as the basis or foundation for developing the estimate for CDM potential.

While there may be many scenarios that could be employed to estimate CDM potential, the OPA is relying on the status quo and aggressive scenarios developed by MKJA. In this context, we have also adopted the terminology used by MKJA. The selection of these scenarios is to facilitate planning for CDM, not limit the pursuit of cost effective and viable CDM opportunities.

In the ensuing discussion, we provide the projected Ontario energy demand based on five scenarios:

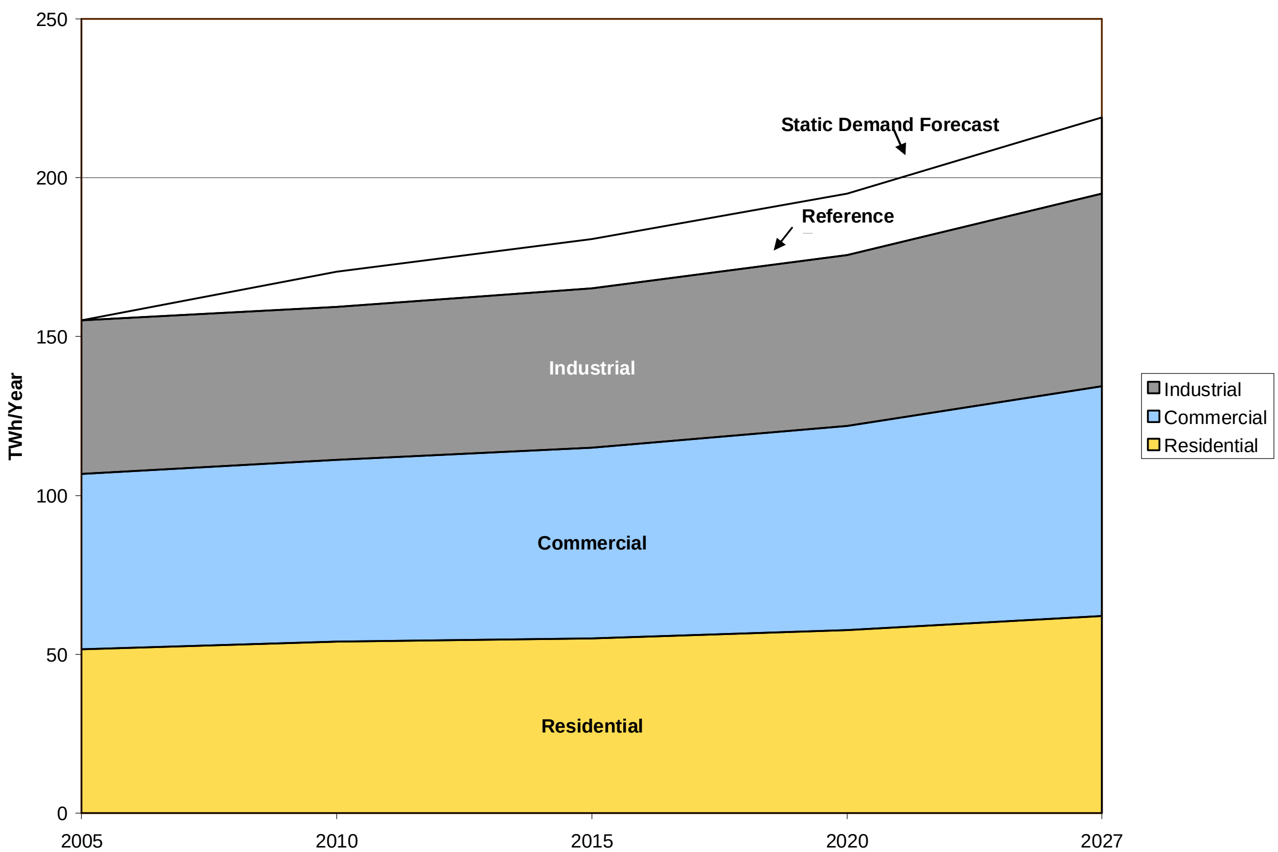
- No naturally occurring CDM ("static scenario")
- Naturally occurring CDM only ("reference case scenario")
- Modest policies in support of energy efficiency
- Aggressive policies in support of energy efficiency
- Full economic potential from energy efficiency

Static demand forecast: This refers to a scenario where there are no naturally occurring CDM savings, in contrast to the reference case which includes naturally occurring CDM.

Reference case demand forecast: A projection of energy demand to the year 2027, assuming naturally occurring CDM but no new and incremental market interventions. This forms the basis of our reference case load forecast, as discussed in our load forecast discussion paper (#2).

Figure A.2 shows the expected growth in energy demand under the static scenario and for the residential, commercial and industrial sectors under the reference case from now until 2027.

Figure A.2 – Reference Case and Static Demand Energy Forecast for Ontario

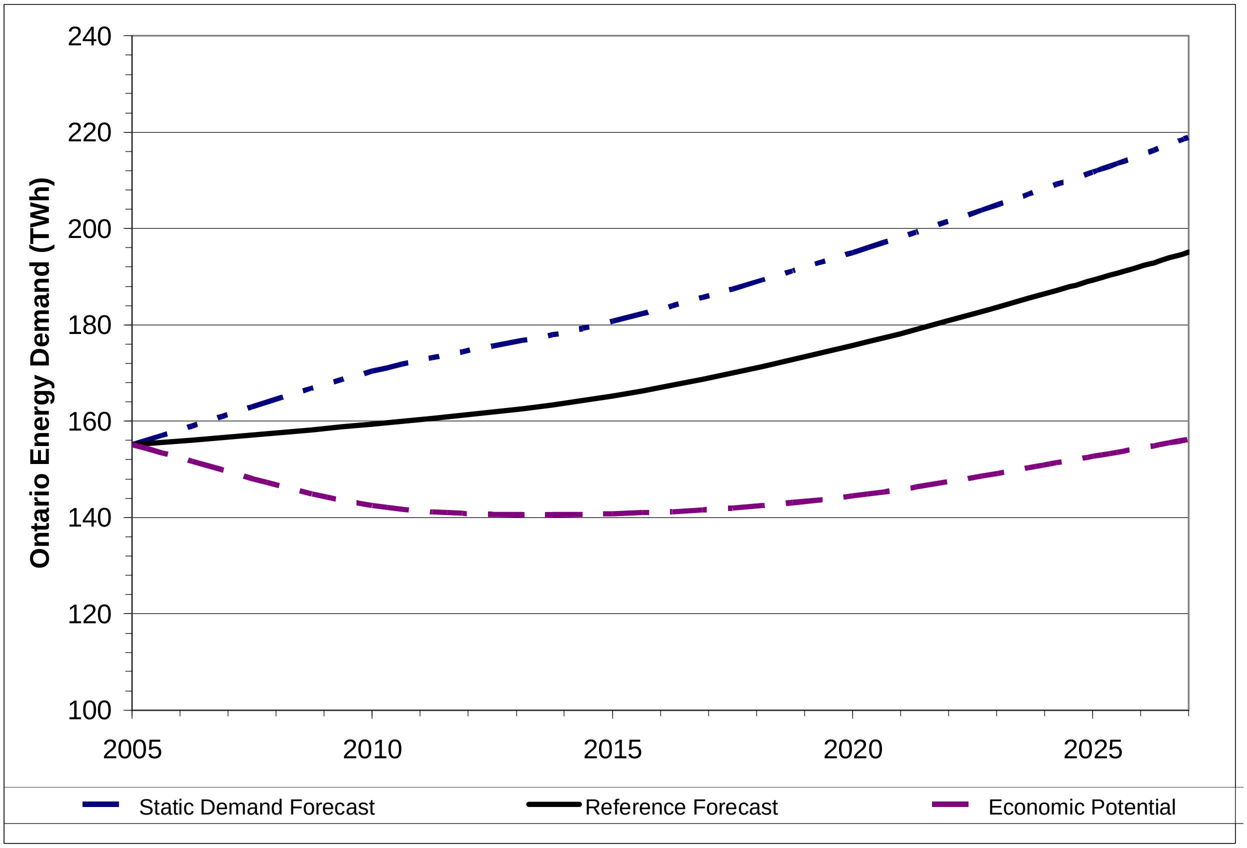


Source: OPA

We now go beyond the reference case foundation and introduce the concept of economic potential and discuss the two achievable potential scenarios (status quo and aggressive) that were modelled in this study.

Economic potential: Nominally, this refers to a scenario where all equipment and building envelope energy management actions that pass a "Total Resource Cost" test are implemented in the target markets in order to obtain savings. That is, all known CDM opportunities are implemented if the present value of the cost is less than the present value of the avoided supply cost, as set out in OEB tables (See Appendix B). The scenario reflects the potential for CDM actions, given a social discount rate and a variety of assumptions about the market, the decision-making process, and the treatment of externalities. For consistency with the naming convention used in the National Study, the MKJA Report and this paper refer to this potential as the Economic Potential. An estimate of the energy demand that would occur under this scenario is shown in Figure A.3.

Figure A.3 – CDM Savings (Energy) - Economic Potential



Source: OPA

Achievable potential - Two achievable potential scenarios are modelled in this study, referred to as Scenario 1 Status Quo and Scenario 2 Aggressive. The achievable potential for CDM savings is a sub-set of economic potential and the "achievable" aspect is intended to bring a sense of practicality to the analysis. The status quo and aggressive scenarios represent considerably different visions of how various policy instruments and programming may be brought to bear on the residential, industrial and commercial/institutional markets during the study period.

Achievable potential - Scenario 1 Status Quo: Under this scenario the CIMS model estimates the achievable potential over the next 20 years assuming a continuation of approximately the current levels and types of market intervention by government, utilities and others. The scenario is driven by two types of policy instruments: subsidies and information programs.

To implement subsidies, decisions were made about which end uses or technologies are targeted, and the subsidy rate applied to the targeted end use or technology. Subsidies are targeted to energy efficient technologies identified in the economic potential scenario. The subsidy rates alter the relative capital costs of competing technologies as the stock turns over and are set in the model consistent with current observed utility incentive levels. Figure A.4 lists the schedule of subsidy rates applied to the targeted technologies in CIMS. Rates differ by sector and by equipment category. The activities include targeted information campaigns, product and building labelling, energy audits and assessments, and training.

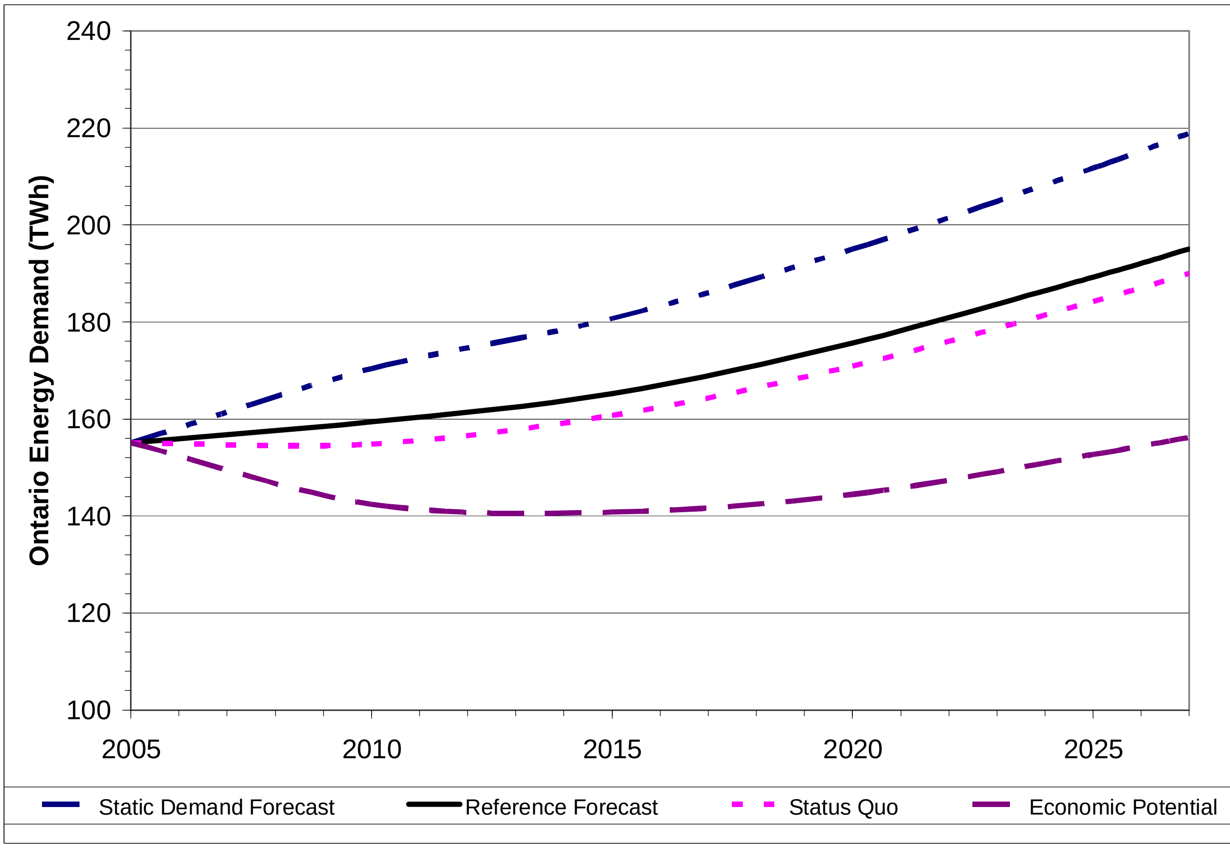
A projection of the energy demand that would occur under this scenario is shown in Figure A.5.

