Ontario's

Integrated Power System Plan:

The Road Map for Ontario's Electricity Future

Preliminary

February 2007

Ontario Power Authority™

Why Ontario Needs an Electricity Plan

All Ontarians depend on electricity every day. Flipping a switch turns on lights. Twisting a dial, pressing a button or plugging into an outlet turns on appliances, air conditioners, furnaces and computers. Our businesses, schools, hospitals and manufacturing plants depend on electricity to keep operating. We have built our quality of life on its reliable and secure supply.

To make sure we can continue to count on reliable electricity service, we need to plan our power system. Ontario has not had an electricity plan for more than a decade. We need one now for several reasons. The province's population and economy continue to grow, increasing the demand for electricity. Ontario's nuclear generating units – which now provide 50 percent of our power – are nearing the end of their useful life and will need replacing over the next 15 years. In addition, the coal-fired generating plants – which now produce 20 percent of our electricity – will shut down to help improve Ontario's air quality.

The Opportunity

Ontario's electricity plan – known as the Integrated Power System Plan – is an exciting opportunity that will map out changes to how we use and make electricity. It will include using newer, cleaner and more efficient technologies and provide for a larger role for conservation and renewable energy resources.

The plan will help us to decide our electricity future by guiding the many important decisions that we must make on power usage, conservation and supply.

Load or Demand – the total electricity used by customers from the power grid

Base load – the load level that exists 70 percent of the time or more

Base load generation – a generating facility expected to operate most of the time to supply base load

Peak load – the highest load level, which exists only for short periods

Peak demand – the highest load of a year, season or day

Transmission – the transfer of large amounts of electricity over a network of wires and facilities over long distances

Distribution – the local transfer of smaller amounts of electricity to individual customers

Generation – the making of electricity from some form of energy such as water, wind, natural gas or uranium

The Integrated Power System Plan

The Ontario Power Authority (OPA) is responsible for preparing the Integrated Power System Plan. We are developing it within the following policies and guidelines set by the Ontario government. We were asked to:

- find ways to put conservation programs in place quickly
- increase the use of renewable energy such as hydroelectric, wind, solar and biomass
- plan for nuclear power to meet base load needs up to the current installed level
- keep the ability to use natural gas generation for high-demand periods
- strengthen the transmission system
- promote system efficiency
- plan to replace coal-fired generation.

A copy of the directive from the Minister of Energy that set out these policies is available on our Web site at www.powerauthority.on.ca.

The plan will cover the next 20 years through to 2027. It will outline the steps needed for a reliable electricity supply. Developing the plan involves combining many elements of the power system – including how conservation will contribute, where the electricity will come from, how it will get to everyone who needs it, what impacts it will have on the environment and how much it will cost.

The plan will do three things at once:

1. It will provide a basis for carrying out decisions to maintain and improve services in the near term,
2. It will develop options so Ontario will have good choices in the mid-term, and
3. It will explore opportunities and risks so that Ontario can take advantage of emerging possibilities in the long term.

The value of the plan is that it will outline what we need to do, now and in the future. It will be flexible – a living process that will look ahead 20 years – and will be updated every three years to adapt to changing conditions, new information and emerging technologies.

Overview of the Plan

A Focused Near Term – 2008-2010

Over the near-term period, Ontario's power supply situation will improve. Between 2008 and 2010, the plan will include:

- more conservation programs to achieve energy savings and demand reductions
- hydroelectric resource development around the province
- increased interconnection capability with Quebec
- more combined heat and power facilities
- coal phase-out plan put into action
- urgently needed natural gas generators, including those in northern York Region and around Kitchener
- transmission reinforcements in the GTA and Windsor-Essex.

In addition, we need to make decisions about what will be required in the medium term, in particular:

- whether to refurbish the nuclear units at Pickering B
- whether to buy power from other provinces under long-term contracts.

Medium Term: Develop Options – 2011-2015

In the 2011-2015 timeframe, we will be able to see how well we are progressing in conservation and adding renewable resources and then adjust the plan

accordingly. For example, good progress might mean we can phase out coal sooner.

For this period, the plan will include:

- phasing out coal-fired generation
- reinforcing north-south transmission
- developing a third supply line for Toronto
- reinforcing transmission west of Sudbury and south of Barrie
- developing wind generation for eastern Lake Superior, eastern Lake Nipigon, Manitoulin Island and the Bruce Peninsula

Some decisions for the long term that must be made in this period are related to the existing nuclear units at Bruce B and Darlington.

Longer Term: Opportunities to Explore – 2016-2027

Beyond 2016, there is a wider choice of resources. The plan will include a range of supply options from which to choose, depending on how several different factors develop. As more information becomes available, subsequent plans for this period will include how to proceed in more detail.

Key items for the 2016 to 2027 timeframe will include:

- retiring and replacing or refurbishing existing nuclear units
- developing hydroelectric sites in northern Ontario.

The following situations that may occur in the near or medium term will affect the plan during this period:

- a decision not to refurbish Pickering B
- a delay in developing new nuclear capacity
- a decision not to develop hydroelectric generation at the Moose River Basin
- greater success in conservation
- success in negotiating power imports from outside the province.