Figure A.4 – Incentives Assumed

	Average Subsidy Rate as a % of Capital Cost
Residential hot water system replacement	25
Residential furnaces replacement	25
Residential envelope upgrades and equipment tune-up (retrofit)	35
Residential appliance replacement	10
Residential new construction	20
Commercial existing retrofit/tune-up	30
Commercial new construction	15
Commercial equipment replacement (boilers, domestic hot water etc.)	25
Industrial process and equipment tune-up	25
Industrial equipment replacement	15

Source: MKJA

Figure A.5 – CDM Savings (Energy) - Economic Potential & Status Quo Scenario



Source: OPA

Relative to the reference case scenario, 14% of the CDM savings inherent in the economic potential scenario are captured in the status quo scenario by the year 2025.

Achievable potential - Scenario 2 Aggressive: Under this scenario the CIMS model estimates the achievable potential assuming implementation of new and expanded policies by all levels of government and heightened activity by utilities and the private sector. The scenario is driven by four main factors:

- Subsidies targeted to energy efficiency measures
- Marginal cost pricing structure for electricity customers
- Aggressive schedule of legislatively backed advanced minimum energy performance targets for equipment and buildings
- Aggressive schedule of subsidies targeted to accelerate the market penetration of on-site renewable energy technologies

The same energy efficiency subsidy or incentive levels used for scenario 1 are applied but a more accelerated rate of application. Figure A.6 lists the more aggressive schedule of standards relevant to this scenario. Equipment and building efficiency standards are specified to remove from the market some share of the capital stocks that are the least energy efficient. Subsidies are applied to induce a greater market penetration of some renewable energy technologies for on-site applications.

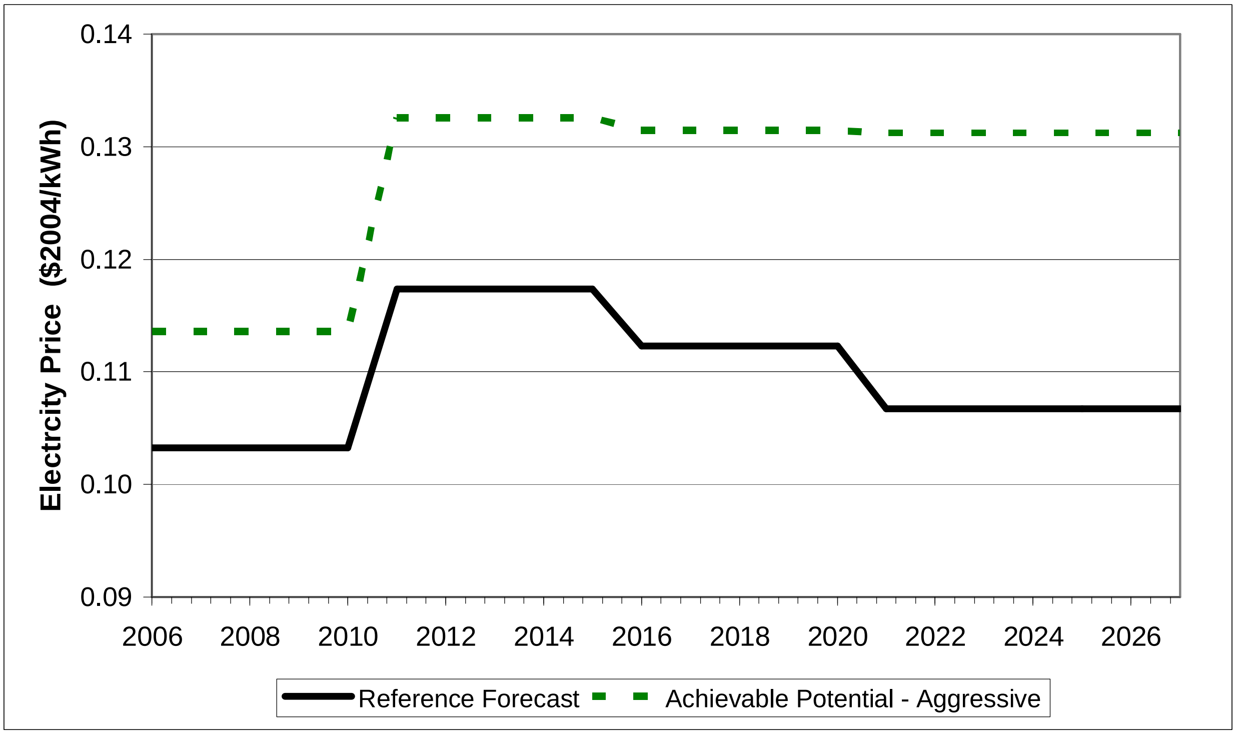
Figure A.6 – Standards Assumed

End-use	Status Quo	Aggressive Scenario
New Housing	Standard and Efficient/R2000 which represent 30% improvement	Ramp so that 30% is R2000 in 2010, 60% in 2015, and 100% in 2020.
Air Conditioning	4 levels for Central (SEER 10 – 15.5); 2 levels for room (EER 9.8 to EER 10.8)	Eliminate lowest efficiency in both classes by 2010.
Refrigerators	485 kWh, 435kWh, 392 kWh, 339 kWh and 281 kWh (this is a custom fridge).	Eliminate 485 kWh in 2005 and 435 kWhin 2010.
Dishwashers	EF 0.46, EF 0.58 and EF 0.94	Eliminate 0.46 by 2010.
Clotheswashers	MEF 23, 29, 31, 36, 46	Eliminate EF 23 in 2010, 29 in 2015, and 31 in 2020.
Freezers	3 levels of efficiency - 1 - standard level; 2 - efficiency improvement of 10% upright, 15% chest; 3- fficiency improvement of 10% upright, 50% chest	Eliminate standard option in 2010.
Ranges	3 levels of efficiency - standard 760 kWh, 598 kWh and 466 kWh	Eliminate 760 kWh in first year.
Residential Lighting	incandescent, CFL, LED	NONE
Commercial HVAC	Technologies are combined in CIMS to develop HVAC EUIs	20% improvement in new HVAC EUIs by 2010 and a 30% improvement by 2020.
Commercial Lighting	Technologies are combined in CIMS to develop lighting EUIs	35% improvement in lighting EUIs by 2015.

Source: MKJA

A higher electricity price than what is assumed to underpin the reference case is considered in this scenario. The two prices are shown in Figure A.7.

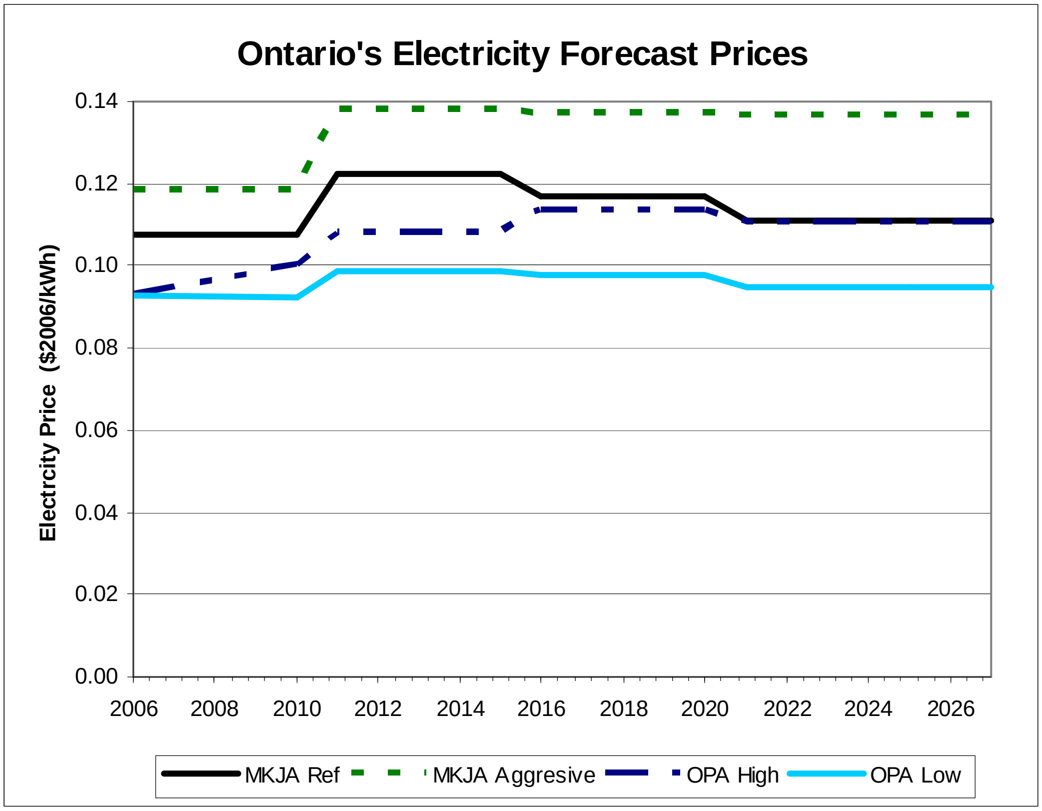
Figure A.7 – Ontario's Electricity Price Assumptions



Source: OPA, MKJA

The price of electricity is a key driver affecting the CDM analysis. Figure 4.8 compares the prices used by MKJA in the Ontario analysis to the OPA's current forecast of the cost of electricity supply into the future. The MKJA price metrics are based on the National Energy Board price forecast. The OPA projections are based on the infrastructure needed to meet the requirements until 2025. As shown, there is a small difference between the two projections.

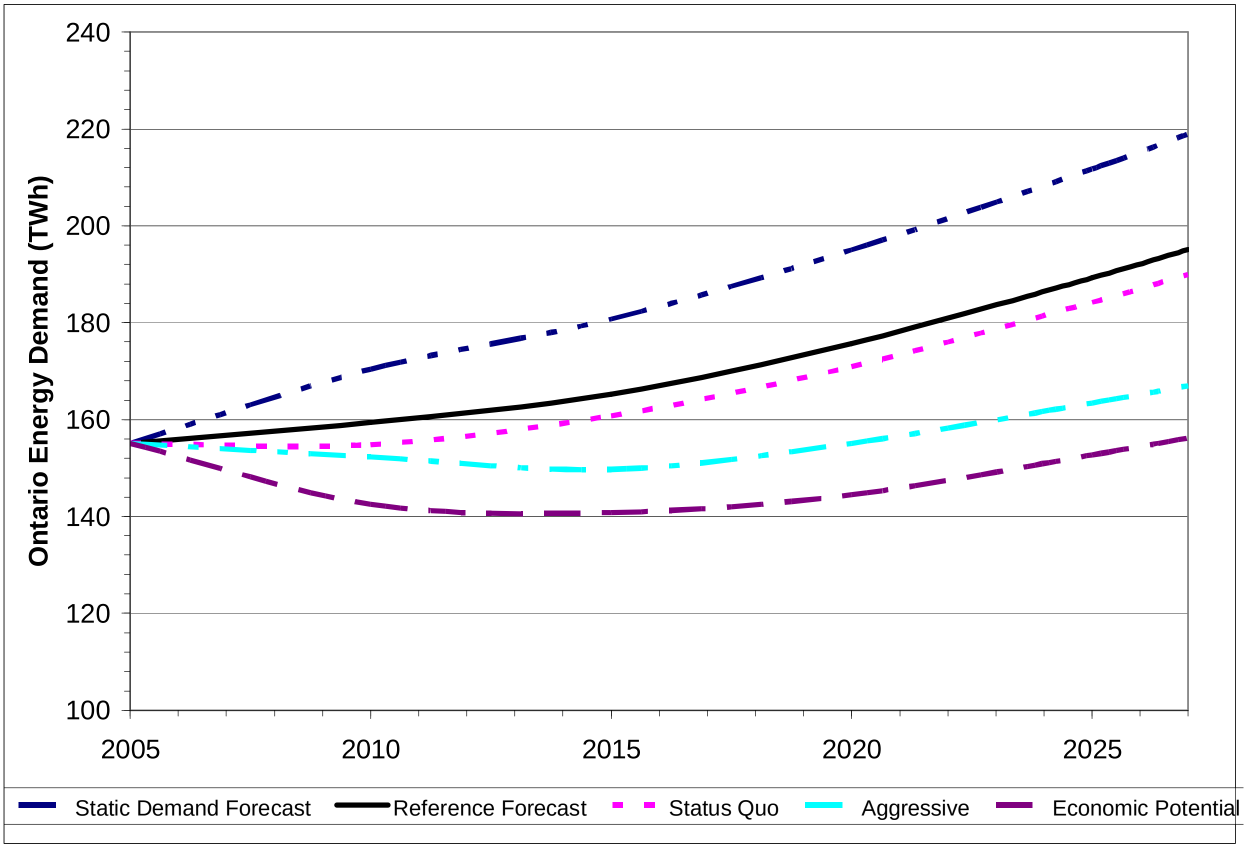
Figure 4.8 – Comparison of MKJA and OPA Electricity Price Forecasts



It can be seen that MKJA assumed slightly higher prices than we currently expect. MKJA's modelling therefore slightly over estimates the amount of natural conservation and underestimates the impact of incentive programs. However, the effect is not expected to be material. It is also expected to be off set by MKJA's estimate of slightly higher than currently expected avoided costs (see Appendix B).

A projection of the energy demand that would occur under this scenario plus other scenarios discussed earlier is shown in Figure A.9.

Figure A.9 – CDM Savings (Energy) - Economic Potential, Status Quo & Aggressive Scenarios



Source: OPA, MKJA

Relative to the reference case scenario, 68 percent of the CDM savings inherent in the economic potential scenario are captured in the aggressive scenario by the year 2025.

The energy savings that result from the status quo and aggressive scenarios can be viewed in Figure A.9 as the difference between the reference case and the status quo/aggressive cases respectively - they are tabulated in Table A.3. The associated MW savings tabulated in Table A.4 are derived from the energy savings and depend on load shapes.

Table A.3 – Achievable Energy Efficiency Potential (TWh Savings)[30]

	2010	2015	2020	2025
Scenario 1 Status Quo	4.56	4.47	4.82	5.07
Scenario 2 Aggressive	7.15	15.52	20.62	25.82

Source: MKJA, OPA

30 At the generator.

Table A.4 – Achievable Energy Efficiency Potential (MW Savings)[30]

	2010	2015	2020	2025
Scenario 1 Status Quo	452	727	971	1,115
Scenario 2 Aggressive	1,327	3,161	4,464	5,598

Source: MKJA, OPA

We have selected the aggressive scenario to provide a further breakdown of the estimated savings by sector. This is shown in Table A.5 and Table A.6. These results show that the greatest energy savings can be found in the commercial sector, at least in the long run. Interestingly, the projected savings in the short run (by 2010) are approximately the same in the residential and commercial sector.

Table A.5 – Scenario 4 (Aggressive) Energy Efficiency Potential (TWh)

Sector	2010	2015	2020	2025
Residential	3.26	6.47	7.17	8.56
Commercial	3.45	8.12	12.00	14.94
Industrial	0.44	0.93	1.45	2.32
Total	7.15	15.52	20.62	25.82

Source: MKJA, OPA

Table A.6 – Scenario 4 (Aggressive) Energy Efficiency Potential (MW)

Sector	2010	2015	2020	2025
Residential	526	991	1,256	1,452
Commercial	737	2,038	3,001	3,814
Industrial	64	132	207	332
Total	1,327	3,161	4,464	5,598

Source: MKJA, OPA

These results suggest that in the short term the greatest energy savings opportunities can be found in the residential and commercial sectors. While all these estimates are subject to refinement, we believe that the assumptions associated with the estimates for the industrial sector may need particular attention. There are known features in the CIMS model that may be contributing to this result. Specifically, the model is designed to simulate changing technologies, but it does not adequately capture the additional energy saving effect of changes in processes and operating procedures that may accompany the introduction of the new technology.

The sector with the most potential for reduction in peak demand is the commercial sector which accounts for about 55 to 70% of all the projected reduction over this time period. (See Section 3.2 on Peak Forecasting Methodology in the Load Forecast discussion paper). http://www.powerauthority.on.ca/Storage/26/2132_Load_Forecast.pdf

Demand Management

Demand management is defined as managing electricity usage by end-use customers so as to bring about changes from their normal consumption patterns, i.e., shift use from on-peak hours to off-peak hours (time of use) and peak clipping where consumption is reduced during peak hours (demand response). Building demand management capability is essential to increasing supply capability through shifting use and/or reduction in peak demand during summer and winter peaks.

Each end-use customer class has unique circumstances when it comes to demand management. In recognition of this the assessment of CDM potential in this program category has been assessed separately for smart meters for residential and small commercial customers and demand response for both price and reliability for all customers, i.e., residential, commercial and industrial.

Table A.7and Table A.8 summarize the achievable potential level for demand management in Ontario.

Table A.7 – Demand Management Energy TWh Savings

Scenario Case	2010	2015	2020	2025
Moderate	0.02	0.02	0.04	0.05
Aggressive	0.02	0.05	0.09	0.14

Source: OPA

Table A.8 – Demand Management Peak MW Savings

Scenario Case	2010	2015	2020	2025
Moderate	199	287	520	674
Aggressive	546	1,192	1,822	2,384

Source: OPA

Time of Use - Smart Meter

The amount of MW available in the future for time of use is primarily a function of the availability of time differentiated pricing and associated metering. We look at the impact of promoting automated thermostat or lighting controls installation in combination with time-of-use or critical peak pricing for the residential and small commercial sectors. Recent experience with automated control equipment suggests that the expected peak reductions from the application of this equipment can double the observed price elasticity from residential customers[31]. We use this fact and other information related to customer preferences to construct aggressive and moderate scenarios of likely peak reductions from time differentiated pricing. These scenarios consider the impact of varying key assumptions that drive the forecast of MW peak demand reduction. These assumptions include:

[31] Faruqui, Ahmed, Impacts from the Statewide Critical Peak Pricing Pilot: Summer 2003 Load Impact Analysis (Prepared for Southern California Edison by Charles River Associates, Oakland, CA. Oct. 11, 2004

penetration rate of smart meters. The previous analysis assumed 100% of residential customers will be placed on a time-of-use price.
price differential between on and off-peak and resulting price elasticity
customers who choose to install automated control systems

Moderate Case – In this case, we assume that technological and other difficulties slow the installation of advanced metering networks to residential customers so that the entire network installation is complete by 2020. In addition, we assume that only 20 percent of the customers sign up for time differentiated pricing and that there is a 2 for 1 on-peak to off-peak price differential. The result is projected peak savings equivalent to roughly 15 percent of the 500 MW estimated in Navigant's Smart Meter Impact analysis, section 4.4[32].

Aggressive Case – In this case, we assume that the LDCs achieve a slight improvement (5%) in the number of meters rolled out in the first years of the deployment schedule for smart meters with 100% of the meters being installed by 2010. In addition we assume that LDCs take advantage of new technological opportunities to roll out smart meters and programmable communicating thermostats at the same time and on schedule. We assume that the LDCs will offer financial incentives for customers willing to automate their response. In many ways this is simply the next stage in the evolution of technology from the simple cycling switches now used by Toronto Hydro and others. As a result 40% of the residential class installs automated controls by 2025 which increases the aggregate elasticity for the residential class of customers from the .11 assumed in a previous analysis to .19. These changes result in an increase in the available MW of roughly 400 MW or the difference between 500 MW by 2025 in a previous study to 902 MW in this high case. Energy savings of <1% are also expected to result in response to the higher prices.

Table A.9 and Table A.8 summarize the achievable potential level for time of use in Ontario.

Table A.9 – Time of Use/Smart Meter - Energy Savings (TWh)

Scenario Case	2010	2015	2020	2025
Moderate	0.00	0.00	0.00	0.00
Aggressive	0.00	0.01	0.01	0.01

Source: OPA

Table A.10 – Time of Use/Smart Meter - Peak Savings (MW)

Scenario Case	2010	2015	2020	2025
Moderate	24	54	71	76
Aggressive	296	645	842	902

Source: OPA

The results suggest there is substantial range in the level of MW that can be expected from pricing and the deployment of smart meters in Ontario: from 76 MW to 902 MW in 2025.

32 Navigant Consulting Ltd., Overview of the Portfolio Screening Model, December 2005. Available at: http://www.powerauthority.on.ca/ipsp/Storage/15/1105_Part_4.1_Navigant_Consulting_PSM_Report_Final.pdf

Demand Response

In electricity grids, Demand Response (DR) is a mechanism to have customer demand play a role in meeting the real-time and long-term supply needs of Ontario's electric system. The main objective of a DR program is to ensure that load participating in the program is available (to provide DR) i.e., load when it is withdrawing energy from the grid has the ability to be curtailed. In DR electricity customers reduce their consumption at critical times on a request by the system operator or in response to prices. These types of DR can be categorized into two types of programs.

- Economic or price based DR can be either voluntary or incentive based and is triggered by a certain market price level. The participant removes a load either voluntarily based on business viability or to meet a pre-determined agreement (i.e., contractual) with the system operator based on the "strike" price. Price based DR fits into a mid to long-term time horizon and is related to ensuring long term capacity planning reserve.
- Reliability based DR is managed through a pre-determined agreement with the system operator related to system capacity and the ability of the system operator to manage the risk of a supply resource or exceptional weather causing demand to increase beyond what was anticipated. Reliability based DR fits into a real-time or near real-time time horizon and provides capacity to meet operating reserve requirements.

To estimate the peak savings for customers we assume that the both time differentiated and real time pricing as well as willingness to pay customers to reduce their load is available. We have assumed that normally residential and small commercial customers will likely respond to price and industrial and large commercial respond to price as well as make reliability contracts for which they get reimbursed. Since the IPSP is examining capacity planning from a long term perspective, OPA has only included the economic or price based DR potential.

There are several possible approaches to estimating the potential for economic or price based DR. We provide below representative scenarios for its assessment.

To estimate the magnitude of residential and small commercial customer load that would respond to price most LDC's will rely on direct controls to reduce load. We assume LDC's will continue to rely on air-conditioning cycling programs for residential and small commercial customers. We assume that roughly 10% of the residential customers sign up for these programs over 20 years and they generate a 20% peak demand reduction in the participating homes. Given these assumptions the MW available in this scenario is equal to 0.76%[33] of total peak system demand.

A well orchestrated program based on financial incentives to large commercial and industrial customers that install energy management and automated response systems can achieve peak savings equivalent to 10% of the typical buildings load[34]. We estimate that these programs could achieve a 33 % market share in the major industrial /commercial sector (load greater than 100 kW) which is sensitive to energy costs over the next 20 years. At an average peak savings

[33] 38% (residential + small commercial share of demand)* 10% (market share)* 20% (reduction) = 0.0076 or 0.76%

[34] Mary Anne Piette, et al, Findings from the 2004 Fully Automated Demand Response Tests in Large Facilities (Demand Response Research Center; Sept 7, 2005 LBNL report #58178)

per customer of 10% during price, we estimate the forecasted peak demand for Ontario could be reduced by 2%[35] of peak demand in 2025.

Table A.11 and Table A.12 summarize the achievable potential level for demand response in Ontario.

Table A.11 – Demand Response - Energy Savings (TWh)[36]

Scenario Case	2010	2015	2020	2025
Moderate	0.02	0.02	0.04	0.05
Aggressive	0.02	0.05	0.09	0.13

Source: OPA

Table A.12 – Demand Response - Peak Savings (MW)

Scenario Case	2010	2015	2020	2025
Moderate	175	233	449	598
Aggressive	250	547	980	1,482

Source: OPA

Fuel Switching

Within the CDM context, fuel switching is defined as the switch of an electricity-driven end-use application to another fuel carried out in a manner which reduces total energy usage. There is potential for fuel switching in all market sectors. This concept is more feasible for and amenable to some end-uses than others.

The OPA commissioned a study[37] to explore the potential of fuel switching as a CDM initiative to reduce Ontario's peak electricity demand. The study examined the fuel substitution potential in all market sectors, and performed an economic assessment of a suite of candidate options resulting in the economic potential forecast for fuel substitution. This represents the level of electricity consumption savings that would occur if all candidate options that pass the Total Resource Cost (TRC) test are considered. The methodology was similar to that used for estimating the potential from energy efficiency. Table A.13 and Table A.14 provide the achievable capacity (MW) and achievable consumption (GWh) savings potential for each milestone year and sector.

Contextually, the results of the fuel substitution achievable potential scenario should be interpreted as falling somewhere in the mid range of the two CDM achievable potential scenarios investigated by MKJA for the OPA. In that study, MKJA investigated the CDM impacts of two achievable potential scenarios, referred to as "DSM Status Quo" and "DSM Aggressive". The modelled scenario for fuel substitution does comprise elements that can be construed to relate to both of the MKJA scenario concepts.

35 62% (Large Commercial and Industrial share of demand) * 33% (market share) * 10% (reduction) = 0.02 i.e., 2%

36 At the generator

37 Marbek Resource Consultants Ltd., Potential for Fuel Switching to Reduce Ontario's Peak Electricity Demand

Table A.13 – Capacity Savings (MW) Achievable Potential From Fuel Substitution

Milestone Year	Residential	Industrial (incl. Agricultural)	Commercial (incl. Institutional)	Total
2010	80	15	17	112
2015	154	33	76	263
2020	217	59	108	384
2025	271	88	147	506

Source: Marbek Resource Consultants Ltd., OPA

Table A.14 – Electricity Consumption Savings (TWh) Achievable Potential From Fuel Substitution

Milestone Year	Residential	Industrial (incl. Agricultural)	Commercial (incl. Institutional)	Total[38]
2010	3.53	0.16	0.20	3.89
2015	6.87	0.36	0.64	7.87
Summer	*0.61*	*0.12*	*0.13*	*0.86*
Off-Summer	*6.26*	*0.24*	*0.51*	*7.01*
2020	8.41	0.63	0.79	9.85
Summer	*0.77*	*0.21*	*0.19*	*1.16*
Off-Summer	*7.64*	*0.42*	*0.60*	*8.69*
2025	9.93	0.96	0.97	11.86
Summer	*0.90*	*0.32*	*0.25*	*1.46*
Off-Summer	*9.03*	*0.64*	*0.72*	*10.40*

Source: MarbekResource Consultants Ltd., OPA

Self-generation/Cogeneration

Self- generation and cogeneration could play an important role in meeting the conservation and demand management goals for 2025. Self-generation is where a customer installs generating equipment, such as solar photovoltaic cells, a windmill, fuel cell, micro turbine or other technology for meeting part or all of their electricity needs. In addition, some customers who have a need for both electricity and heat can take advantage of cogeneration, also referred to as combined heat and power, where the waste heat produced by a generator produces both sources of energy: electricity and heat. By producing both electrical and thermal energy at the same time, cogeneration technology produces more usable energy from a single fuel source. The cogeneration potential has been estimated using the CIMS model.

[38] The MW savings attributable to fuel switching are based on summer peak (coincident with annual system peak). The GWh savings are attributable to annual energy consumption - it should be noted that a majority of these savings occur in the off-summer period. The OPA has conducted further analysis to parse the annual GWh savings number into a summer component and an off-summer component. The main reason for the large off-summer savings potential can be attributed to the fuel substitution potential in space heating end-uses in the residential and commercial sectors. The only end-uses with a larger savings potential during summer when compared to the off-summer period are pool heaters in the residential sector, and space cooling in the commercial sector.