The plan will have enough flexibility to respond to these situations and still provide reliable service.

The Plan Results in Brief

The Integrated Power System Plan will map out how to achieve four key results:

- Growth in demand is limited through conservation.
- Coal is replaced in the power supply mix with renewable energy and natural gas.
- Nuclear power is restored through refurbishments and new builds.
- Transmission is reinforced for better and reliable service.

Growth in demand limited through conservation

Conservation and demand management have an important role to play in meeting our power needs. By reducing electricity use, customers can contribute to improving the environment by reducing the size of the supply system needed. Conservation is cost-effective and has many environmental advantages. In fact, in developing the plan, this is the first resource considered. Conservation is, therefore, an important part of the plan.

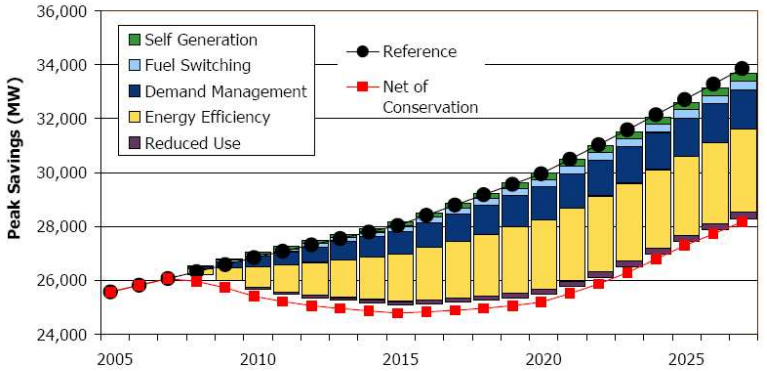
Conservation – actions taken to reduce the amount of electricity used from the grid

Demand or Load -- the total electricity used by customers from the power grid

Demand management – measures taken to manage the time that electricity is used

Recognizing how important conservation is to the province's power system plan, the Ontario government set high targets for reductions in electricity demand. Ontarians have been asked to reduce peak demand by 6,300 megawatts by 2025, which represents almost all of the expected growth in demand during this period. This is equal to about one-quarter of the electricity used on an average day in Ontario.

This graph shows how each category of conservation will help in limiting peak demand over the planning period:



It is to everyone's benefit if electricity is used wisely and these targets are met. Many people and organizations work to conserve electricity and to reduce demand – these include local utilities, governments, non-governmental organizations and others. They help raise awareness of the need to conserve and deliver programs to help customers to reduce their power use. The OPA is a leader in Ontario's effort to reduce electricity demand, and we coordinate these efforts across the province, but in the end, it is up to you.

The OPA is fulfilling its role in Ontario's conservation efforts in several ways. We support awareness activities to help consumers use energy wisely. We help groups to design and deliver conservation programs by sharing research, training and financial support. We work with customers in all sectors of the economy – residential, commercial, institutional, industrial and agricultural – to find ways they can become more energy efficient. We also provide advice to government on areas such as improvements in building codes and in energy-efficiency standards for appliances and equipment.

Our vision is that conservation will lead to long-lasting changes in how we use electricity in the province. We believe that all Ontarians will use power more wisely, and electricity savings will endure over time. We believe in Ontario having a culture of conservation.

How is electricity measured?

The "speed" at which electricity is used is measured in watts (W). A 100-watt light bulb uses 100 watts. A typical desktop computer uses 65 watts. A central air conditioner uses about 3,500 watts. A kilowatt (kW) is one thousand watts, and a megawatt (MW) is one million watts.

The "amount" of electricity used for a specific device depends on how long it is used. If you lit 10 100-watt light bulbs for one hour, you would use one kilowatt hour (kWh) of electricity. The average home uses about 1,000 kilowatt hours per month.

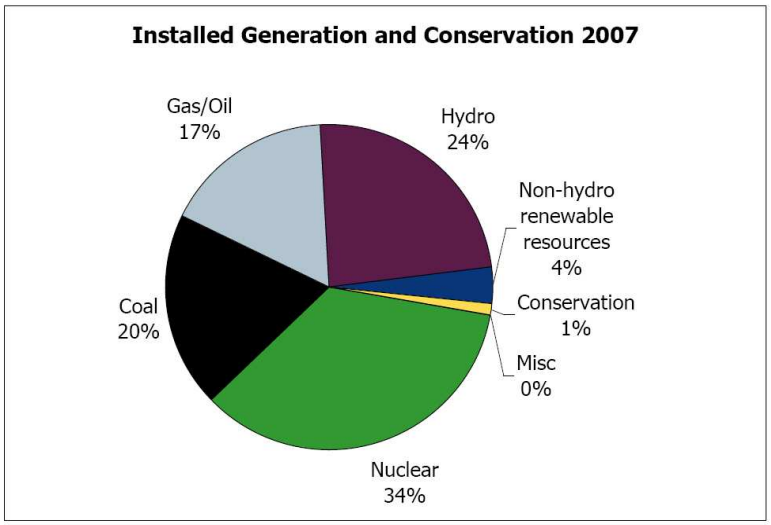
Coal replaced with renewable resources and natural gas