There is a growing policy momentum around the world to encourage customers to install onsite systems such as solar and in some cases micro turbines to provide all or a portion of small customers electricity needs. Ontario has also taken the lead and on June 13, 2006, the Minister of Energy issued a directive to enunciate two specific goals related to self-generation over the next 20 years. One of the goals is to install 2700 MW of renewable resources from large commercial generators by 2010. The other goal is for CDM to include small scale (10 MW or less) customer based generation, including small scale natural gas fired cogeneration and tri-generation and generation encouraged by the net metering regulation.

The directive requires that any "customer-based" generation projects that are used to displace customer load, and are less than 10 MW, would be counted towards meeting the CDM target. Such generation would be encouraged by net metering.

While the current net metering requirement allows customers with loads of less than 500 kW to have net meters, in reality the actual size of self generation that would meet the CDM target is likely to be in the 100 kW range for small users. It is difficult to estimate exactly how much generation from solar, wind and bioenergy projects would meet the requirements outlined above. Our assessment is that solar and wind technologies are most likely to be developed at levels below 100 kW by residential customers. Due to economies of scale, 10 MW or lower capacity level will fall under the standard offer program and be developed by generation developers, industrial and commercial customers for their own use as well as for sale to the grid. The projects in the 100 kW to 10 MW categories are included in the supply side resources of the IPSP. We define this potential displacement of load from these resources assuming both from business as usual conditions (no new programs) for the moderate case and incentive programs to promote these on-site generation projects in the aggressive case.

Table A.15 provides an estimate of overall potential for the renewable resources. In part this estimate was based on an internal study that examined municipal, agricultural and forestry bioenergy and wind potential. In the case of solar the estimate is based on a presentation made by the Canadian Solar Industries Association (CanSIA) during supply mix. CanSIA indicated that photovoltaic participation would be by homeowners and not through central power generation. CanSIA view was that given a subsidy of 42 c/kWH about 15,000 residential systems in Ontario would be installed by 2010. In our view, the significant capital expense of installing a 1 kW system in the range of $10,000 to $14,000 will act as a constraint on the development of larger than 1-2kW systems in residential market. For our forecast we assumed each residential home installs 2 kW systems and same subsidy and the penetration rate of 15000 homes every 5 years continues until 2025. This will result in self-generation from solar of 30 MW every five years.

Table A.15 – Total Renewable Potential (MW)

Technology	2010	2015	2020	2025
Bioenergy	230	485	1,050	1,050
Fuel Cell	0	10	150	500
Wind	500	2,875	3,614	3,614
Solar[39]	30	60	90	120

Source: OPA

Table A.16 shows the breakdown of the above potential into the customer based self-generation definition. These aggressive estimates assume programs encouraged by the net metering regulation offer for renewable technologies, such as bioenergy, solar, wind and fuel cell.

Our estimates of the potential to develop municipal, agricultural and forestry bioenergy were presented in Table A.15. In the case of the aggressive scenario we assume that agricultural waste will contribute 70 percent of the total estimate and forestry and municipal waste will each contribute 10 percent to self-generation. We assume that the low case scenario takes 50 percent of the savings.

For solar or photovoltaic (PV) generation, there appears to be limited development of PV systems in the 200 kW to 1 MW range in Ontario. For these reasons, we project that 70 percent of total potential capacity from PV will be in the 2 kW range and in residential customer market.

From these total estimates we believe that 70 percent of the agricultural bioenergy total of 100 MW will come from small farms that seek to self generate with anaerobic digestors. On the other hand, we believe the vast majority of bioenergy generation from municipal and forestry waste generation in the short term will come from large customers with capacities exceeding 100 kW and sold to the grid. Thus we assume 95 percent of the total potential is for customers greater than 100 kW who will sell energy to the grid, and the remainder is for small customers who self generate.

For wind, the OPA believes that the highest priority and lowest cost projects are likely to be in the 10 MW and above category because of significant economies of scale for most wind machines. We are not aware of any commercially available products on a small scale (<100 kW) that are cost effective at current generation prices. Thus, we have estimated that 90 percent of the near term potential wind will be from wholesale generators and 10 percent from self generation.

For fuel cells, the *Supply Mix Advice Report* concluded there was a reasonable probability that no additional fuel cell capacity would be developed by 2010 and we have no additional information to change this estimate at this time.

39 Solar potential based on Canadian Solar Industries Association Supply Mix presentation to the OPA.

Table A.16 – Self-generation - Renewable CDM Potential (MW)

	2010	2015	2020	2025
Moderate	24	34	59	74
Aggressive	122	147	413	769

Source: MJKA, OPA

Table A.17

Table A.17 – Self generation - Renewable Energy Potential (TWh)

	2010	2015	2020	2025
Moderate	0.24	0.58	0.60	0.75
Aggressive	1.21	2.50	4.20	7.78

Source: OPA

Cogeneration – Small-scale electricity and heat production

Cogeneration increases relative to the reference case, resulting in an electricity energy savings of 1.5 TWh/year by 2025. Sixty-five percent of this energy savings occurs in the industrial sector and is concentrated in the pulp and paper and other manufacturing sub-sectors.

At the present time, high natural gas prices are making cogeneration less economic because they are reducing the "spark spread", i.e., the cost differential between natural gas and electricity. However, the simulation of the achievable potential includes policies that favourably influence the economics of cogeneration – in particular, marginal cost pricing for electricity increases the differential between gas prices and electricity prices – which are critical to cogeneration development.

We present estimates of achievable potential for cogeneration resources that were derived for Ontario from the National Study described in the section on energy efficiency. Table A.18 presents the energy savings estimate range while Table A.19 gives the capacity range for peak savings or MW production capacity. The National Study used data from the existing Canadian cogeneration database to understand the factors that drive customers to invest in cogeneration and then subsequently estimated the fraction of those customers with demands lower than 1 MW likely to invest in cogeneration.[40] We present the National Study results below from the status quo, or business-as-usual case, and aggressive scenarios described earlier.

Table A.18 – Cogeneration Energy Contribution Potential (TWh)

	2010	2015	2020	2025
Scenario 1 Status Quo (Low)	0.12	0.17	0.21	0.24
Scenario 2 Aggressive (High)	0.19	0.58	0.98	1.40

Source: OPA

[40] Canadian Industrial Energy End Use Data and Analysis Centre, Canadian Cogeneration Database Update 2004 (prepared for Natural Resources Canada May 2004).

Table A.19 – Cogeneration CDM Contribution Potential (MW)

	2010	2015	2020	2025
Scenario 1 Status Quo (Low)	20	29	36	41
Scenario 2 Aggressive (High)	32	96	161	231

Source: MJKA, OPA

Solar panels, windmills, bioenergy, fuel cells and micro turbines all offer promising technologies for production of electricity in residential and commercial applications and can contribute to future conservation and demand management targets.

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Appendix B: CDM Cost/Benefit Assessment

Introduction

The following sections describe:

- the avoided costs underlying the determination of the economic potential for CDM
- the OPA's current estimates of the value (avoided cost) of the CDM resource plan as a whole and for the individual CDM categories, including the methodology used, and the values which will be used going forward as part of the design and assessment of individual CDM programs
- the OPA's planning estimates for the cost of the CDM categories
- the OPA's estimates of the net benefit (TRC) of the CDM categories.

The appendix concludes with a summary of findings.

Potential Assessment

As described in the main body of the paper, our estimates of the potential CDM resource are based on work done by Mark Jaccard and Associates (MKJA) for energy efficiency and co-generation and Marbek Consultants Ltd. for fuel switching. Both MKJA and Marbek used the TRC test as a screen on the range of possible technology improvements across various end uses. For their estimates of avoided costs, both MKJA and Marbek used the estimates of incremental avoided costs published by the OEB in their September 2005 "Total Resource Cost Guide".[41]

OEB Avoided Costs

Through the 1980s until the publication of the 1984 Demand Supply Plan, Ontario Hydro regularly calculated avoided costs. The methodology used at that time is described by Shalaby[42] and in the Demand Supply Plan report. The methodology used was essentially the development of system incremental cost tables[43] based on system energy production simulations and, on the capacity side, using a representative mix of generation. Environmental externalities were not included.

The Incremental cost tables show, for each year of interest, the average cost of meeting an increment of demand (1 kW) in different periods of the year. The simplest case would be to divide the year into off peak and peak hours. The avoided cost calculation for any one year would look as shown in the Table B.1 below, with the total avoided cost, in that year, being the sum of three components shown in row 3.

[41] http://www.oeb.gov.on.ca/documents/cdm_trcguide_141005.pdf

[42] Amir Shalaby, *Avoided Costs: Ontario Hydro's Experience* IEEE transactions on Power Systems, Vol 4, No. 1, February 1989.

[43] Tables of incremental power and energy costs are produced to allow avoided cost calculations to be divorced from the need to run major computer simulations. These tables generalize the results from detailed simulations. From these tables, the avoided costs of any option can be determined from knowledge of certain basic parameters, such as the option's load reduction at time of the system peak and the distribution of its energy savings through the year. Due to non linearities in the incremental cost vs. demand curves, such tables are only considered accurate for small changes in demand.

Table B.1 – Example of avoided cost calculation from incremental costs

Year X	Row #	Off-peak energy	On-peak energy	Reduction in peak demand
Incremental costs	1	Average cost of 1 kWh of incremental energy in off-peak period	Average cost of 1 kWh incremental energy in-peak period	Cost of meeting 1 kW of new peak demand
Measure savings	2	KWh saved in off-peak hours	kWh saved in on-peak hours	kW reduction in demand at time of system peak
Avoided Cost	3	Row 1 x Row 2	Row 1 x Row 2	Row 1 x Row 2

Source: OPA

After Ontario Hydro was split into its successor companies, no new estimates were published until February 2005, when the OEB requested Hydro One to provide estimates of incremental costs that could be used by Hydro One and other LDCs to estimate the value of savings from their CDM programs. Hydro One in turn contracted with Navigant Consulting Ltd., whose estimates have been incorporated in the OEB's Total Resource Cost Guide.

Navigant used a detailed simulation model (PROSYM) to calculate these incremental energy cost tables based on estimated market-clearing prices in the IESO-administered electricity spot market. For their presentation of the incremental energy costs, they divided the hours by season and time of use. The periods and hours used are shown in Table B.2 and Table B.3

Table B.2 – Seasonal Periods

Season	Months Included
Winter	December – March
Summer	June – September
Shoulder	April, May, October, November

Source: IESO, OPA

Table B.3 – Peak versus Off-Peak Hours

	Winter	Summer	Shoulder
Peak	0700-1100 and 1700-2200 weekdays	1100-1700 weekdays	None
Mid-Peak	1100-1700 and 2000-2200 weekdays	700-1100 and 1700-2200 weekdays	0700-2200 weekdays
Off-Peak	0000-0700 and 2200-2400 weekdays; all hours weekends and holidays	0000-0700 and 2200-2400 weekdays; all hours weekends and holidays	0000-0700 and 2200-2400 weekdays; all hours weekends and holidays

Note: Numbers are the daily hours for the various periods.
Source: IESO, OPA

Their calculation of generation capacity costs was consistent with the terms in the contracts used by the Ministry of Energy in its 2,500 MW RFP. They calculated capacity costs equal to the top-up payments in those contracts required to cover the generator's fixed operating and capital costs and give a satisfactory return on the capital invested. Navigant calculated the capacity charges using a 13 percent (nominal) discount rate.

Navigant's estimate of the transmission capacity avoided costs was calculated by determining which parts of Hydro One's transmission plan could be avoided by CDM investments. They also estimated environmental externality cost savings of reduced energy production based on damage cost estimates, but these were not included in the OEB's avoided cost numbers.

The OEB values are quoted at the wholesale metering point. The incremental transmission losses used were those found in the Navigant study and are shown in Table B.4.

Table B.4 – Transmission Losses by Season and Time-of-Use Period

	Winter			Summer			Shoulder	
	Peak	Mid-Peak	Off-Peak	Peak	Mid-Peak	Off-Peak	Mid-Peak	Off-Peak
Marginal Losses (%)	9.9	7.4	5.7	5.6	5.7	5.3	12.3	4.6

Source: Navigant Consulting Inc.

Values used in the Assessment of Economic Potential

MKJA used the OEB avoided cost data as an input to the CIMS model for assessing the economic potential for energy efficiency and cogeneration in Ontario. They, in effect, performed a TRC test on each technology to determine if the technology's potential could be included. Marbek performed similar calculations for fuel switching technologies. From the OEB-adopted incremental costs, MKJA calculated a five-year rolling average annual cost per kWh, the cost of meeting an extra continuous1 KW of load 24/7/52, which included the incremental energy cost and generation, transmission, and distribution capacity costs. They also compared the values obtained with values they had used for the national study[44] and those used by ICF in a report on CDM potential[45] and found them to be in the same range. Their values and the comparators are shown in Table B.5.

[44] Marbek Resource Consultants Ltd. and M.K.Jaccard and Associates, Inc. *Demand Side Management Potential in Canada: Energy Efficiency Study*. Submitted to Canadian Gas Association, May 2006. Available at: http://www.canelect.ca/en/News2006/EE-DSM_Final%20Report.pdf

[45] http://www.powerauthority.on.ca/Storage/15/1106_Part_4.2_ICF_Report_on_CDM_Potential_with_appendices.pdf
Note the avoided costs used in this report were also based on the Navigant/OEB incremental cost tables.

Table B.5 – Comparison of Avoided Costs

$2006 cents/kWh				
Year	**Navigant**	**ICF**	**National Study**	**Values used by MKJA**
2005			10.31	9.35
2006	8.32	8.55	"	"
2007	8.02	8.32	"	"
2008	10.83	8.48	"	"
2009	10.23	8.27	"	"
2010	9.89	8.20	10.63	10.04
2011	9.91	8.29	"	"
2012	9.97	8.59	"	"
2013	10.13	8.87	"	"
2014	10.32	9.07	"	"
2015	10.36	9.44	10.44	10.36
2016	10.37	9.62	"	"
2017	10.37	9.79	"	"
2018	10.36	9.95	"	"
2019	10.34	10.09	"	"
2020	10.30	10.22	10.24	10.42
2021	10.38	10.47	"	"
2022	10.44	10.70	"	"
2023	10.47	10.90	"	"
2024	10.49	11.09	"	"
2025	10.48	11.24	10.01	10.48

Source: MKJA, ICF, Navigant Consulting Inc.

MKJA valued the annual energy saving of the proposed technologies at the rolling five year average unit avoided cost.

The values used are all around 10 cents/kWh.

OPA Estimates of Avoided Costs

OPA Methodology

Reductions in demand allow savings in the cost of energy production from the generating plants and also, if persistent, allow reductions in expenditures on building new generation, transmission and distribution facilities.

The simplest approach to calculating the value of these savings is the *proxy plant* method. In this approach an assumption is made about the fuel and technology of the next generating plant. If a combined cycle gas-fired plant is assumed, then its costs (levellized unit energy costs, or LUEC) are assumed to be the avoided costs. A variation of this method would be to assume a *composite proxy plant* that is part combined cycle and part simple cycle gas-fired plant. For an interconnected jurisdiction, such as Ontario, the *cost of purchase* from an interconnected utility can also be taken as a measure of avoided costs. However these methods do not appropriately reflect the integrated nature of Ontario's operating and planning processes.

The most rigorous method of calculating the value of reductions in demand is to compare two detailed power system generation and transmission expansion plans. One is a base case, without the CDM measure, and the other with the CDM, which has less demand. The difference in cost between the two system expansion plans is cost avoided by having less demand.

Like any other analytical methods or modeling, this method relies on data and assumptions, such as economic and financial projections, load forecasts, fuel prices, capital cost estimates and the timing of various expansion decisions. This method also has significant limitations. If the increment of load reduction is less than a year's load growth or less than the smallest size generation unit that are being considered, it is not possible to make meaningful changes to the generation and transmission system expansion plan with resolution of less than a year.

For ease of use and to allow avoided cost calculations to be carried out by many CDM program designers without the need to run complex computer simulations, tables of incremental power and energy costs were produced.

The OPA has used both the full simulation and the incremental cost approaches.

- The CDM proposed plan as a whole was assessed using the full simulation approach, comparing the preliminary plan with the plan modified to compensate for the absence of CDM.
- The CDM categories were assessed using tables of incremental costs of power and energy.

System simulations for the program as a whole were performed using the PROSYM model, assuming an interconnected system, with exports/imports. These simulations were done at five-year intervals, and other years' values were determined by interpolation or extrapolation. The simulations were based on the preliminary IPSP, modified to reflect the latest load forecast and the expectations for CDM described in this report.

The tables of incremental costs were developed in the following manner. To determine incremental cost of energy, simulations of the preliminary plan, as described in the preceding paragraph, were used. As a simplifying assumption, the incremental capacity was taken to a simple cycle gas turbine plant. In line with the social cost perspective being used by the OPA for developing the IPSP, a four percent (real) discount rate was used to annualize the capital costs. Values were also calculated using a 10% discount rate.

All avoided cost values were increased by 10 percent, reflecting the uncertainty in generation cost estimates. This difference is representative of the premium between median and most likely values found in the supply mix studies.

The OPA calculated incremental costs and avoided costs assuming the load reductions included the effect of transmission and distribution losses. To allow comparison with the OEB incremental costs, which are at the wholesale point of supply, the calculated values were increased using Navigant's estimates of transmission marginal losses shown above in Table B.4.

Avoided Cost of Total CDM Resource

This study was described in brief in Discussion Paper # 7. As described in the above methodology section, the avoided cost of the aggregate CDM program was calculated by comparing the operating and capital cost of two generation and transmission expansion plans, one with and one without the proposed CDM initiatives. The plan without the CDM initiatives required extra generation resources to reliably meet the demand. The extra generation resources required were:

- A firm import of 2000 MW starting in 2015, costing $4500/kW[46]
- Simple cycle natural gas capacity - 600 MW in 2015 and an additional 900 MW in 2027 - costing $750/kW
- Two extra nuclear units of 700 MW each, coming in service in 2016 and 2017 respectively, costing $3,400/kW.
- Advancing 500 MW of Pumped Generating Station (PGS) from 2020 to 2016 and adding another 1000 MW of PGS in 2016, each costing $1500/kW

Additional reliance on the interconnections in the short term has also been assumed and costed at the price on imports from the interconnected market.

In these studies no explicit increases in transmission have been identified. The generic transmission and distribution costs found by Navigant ($5.4 and $ 6.7/kWyr) were applied instead.

Calculations were done using the PROSYM model for the years 2010, 2015, 2020 and 2025 and the results interpolated to obtain intermediate results. The 10 percent uncertainty factor described above has been added to these values.

This study has been repeated with the revised load forecast and CDM estimates, a slightly modified preliminary plan, a modified set of extra resources, giving very similar results.

The results are presented for the two discount rates, 4% and 10%. The results are shown in Table B.6.

Table B.6 – Value (Avoided Cost) of Total Proposed CDM Program

Discount rate	4%	10%
Present Value of Cost difference between plans ($B)	11.5	7

Source: OPA

Discussion Paper #7 reported a value of $10 Billion for the 4% discount rate case. The increase is almost entirely due to the larger amount of energy savings from fuel switching that is now assumed.

As a sensitivity study, it was assumed that that the energy savings achieved in the study period would persist for another 10 years on average. In this case the avoided cost increases from $11.5 to $16 billion.

Thus, to be economic, the present value total expenditure on the CDM program, including all incremental capital and operating costs, including end of life replacement incremental costs; all program delivery and administration costs, including measurement and validation; and costs of

46 The capital costs quoted include interest during construction

market transformation, culture change[47] etc. in the next 20 years must be less than $11 billion – $16 billion depending on the persistence of the savings. In addition there is uncertainty in the estimates of avoided costs of at least plus or minus 10%.

Avoided cost of CDM categories

Incremental costs of energy and capacity

As mentioned earlier the value of CDM categories was estimated using incremental cost approach. This was done using the revised load forecast and estimates of CDM, and a slightly modified preliminary plan. The results are essentially the same as calculated for the preliminary plan and presented in discussion paper #7 The table is repeated here. Table B.7 shows OPA's estimate of the cost of incremental energy and generation, and the incremental transmission and distribution capacity costs used. [48]

[47] The decision to include of transformation, culture change costs could depend on the view taken on the level of ongoing subsidization of supply side options.

[48] The seasons and time of use periods are identical with the Navigant/OEB definition with the exception that we did not differentiate between work days and holidays.

Table B.7 – Incremental Costs by Season and Time-of-Use Period

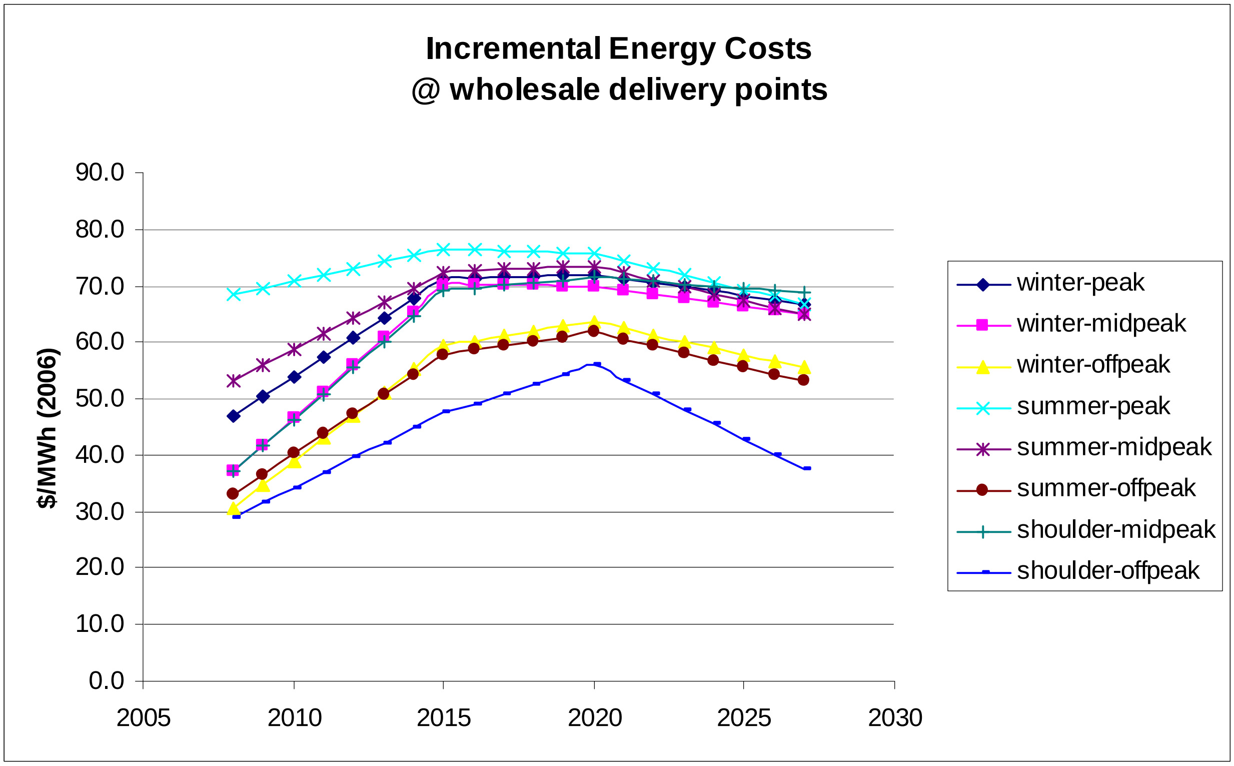
Year	Ontario Seasonal Average Avoided Energy Cost (CAD$2006/MWh)								Avoided Capacity Costs (CAD$2006/kw-yr)			
	Winter			Summer			Shoulder		Generation		Transm.	Distr.
	On Peak	Mid-Peak	Off-Peak	On Peak	Mid-Peak	Off-Peak	Mid-Peak	Off Peak				
Hours /Period	602	688	1614	522	783	1623	1305	1623	n/a	n/a	n/a	n/a
									4% real	10% real		
2008	46.9	37.0	30.7	68.4	53.0	33.1	37.1	28.9	83.9	118.9	5.35	0.00
2009	50.4	41.8	34.8	69.6	55.8	36.6	41.7	31.5	83.9	118.9	5.35	6.66
2010	53.9	46.5	38.9	70.8	58.6	40.1	46.3	34.2	83.9	118.9	5.35	6.66
2011	57.3	51.3	43.0	71.9	61.4	43.7	50.8	36.8	83.9	118.9	5.35	6.66
2012	60.8	56.0	47.1	73.1	64.1	47.2	55.4	39.5	83.9	118.9	5.35	6.66
2013	64.3	60.7	51.2	74.3	66.9	50.7	60.0	42.1	83.9	118.9	5.35	6.66
2014	67.7	65.5	55.3	75.4	69.7	54.3	64.6	44.8	83.9	118.9	5.35	6.66
2015	71.2	70.2	59.4	76.6	72.4	57.8	69.2	47.4	83.9	118.9	5.35	6.66
2016	71.4	70.2	60.2	76.4	72.6	58.6	69.6	49.1	83.9	118.9	5.35	6.66
2017	71.5	70.1	61.1	76.2	72.8	59.4	70.1	50.8	83.9	118.9	5.35	6.66
2018	71.7	70.1	61.9	76.0	73.0	60.2	70.6	52.6	83.9	118.9	5.35	6.66
2019	71.8	70.0	62.7	75.8	73.2	61.0	71.0	54.3	83.9	118.9	5.35	6.66
2020	72.0	69.9	63.6	75.6	73.4	61.8	71.5	56.0	83.9	118.9	5.35	6.66
2021	71.2	69.2	62.4	74.4	72.2	60.5	71.1	53.3	83.9	118.9	5.34	6.66
2022	70.5	68.5	61.3	73.1	71.0	59.3	70.7	50.7	83.9	118.9	5.35	6.66
2023	69.7	67.9	60.1	71.8	69.7	58.0	70.3	48.0	83.9	118.9	5.35	6.66
2024	69.0	67.2	59.0	70.5	68.5	56.8	70.0	45.4	83.9	118.9	5.35	6.66
2025	68.3	66.5	57.8	69.2	67.3	55.5	69.6	42.7	83.9	118.9	5.35	6.66
2026	67.5	65.8	56.7	67.9	66.1	54.3	69.2	40.1	83.9	118.9	5.30	6.70
2027	66.8	65.1	55.5	66.7	64.8	53.0	68.8	37.4	83.9	118.9	5.30	6.70

Source: OPA

The avoided transmission and distribution costs are the Navigant/OEB estimates, which the OPA considers appropriate.

The energy costs, including the cost of losses, are shown graphically in Figure B.10.

Figure B.10 – Incremental Energy Costs by Season and Time-of-Use Period



Source: OPA

It will be seen that, as expected, incremental costs are significantly lower in the off-peak periods, and that they are highest in the summer peak hours. There is a significant increase in the early years of the plan, driven by the replacement of the coal fired plant and the nuclear refurbishment schedule. In the longer term, costs start to decline as the proportion of low marginal cost resources, namely nuclear and renewable generation, increases. In the long term the summer and winter peak values converge indicating that the CDM efforts have effectively reduced the summer peak relative to the winter peak.

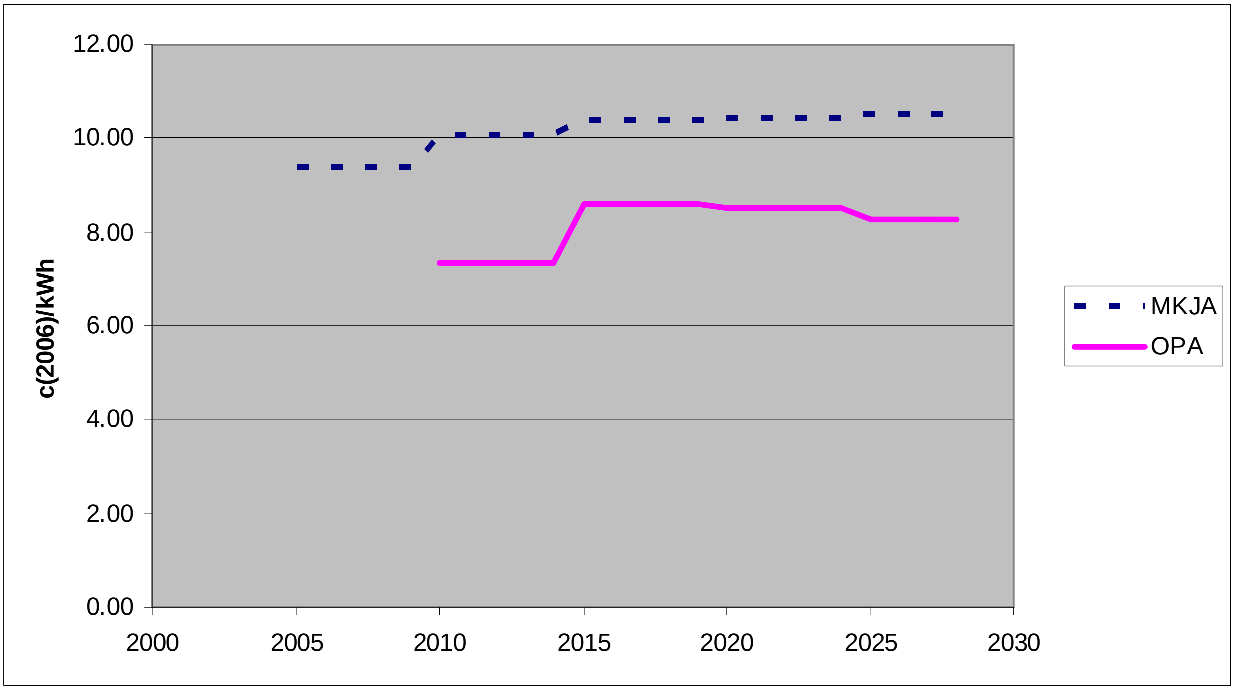
To determine if these values are significantly different from the OEB values, we have repeated MKJA's calculation of average incremental costs using the OPA's incremental cost values. The results are shown in Table B.8. The comparison is shown graphically in Figure B.11. It will be seen that the OPA derived average incremental costs are about 20 percent lower than those used by MKJA and Marbek in their determination of the economic potential of energy efficiency, cogeneration and fuel switching technologies. While the reduction from the OEB numbers has not been analyzed in detail, it is believed it is due to the fact that the preliminary plan has much less gas-fired plant going forward than was assumed by Navigant in its analysis.

Table B.8 – MKJA Calculation of Avoided Costs using OPA Incremental Costs

	Comparison of avoided costs $2006 c/kWh					
Year	**Navigant**	**ICF**	**National Study**	**Values used by MKJA**	**OPA Based Avoided Costs**	**OPA as % of MKJA**
2005			10.31	9.35		
2006		8.55	"	"		
2007		8.32	"	"		
2008	7.31	8.48	"	"		
2009	7.82	8.27	"	"		
2010	8.25	8.20	10.63	10.04	7.34	73
2011	8.68	8.29	"	"	"	
2012	9.11	8.59	"	"	"	
2013	9.54	8.87	"	"	"	
2014	9.97	9.07	"	"	"	
2015	10.40	9.44	10.44	10.36	8.59	83
2016	10.44	9.62	"	"	"	
2017	10.49	9.79	"	"	"	
2018	10.54	9.95	"	"	"	
2019	10.59	10.09	"	"	"	
2020	10.64	10.22	10.24	10.42	8.50	82
2021	10.59	10.47	"	"	"	
2022	10.54	10.70	"	"	"	
2023	10.50	10.90	"	"	"	
2024	10.45	11.09	"	"	"	
2025	10.41	11.24	10.01	10.48	8.27	79

Source: OPA, ICF, Navigant Consulting Inc.

Figure B.11 – Comparison of MKJA and OPA Avoided Costs



Source: OPA

Avoided Cost of Individual CDM Categories

The value (avoided cost) of the individual program categories was found using the incremental cost approach. The 8760 hourly energy savings profile of the program categories were "bucketed" into the season and time of use periods, and the incremental costs were applied to the resulting energy savings. The savings at the time of system peak demand were used to determine the capacity savings. Table B.9 below shows, for a sample year (2010), the energy savings and peak demand use. The profiles do not change significantly through the study period, though of course the amount of energy savings and the peak demand reductions increase year by year.

Table B.9 – Program Category energy savings by season and TOU period

Year 2010	Energy Savings (%)									
	Winter			Summer			Shoulder			
	On Peak	Mid-Peak	Off-Peak	On Peak	Mid-Peak	Off-Peak	Mid-Peak	Off-Peak	Total GWh	Peak Savings MW
CDM Category										
Conservation	0	0	0	56	37	7	0	0	9	60
Energy Efficiency	9	9	18	7	10	16	15	16	4,185	777
Demand Management[49]	0	0	0	93	0	7	0	0	15	163
Fuel Switching[50]				18	30	53			277	81
SG/CHP	7	9	19	6	8	16	16	19	732	86
Total	8	8	17	8	11	18	14	15	5,218	1,166

Source: OPA

The total value (avoided cost) over the study period is presented above in Table B.10.

Table B.10 – Avoided cost by Program category

CDM Category	Total	Conservation	Energy Efficiency	DM	Fuel Switching	SG/CHP
MW saved by 2027	5,400	240	3,100	1,450	300	300
Period Avoided Cost from incremental cost	11,700	160	8,400	1,000	640	1,500

Source: OPA

It can be seen that the bulk of the value, like the bulk of the MW savings, is expected to come from the energy efficiency programs. Demand Management saves little energy and hence is expected to makes less savings relative to energy efficiency. The value or Avoided Cost presented above is the gross value; the cost of the programs has to be subtracted from this to understand their cost effectiveness. The costs of the programs is addressed in the following section, which is followed in turn by an examination of the net or Total Resource cost benefit of the individual CDM program categories and the aggregate program.

49 Large users only.

50 For costing purposes, only the summer impactive fuel switching has been modeled.

Program Costs

Introduction

This section documents the processes and data used to estimate, for long term planning purposes, three specific types of CDM costs (incremental measure costs, incentive costs and administration costs) associated with the deployment of the five different categories of CDM programs over the forecasting period 2007-2025.

- Incremental costs can, depending on the nature of the decision being made, be either the cost difference between competing technologies, or, in the case where it is all or nothing, the full cost of the technology.
- Incentive costs are cash contributions to customers to offset the incremental costs.
- Program costs are the costs of program design, delivery and administration, including EM&V costs.

Estimating these costs requires developing a relationship between the energy savings level achieved and the average incremental cost of measures procured to achieve these savings. Data was taken from the MKJA study[51] and data bases of historical program and incremental measure costs and energy savings relationships in California and New York[52] After this relationship was established we used the multiplier relationships developed in the MKJA study which estimated administrative costs at 25 percent of total program costs, and incentive costs as a case dependant fraction of the incremental costs of measures. All costs were estimated in constant $2005 dollars.

It should be noted some electricity customers will be making the decision to adopt the technology, regardless. In the load forecast these are reflected as naturally occurring conservation. A certain proportion of these customers, on seeing the programs, will take the incentives anyway. These customers are called “free riders”. They have the effect of increasing the total amount of incentive payments that are made, and also cost of program administration.

To determine the societal benefit of the proposed program, the sum of the incremental measure cost and the administration cost is required. Incentives are viewed as a transfer payment, not a resource cost. This sum is referred to below as the social cost of the program. To determine the impact of the cost of electricity service, it is the sum of the administration cost and the cost of incentives that is important as these are the costs that have to be recovered in the electricity rates. This sum is referred to as the delivery cost

To summarize, incremental costs for energy efficiency programs are a function of the measures assumed to be installed and the resulting forecasts in energy and peak savings. Program incentive and administration costs are derived directly as a function of incremental costs using

[51] M.K. Jaccard and Associates, Modeling and Scenario Documentation: (OPA: Final report prepared for OPA September 6, 2006)

[52] M. Messenger, Proposed Energy Savings Goals for Energy Efficiency Programs in California: (Sacramento, CA; September 2003 CEC publication # 400-03-022)

multipliers or observed relationships between incremental costs and program costs from the studies referenced.

These forecasts of future costs are inherently uncertain. The largest uncertainty in the resulting costs relates to the expected changes in the incremental costs of measures over the 20 year forecast period. These were not explicitly modeled in the data sources used here. The next largest uncertainty relates to the probability that emerging technologies will be commercialized and thus affect the costs of substitutes over this time period. Finally we have assumed that the mix of measures will be dominated by lighting and HVAC end uses when in fact the next generation of building controls and communication infrastructures could dramatically change that mix and the funding to support them over time.

It also has to be noted that these costs do not include any end of life replacement costs. Many of the technologies involved have lives of less than 20 years and so those installed in the early years of the study period will need replacing within the study period. The cost of this has not been included.

Finally it should be noted that these are long term planning estimates, they will need refinement before they can be used to set short term budgets.

The methods and sources used to estimate costs for each CDM category are discussed below.

Conservation Program

The CDM savings forecast for 2007-2025 assumes that conservation program activity is focused on providing the public with different ways of reducing or shifting their demand from peak hours to off peak hours. The level of peak savings is assumed to ramp up from 0.07 percent of total peak demand in 2008 (assumes conservation actions taken by 50,000 households) to 0.1 percent of peak demand in 2025 (assumes actions taken by 650,000 households or 10 percent of province). Costs include cost of developing and delivering media campaign but no incremental costs or investments are assumed. The program activity is assumed to be confined to media campaigns designed to educate and motivate public to use less energy during peak periods.

Program costs were estimated by examining total costs currently spent by OPA and LDCs on conservation program messages in 2006. This cost was estimated at $5 million total between both organizations in 2006. We projected this amount into the future in proportion to the expected increase in peak savings. Data Sources include OPA budget and utility program budgets and savings estimates for 2005.

Energy Efficiency

Incremental Costs

The relationship between incremental energy savings and the incremental costs required to produce these energy savings calculated by MKJA, was used to estimate the same costs for the proposed savings scenario. This relationship was first calculated for 2010, then updated every 5 years, to reflect the new mix of measures installed in each five year forecast period. The final multipliers used to convert savings levels to the incremental costs were calculated from the energy savings using the weighted average of incremental cost ratios estimated for the residential, commercial and industrial sectors.

This MKJA estimate of incremental costs was then cross checked against the actual relationship between reported energy savings and program and incremental costs in California over the last 15 years. The relationship of first year program costs and kWh saved based on the recorded California experience for Pacific Gas & Electric (PG&E) and Southern California Edison (SCE) was then converted to the same incremental cost/kWh saved multipliers used in our analysis and discussed below.

Table B.11 below shows the comparison of the relationships between program dollars, incentive dollars and incremental costs for 2004 programs as reported by PG&E and SCE and the relationships we infer from the MKJA study. This suggests that the MKJA numbers we are using are within the bounds of the relationships set by the two California utilities.

Table B.11 – Comparison of Program Cost Data and Assumptions

2004 Program Data	PG&E	SCE	OPA[53]
Program cost[54] $/kWh	0.26	0.17	0.22
Incentive cost $/kWh	0.22	0.14	0.19
Incremental cost $/kWh	0.31	0.21	0.27

Source: OPA

Incentive costs

Incentive costs are estimated as a function of incremental costs in most studies of energy efficiency potential[55,56,57]. Incentives range from 20 percent to 100 percent of incremental measure costs in most programs, and are usually associated with a measure penetration curve that assumes more take up as incentive are increased. MKJA assumes that incentive costs will range from 10 to 25 percent of residential incremental measure cost, 15 to 30 percent of commercial measure costs and 25 percent of the incremental cost of industrial measures. California's experience is that incentive costs up to 70 percent of incremental measure costs need to be paid in the residential sector, 100 percent in the commercial sector and up to 50 percent of industrial measure costs. The OPA, to be conservative, used a ratio of 70 percent (incentive cost to incremental cost).

53 Derived from MKJA data.

54 Sum of administration and incentive costs

55 Mike Rufo and Fred Coito, California's Secret Energy Surplus: The Potential For Energy Efficiency http://www.ef.org/energyseries_secret.cfm (The Energy Foundation, San Francisco, Ca. October 2002).

56 M.K.Jacard, ibid.

57 Fred Barnes Itron, California Energy Efficiency Potential Study: Summary Study (May 24, 2006) available at www.calmac.org

Administrative costs

MKJA uses the assumption that administrative costs will be equivalent to 25 percent of total program costs or 30 percent of estimated incremental costs. We use the MKJA assumption throughout the forecast period. California's experience is that program administration costs have ranged from 8 to 19 percent of total portfolio costs so MKJA is a conservative, (e.g., upwardly biased) cost estimate.

Energy Efficiency Total Program costs

These are the sum of program Incentive costs + administrative costs. Estimated total energy efficiency program costs range from a low of $72 million per year in 2013 to a high of $252 million in 2010 (see chart of expenditures and spreadsheet for details).

Demand Management

For the small customer sector, the costs are primarily those of the installation of smart meters. Since the government has already decided on this program, there are no new costs. For the industrial and large commercial sector, program costs were estimated using data from other demand response programs and OPA's initial program set. From this data, the program is estimated to pay incentives to reduce the capital cost of control equipment and energy payments for the actual load relief delivered on critical peak days, equivalent to $120/MWh. The capital cost incentives for automating load reduction responses are estimated to start at $150/kW for the first three years and then ramp down to $100/kW for the next three years and finally settle at $50/kW by 2020. We also estimated program administration costs at 20 percent of the capital cost for any given year.

Fuel switching

Marbek and Associates estimated the incremental capital and fuel costs associated with a large scale program to reduce electricity usage via fuel switching[58]. We prorated the costs provided by Marbek based on the energy savings expected in the proposed portfolio. It was assumed that the incentives were 70% of the incremental capital costs. Consistent with the avoided cost calculation, the costs have only been included for the summer impactive fuel switching.

Self Generation/Cogeneration

Incentives being offered by OPA are estimated to be $15,800 per MW-month based on information obtained from ongoing solicitation. A 20 percent overhead factor was covered to deal with program costs. The incremental costs are assumed to be equal to the incentives currently being offered.

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[58] Marbek and Associates, Potential for Fuel Switching to reduce Ontario's Peak Electricity Demand, (Prepared for OPA, October 2006, costs from exhibits 1 and 2)

Self Generation/Renewables

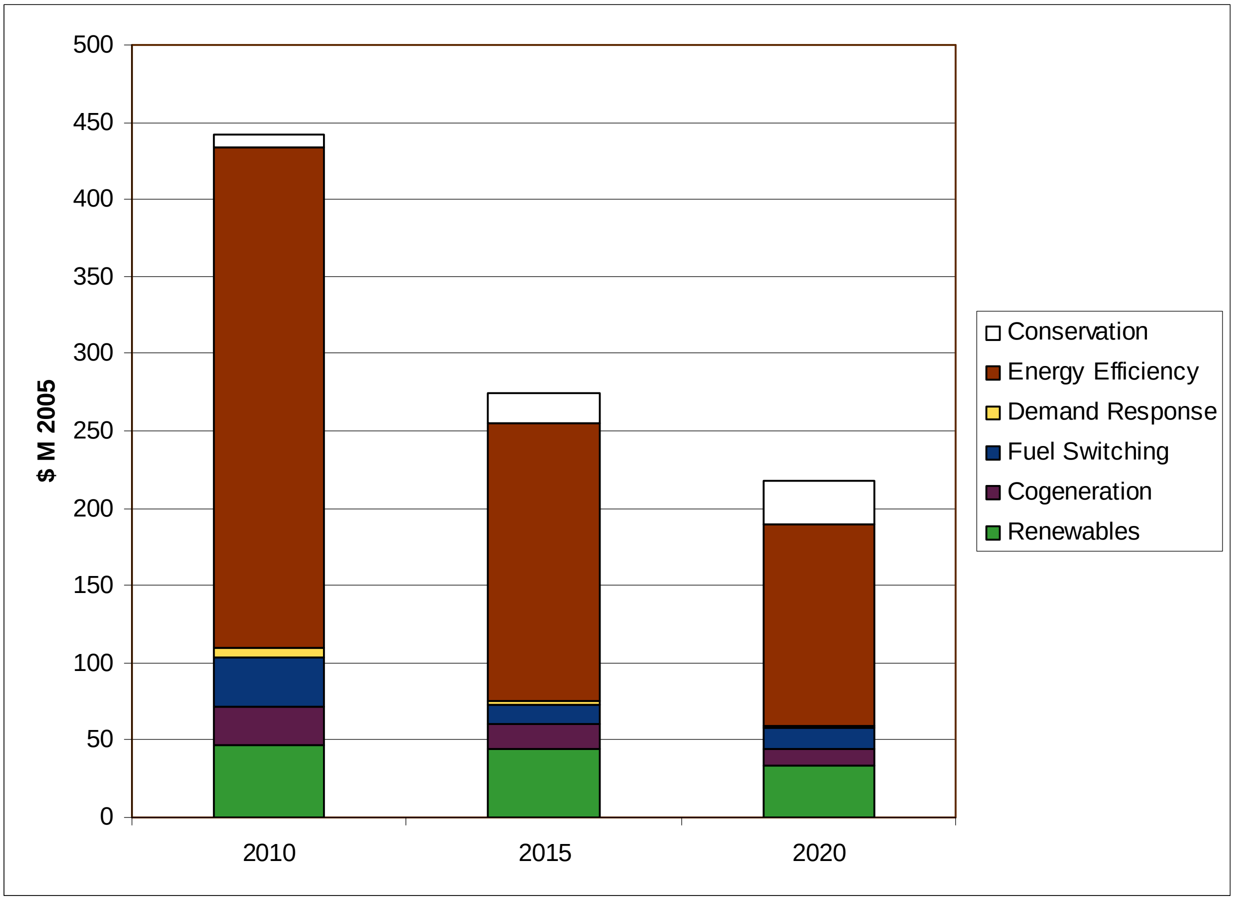
At the time of estimation most of the self generation was expected to be from solar panels, so these were used as the basis for estimating costs. The cost of solar panels has been taken to be $4/W. Since the customer's decision is "panel or no panels", the full capital cost has been taken as the incremental cost. The program costs are assumed to have two components, an up front capital cost incentive and energy payments. The capital incentive was assumed to be 50 percent of the present value of paying 40 cents/kWh for renewable output of photovoltaic facilities over 15 years (42 cents/kWh is the current subsidy for these systems). Energy payments equivalent to 20 cents/kWh are paid for the remaining useful life and treated as a program cost. The Capital subsidy is removed in the year 2015 but program still continues to pay 20 cents/kWh in real 2005 dollars for new systems installed after this date. It is recognized that not all the generation will be from solar panels. It is thought that this estimate of costs is on the high side of what will occur.

Summary of Cost Work

Table B.12 shows the results for the near term, 2007 to 2016, while Table B.13 shows the costs in latter years. These tables provide estimates of program costs by category and a summary of all program delivery costs (administration and incentive costs) in the second to last row and all societal costs in the final row.

Figure B.12 shows how the annual CDM program type costs are projected to change over time. The general trend reflects OPA's strategy to intervene as a strong and systemic presence in the early years of this period and then gradually withdraw as the culture of conservation takes hold and private firms actively sell conservation goods and services.

Figure B.12 – Projected Program Delivery Costs by CDM Category



Source:

Total program delivery costs start at $ 312 million for the 12 months from mid-2007 to mid-2008, rise to $445 million in 2010 and then decrease to a level that ranges from $275 to $350 million per year from 2011 to 2017.The large increase in early years is due to the need to rapidly increase savings levels from 30 MW in 2006 to 1,350 MW in three years. Estimates post-2017 are considered much more uncertain given the difficulties of projecting technology and measure costs more than 10 years out. It should be mentioned that these are long-term planning estimates. They will need refinement before they can be used to set short-term budgets.

Total societal costs including all program administration costs and the incremental costs paid by customers for more energy efficient measures or self generation facilities are shown in the last table row. These costs range from $330 million to $660 million over the period of interest with an average cost over the 20 year period of $430 million per year.

Table B.12 – CDM Costs (2005 $M)- 2008-2016

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Conservation									
Administration	3	5	9	12	14	16	18	20	22
Energy Efficiency									
Incremental Costs	289	379	449	287	261	216	216	214	201
Incentive Costs	202	227	270	201	183	151	151	150	141
Admin Costs	40	45	54	40	37	30	30	30	28
Demand Management									
Incremental costs	9	13	9	7	6	3	3	3	3
Incentives	6	9	6	5	4	2	2	2	2
Admin costs	1	1	1	1	1	0	0	0	0
Fuel Switching									
Incremental capital costs	13	19	23	14	12	11	11	9	10
Replacement fuel costs	0	1	2	2	2	3	3	3	4
Admin Costs	5	7	8	5	4	4	4	3	3
Incentives	13	19	23	14	12	11	11	9	10
SG/CHP									
Incentives	39	63	67	59	57	54	55	57	60
Incremental Costs	62	94	94	75	68	60	58	58	58
Admin	2	4	4	3	3	3	3	2	2
Sum of Delivery Costs	312	383	445	343	318	275	279	280	274
Sum of Societal Costs	426	572	658	448	408	345	345	342	329

Source: OPA

Table B.13 – CDM Costs (2005 $ M) - 2017-2025

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Conservation									
Administration	25	26	28	29	30	28	27	26	24
Energy Efficiency									
Incremental Costs	176	176	163	155	139	123	91	51	24
Incentive Costs	123	123	114	108	97	86	64	36	17
Admin Costs	25	25	23	22	19	17	13	7	3
Demand Management									
Incremental costs (DR)	3	3	2	2	2	1	1	0	0
Incentives	2	2	2	1	1	1	1	0	0
Admin costs	0	0	0	0	0	0	0	0	0
Fuel Switching									
Incremental capital costs	9	9	10	9	5	4	2	1	0
Replacement fuel costs	4	4	4	5	5	5	5	5	5
Admin Costs	3	3	3	3	2	1	1	1	0
Incentives	9	9	10	9	5	4	2	1	0
SG/CHP									
Incentives	39	41	42	43	43	42	42	39	39
Incremental Costs	45	44	41	37	32	26	19	7	8
Admin	2	2	2	2	2	1	1	0	0
Sum of Delivery Costs	235	238	230	226	207	189	158	118	93
Sum of Societal Costs	290	290	274	262	231	202	154	94	60

Source: OPA

These costs are all based on the proposed CDM portfolio.

Total Resource Cost Effectiveness

To determine the cost effectiveness of the CDM programs separately and in aggregate requires estimates of the costs of delivering the programs. These estimates of the program costs have also been made. Program costs are made up of program administration, program incentives, and the incremental cost of buying and operating the new technology. For the Total Resource Cost comparison, the only costs that are included are the program administration costs and the incremental technology costs, incentives being a transfer not a resource cost. It should be remembered that these cost estimates are very difficult to make, and are very preliminary. Table B.14 compares the present value of the Avoided Costs with the present value of the CDM Resource cost, and shows the net Total Resource Cost benefit of the individual programs and the program as a whole. This analysis is done using a 4 percent discount rate.

Table B.14 – CDM Costs and Benefits (Present Value in $M) (2008-2027)

CDM category	Row	Total	Conservation	Energy Efficiency	DM	Fuel Switching (SO)	SG
MW saved by 2027	1	5,400	240	3,100	1,450	300	300
Period Avoided Cost (PV in $M)	3	11,700	160	8,400	1,000	640	1,500
Period Resource Cost (PV in $M)	5	4,500	250	3,200	50	300	700
Net Benefit (PV in $M)	(3)-(5)	7,000	-100	5,000	1,000	350	800

Source: OPA

Table B.14 shows that the gross benefits (the period avoided costs) are some $11.5 billion, while the gross resource costs (including all program related and customer costs) are estimated to be $4.5 billion dollars. This means that the CDM program is expected to result in net benefits of roughly $7 billion, plus or minus $2 billion, given our assessment of the uncertainty in both the costs and benefit estimates. Using a 10 % discount rate the benefit is in the range of $2 to 4 billion.

As can be seen, the Energy Efficiency program is the largest contributor to both the expectations and the societal benefit. In Demand Management, the small customer (TOU) component has not been allocated any costs as the primary cost, improved metering, has already been committed. This, in part, explains Demand Management's high benefit.

The conservation appears not to have a net benefit, but it must be remembered that to a large extent it is facilitating other programs, through developing a culture of conservation.

The total present value resource benefit of the expected aggregate CDM program thus appears, including allowance for the uncertainty in the avoided costs and the program costs, to be in the order of $5 to $9 billion.

Summary of Findings

The avoided costs resulting from the preliminary plan are about 20% lower than those used by MKJA and Marbek in determining the economic potential of energy efficiency, cogeneration and fuel switching. To some extent the MW and MWh potentials used in the study may be over estimates of what is economic for the province to pursue. However this is offset to some extent by the higher electricity prices that they have used.

The net present value of pursuing the expected amounts of CDM appears to in the order of $5 to $9 Billion.

Energy Efficiency is the major contributor to the net benefit of the aggregate CDM program.

Demand management appears to have the highest benefit relative to the costs involved. However a large part of those costs, the cost of smart metering, have not been included as they have already been either spent or are committed to be spent.

The conservation appears not to have a net benefit, but it must be remembered that to a large extent it is facilitating other programs, through developing a culture of conservation.

Appendix C: Energy and Peak Savings By End Use and Sector (Aggressive Scenario)

The energy efficiency savings for the proposed CDM portfolio fall within the range bounded by the aggressive scenario and the status quo scenario. Table C.1, Table C.2, Table C.3, Table C.4, Table C.5, Table C.6 and Table C.7 show the MKJA estimates of energy-efficiency savings by end use and by sector for the aggressive scenario.

Table C.1 – Total Energy-Efficiency Savings (GWh): Aggressive Scenario

	2005	2010	2015	2020	2025
Total Energy Efficiency Savings	0	7,150	15,516	20,619	25,821

Source: MKJA/Navigant/OPA

Table C.2 – Residential Energy-Efficiency Savings – GWh

	2005	2010	2015	2020	2025
Residential Total	**0**	**3,260**	**6,467**	**7,170**	**8,557**
Space Heating (single detached)	0	159	312	555	839
Space Heating (apartment/attached)*	0	-372	-522	-642	-667
Room AC	0	12	25	26	28
Central AC	0	142	252	320	343
Furnace Fan	0	149	243	345	433
Lighting	0	2,405	3,652	3,296	3,686
Refrigeration	0	73	147	213	237
Freezer	0	57	113	165	217
Water Heating	0	142	1,081	1,189	1,258
Dish Washer	0	36	74	101	114
Clothes Washer / Dryer	0	82	202	321	424
Minor Appliances	0	374	890	1,281	1,647

Notes: * The savings for apartment/attached space heating are negative due to an increase multi-residential dwellings that use this heating source.
Source: MKJA/Navigant/OPA

Table C.3 – Residential Energy-Efficiency Savings -

	2005	2010	2015	2020	2025
Residential Total	**0**	**526**	**991**	**1,256**	**1,452**
Space Heating (single detached)*	0	0	0	0	0
Space Heating (apartment/attached)*	0	0	0	0	0
Room AC	0	20	41	44	47
Central AC	0	223	398	509	547
Furnace Fan	0	118	193	274	345
Lighting	0	87	132	120	134
Refrigeration	0	9	19	27	30
Freezer	0	8	16	24	31
Water Heating	0	9	68	75	79
Dishwasher	0	3	6	9	10
Clothes Washer / Dryer	0	10	25	39	52
Minor Appliances	0	39	94	136	175

Notes: * Residential space heating is not in use at the time of Ontario's system peak, which occurs during the summer.
Source: MKJA/Navigant/OPA

Table C.4 – Commercial Energy-Efficiency Savings – GWh

	2005	2010	2015	2020	2025
Commercial Total	**0**	**3,446**	**8,120**	**11,995**	**14,938**
Space Heating	0	326	745	1,728	2,800
Space Cooling	0	269	871	1,332	1,776
Ventilation	0	582	1,172	2,081	2,982
Lighting	0	2,137	5,032	6,394	7,135
Electric Auxiliary	0	78	174	292	191
Water Heating	0	54	125	167	54

Source: MKJA/Navigant/OPA

Table C.5 – Commercial Energy-Efficiency Savings – MW

	2005	2010	2015	2020	2025
Commercial Total	**0**	**737**	**2,038**	**3,001**	**3,814**
Space Heating*	0	-5	-10	-15	-21
Space Cooling	0	297	1,024	1,626	2,231
Ventilation	0	74	149	265	383
Lighting	0	352	832	1,056	1,185
Electric Auxiliary	0	12	27	45	29
Water Heating	0	7	17	22	7

Notes: * Values for commercial space heating should not be attributed significance as they are due to data volatility.
Source: MKJA/Navigant/OPA

Table C.6 – Industrial Energy-Efficiency Savings – GWh

	2005	2010	2015	2020	2025
Industrial Total	**0**	**443**	**929**	**1,454**	**2,327**
Process Machine Drive	0	220	548	848	1,310
Electrochemical Processes	0	6	16	29	67
Steam Production	0	0	0	0	0

Heat Production	0	168	259	383	641
HVAC	0	38	76	137	210
Lighting	0	12	30	57	99

Source: MKJA/Navigant/OPA

Table C.7 – Industrial Energy-Efficiency Savings - MW

	2005	2010	2015	2020	2025
Industrial Total	**0**	**64**	**132**	**207**	**333**
Process Machine Drive	0	28	70	109	170
Electrochemical Processes	0	1	2	4	8
Steam Production	0	0	0	0	0
Heat Production	0	25	39	57	95
HVAC	0	8	17	30	46
Lighting	0	2	4	8	14

Source: MKJA/Navigant/OPA

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Appendix D: Current and On-going CDM Policy and Program Development

The results of studies completed by MKJA show there is significant energy-efficiency potential in Ontario. The vast majority of these estimated savings are realizable through the introduction of codes and standards. The Conservation Bureau has advocated for increased energy-efficiency requirements in codes and standards, worked to identify regulatory barriers to CDM and increased public awareness of CDM. The journey to help the province tap this potential has been assisted by the implementation of several legislative/policy instruments, as well as CDM programs targeted towards savings in specific areas.

Legislative/Policy Instruments

Included in the major legislative/policy instruments are:

- **Building codes and labelling**: On February 24, 2006, the Ministry of Municipal Affairs and Housing announced that it would be conducting public consultations[59] on proposed changes to the Building Code that would increase the energy efficiency of buildings. The proposed amendments will introduce higher requirements than the 1997 Building Code and previous codes and have been grouped in five key areas:
    - increasing energy-efficiency requirements for houses.
    - increasing energy-efficiency requirements for commercial buildings and large scale residential buildings.
    - introducing energy-efficiency labelling of new houses to identify the level of energy efficiency achieved. (There were previously no requirements for labelling of houses in the Code).
    - enabling the use of “green” technologies.

The ministry held province-wide consultations on the proposed energy-efficiency changes from February to April 2006. A technical advisory committee reviewed the input from these consultations and made recommendations which are closely reflected in the Building Code changes. Some of the approved energy efficiency changes take effect at the start of 2007; others are scheduled to take effect in 2009 and 2012.

The higher energy efficiency requirements balance energy efficiency with affordability. For example, the extra cost to build a house or non-residential/larger residential building in 2007 will be recovered respectively in three and four years through reduced energy bills because of higher efficiency standards that are respectively about 21 percent and 17 percent more energy efficient[60].

- **Energy-efficiency product standards:** There have been recent amendments to Ontario and federal regulations related to energy efficiency.

[59] Ontario Building Code: Energy Efficiency Consultation (http://www.toronto.ca/legdocs/2006/agendas/committees/ren/ren060606/it005bii.pdf)
[60] Energy Efficiency in the 2006 Building Code (http://www.mah.gov.on.ca/userfiles/HTML/nts_1_27483_1.html)

  - Ontario Regulation 38/06[61] related to air conditioners, heat pumps and thermostats was filed on February 15, 2006.
  - Energy-efficiency requirements for air conditioners, heat pumps, beverage vending machines, commercial refrigeration, residential refrigerating appliances, lighted exit signs and fluorescent lamp ballasts were updated by Amendment 9 to the federal energy-efficiency regulations on November 15, 2006.
- **Energy Conservation Leadership Act - Bill 21 2006**[62]: This legislation establishes a public sector accountability framework by requiring public agencies to prepare an annual energy conservation plan, which must include the following information:
  - an itemized description of the public agency's significant energy-consuming technologies and operations
  - a summary of annual energy usage for each of the public agency's technologies and operations
  - a description of current and proposed activities and measures to conserve the energy used by the public agency's technologies and in the public agency's operations and to otherwise reduce the amount of energy used by the public agency
  - a summary of the progress and achievements in energy conservation and other reductions since the previous plan
  - such additional information as may be prescribed.

MKJA in its aggressive scenario relies heavily on codes and standards because of its belief that these mechanisms are essential for achieving cost-effective and long-term savings. They make a number of assumptions for the residential and commercial sectors that affect electricity use, such as the continued support by the government of the above mentioned types of policy initiatives, e.g. the MKJA analysis assumes on-going improvement (i.e., progressively increasing market share) in building envelope as represented by R2000 quality homes.

Programs

The government, LDCs and the OPA have been actively involved in implementing several CDM programs for the last few years.

Government

The government has moved in several areas such as:

- powerWISE™[63] [64] - The Ministry of Energy has taken a leadership role with six of Ontario's largest LDCs working cooperatively under the name powerWISE® to deliver a multi-year, initiative designed to promote energy conservation to customers and reduce the demand for electricity in their respective service areas.

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[61] Ontario Regulation 38/06 (http://www.e-laws.gov.on.ca/DBLaws/Source/Regs/English/2006/R06038_e.htm)

[62] Bill 21 2006 (http://www.ontla.on.ca/documents/Bills/38_Parliament/session2/b021ra_e.htm)

[63] The OPA has signed a Memorandum of Understanding to acquire the powerWISE brand from Hamilton Utilities Corp. The acquisition will occur on March 29, 2007 and, going forward, all CDM programs will be promoted under this brand.

[64] powerWISE (http://www.powerwise.ca/)

- Smart Meters[65] - The government is committed to installing a smart electricity meter in 800,000 homes and small businesses by 2007 and throughout Ontario by 2010.
- Education
    - Community Conservation Initiatives (CCI)[66] - the 2006/2007 CCI program is dedicated to supporting community-based and grassroots projects, with a focus on education, outreach and action-oriented electricity conservation initiatives. This includes education and outreach programs focused on promoting small-scale "behind the meter" renewable energy. The program is supporting 24 community-based projects across Ontario.
    - Energy Saving Tips[67] - in one high-rise complex in Toronto, which is home to 800 tenants from several nationalities, the Ministry of Energy has led the design and delivery of an energy education program.
    - Community of Shelburne[68] - the Ministry of Energy supported an initiative comprising a door-to-door energy conservation education program in Shelburne.
- Building a Conservation Culture[69] - The Ministry of Energy has helped foster a conservation culture by recognizing and awarding a Certificate of Leadership to seven organizations across the province for undertaking significant conservation and energy- efficiency initiatives. (This recognition program is in addition to a similar program managed by the Conservation Bureau.)

Load Distribution Companies

LDCs have been actively pursuing CDM programs over the last two years. In 2006, LDCs played a significant role[70] in assisting the Conservation Bureau's Every Kilowatt Counts coupon program to 4.3 million electricity customers across Ontario, supporting the government's smart-metering program and initiating a number of innovative programs to help electricity customers reduce their electricity consumption.

LDCs' spending commitments relate initially to the $163 million worth of CDM programs to be initiated in a three year period commencing 2004 and ending September 30, 2007 (Third Tranche[71] funding). To enable LDCs to continue delivering CDM programs after the expiry of this pool of funds, an additional $400 million of funding over three consecutive years has been established.

65 Smart Meters (http://www.energy.gov.on.ca/index.cfm?fuseaction=electricity.smartmeters)
66 Community Conservation Initiatives (http://www.energy.gov.on.ca/index.cfm?fuseaction=conservation.community)
67 How do you spell "conservation"? (http://www.energy.gov.on.ca/index.cfm?fuseaction=conservation.leadership#brahms)
68 Community of Shelburne Reduce the Juice (http://www.powerupenergy.ca/reducethejuice/)
69 Leadership Awards (http://www.energy.gov.on.ca/index.cfm?fuseaction=conservation.leadership#brahms)
70 Electricity Distributors Association: Local Electricity Distribution Companies Prepared to Help Government meet Aggressive Conservation Targets (http://www.eda-on.ca/eda/edaweb.nsf/(W-PubsByYear)/B3A8CB1F780D92658525718C006D073C)
71 Funding of LDC Activities, http://www.conservationbureau.on.ca/Storage/14/1989_Directive_-_LDC_CDM_Programs_-_2006-07-13.pdf and Role of LDCs in CDM in 2007, http://www.conservationbureau.on.ca/Storage/13/1833_CB_CDM_Options_Paper.pdf

The OPA has been tasked by the Minister of Energy to assume responsibility for coordinating the delivery and funding of CDM programs through LDCs. The OPA has established two advisory groups to identify funding processes and core programs:

- The Program Operations Advisory Group (POAG) is to provide advice on the rules and guidelines to be established by the OPA for the administration of LDC funding for CDM for 2007 and beyond.
- The Program Design Advisory Group (PDAG) is to provide advice on the selection and design of the OPA's LDC-based programs for 2007.

Funds will be collected under the "Global Adjustment Mechanism" and will not include provisions for smart meters. LDCs would contract to deliver programs funded by an OPA-administered LDC fund on a non-competitive basis in their territory. The OPA will support the OEB in its continuing efforts to reduce barriers to CDM, including decreases in revenues due to the LDCs' CDM programs.

Ontario Power Authority

The OPA has committed[72] two programs since August 2006 and launched[73] 10 programs since October 2005 and has nine others currently in development. These programs are detailed in Table D.1 and Table D.2. Updated information on the OPA's current CDM initiatives has been provided in the Chief Energy Conservation Officer's 2006 Annual Report, including progress on achieving the 2007 target of 1,350 MW.

Table D.1 – CDM Resources (MW) - Committed Programs

Description	MW	Status
CES Loblaw Demand Response	10	Committed
York Region Demand Response	3	Committed

Source: Discussion Paper 7, Integrating the Elements

[72] Discussion Paper 7, Integrating the Elements - A Preliminary Plan, Table 2.3, http://www.powerauthority.on.ca/ipsp/Storage/32/2734_DP7_IntegratingTheElements.pdf
[73] Annual Report 2006, Chief Conservation Officer, Table 5.1, http://www.conservationbureau.on.ca/Storage/16/2123_CECOAR2006.pdf

Table D.2 – CDM Resources (MW) - Programs Launched and In Development

Sector	Description	MW	Status
Residential	Every Kilowatt Counts (spring)	8.7	Launched
	Cool Savings Rebate Program	31	Launched
	Secondary Fridge Retirement Pilot	1.6	Launched
	Aboriginal Conservation Initiative Pilot	2.3	In development
	Every Kilowatt Counts (fall)	15	Launched
	Hot Savings Rebate Program	8	Launched
Commercial, Municipalities, Universities, Schools and Hospitals	Social Housing Phase 1	10	Launched
	Low-Income Single Family	1.3	Launched
	Affordable Housing Program Phase 1	0.2	In development
	Low-Income Multiple Unit Residential Building	TBD	In development
	Colleges Secretariat	TBD	Launched
	Municipal Lighting Program	TBD	In development
	Energy Efficiency Contractors Network	TBD	Launched
Toronto	Building Owners and Managers Association	150	In development
	City of Toronto	90	In development
	Toronto Hydro	90	In development
Industrial & Agricultural	Demand Response Program	250	Launched
	Agricultural Program	2	Research underway
	Capability Building-Demand Response	125	In development
Total CDM Resources		785	

Source: Chief Energy Conservation Officer, *Annual Report 2006*, OPA

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