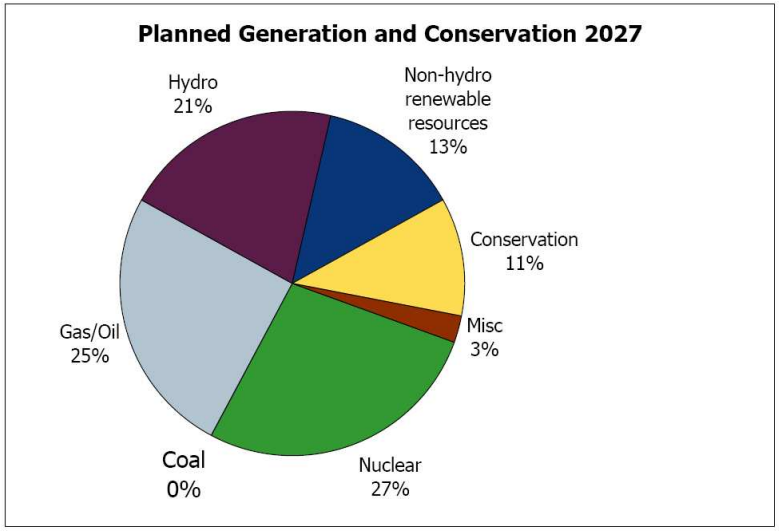
The Ontario government has decided to phase out coal-fired power generation in the province as quickly as possible. The plan will manage the phase-out of coal and ensure reliable power supplies while keeping costs and impacts on the environment to a minimum.

Coal-fired generation should be gone from the Ontario power system by 2014. We will use less coal starting in 2011 as new power sources, such as conservation, renewable resources and new natural gas generation, come online. Separately from the Integrated Power System Plan, the OPA will report to the Ontario government on the options available to reduce the emissions from coal-fired plants during the phase-out period.

Ontario's existing installed electrical generation capacity (in megawatts (MW))	
Hydroelectric Generation	7,768 MW
Nuclear Energy	14,000 MW installed 11,419 MW operating
Coal	6,434 MW
Natural Gas and Oil	5,103 MW
Wind	395 MW
Biomass	70 MW

The following charts show Ontario's current installed generating capacity and the contribution that each resource will make in 2027.





Coal will be replaced with natural gas and renewable resources such as hydroelectric, wind, solar and bioenergy. Renewable and clean energy resources will provide a greatly increased share of the electricity we use.

Bioenergy – a type of renewable energy that comes from organic matter. For example, animal manure or landfill waste can produce a gas consisting mainly of methane and carbon dioxide. When burned in an engine or a turbine, this gas drives a generator to create electricity.

Between now and the end of 2015, we expect about 700 megawatts of additional hydroelectric power to come online. There is potential to develop a further 2,200 megawatts of hydroelectric power at undeveloped sites. However, those sites should not be developed until the 2016-2025 timeframe because they are in remote areas of northern Ontario and will require upgrades to the transmission system.

Wind power will provide about 5,000 megawatts to Ontario's power system. Wind is an intermittent source of power -- when the wind is not blowing, wind-powered generation is not available. Unfortunately, this often happens on the hottest days of summer when electricity demand peaks. There is a limit to the amount of intermittent generation, such as wind, that the power system can have and still ensure reliable service. Studies suggest that, on average, we can count on about 17 percent of wind capacity during the summer peak demand.

We expect that most solar-powered electricity generation will come from photovoltaic equipment built into building structures, roof tiles and picture window modules. For example, solar power could be used in office buildings to offset some air-conditioning use and reduce peak demand on hot summer days. We expect that solar generation could provide about 40 megawatts over the planning period.

Bioenergy resources include forestry biomass (harvest and mill residues, etc.), agricultural biomass/biogas (crop and animal residues, dedicated crops), municipal solid wastes and municipal wastewater biogas. We expect about 800 megawatts from bioenergy to be added to Ontario's power system by 2027. About 300 megawatts could be possible by the end of 2015. For the most part, bioenergy generating plants are small, usually less than 10 megawatts.

We expect about 7,000 megawatts of new natural gas-fired resources to be added to Ontario's power system during the planning period. Of that amount, 4,300 megawatts are already planned. Natural gas-fired generation is flexible to operate and relatively quick and inexpensive to locate and construct. However, natural gas prices are not stable, and natural gas is a valuable, finite resource that needs to be used wisely. For all these reasons, the plan is based on a "smart gas" strategy, by which natural gas is used during high-demand periods or when renewable resources are not available. It will be installed at locations where it can improve local supply reliability and postpone some transmission upgrades. The majority of new natural gas projects will be in service by 2013.

Nuclear capability restored

Ontario has relied on nuclear power to meet some of its electricity demand for more than 40 years. The province's nuclear generating units (built during the 1970s and 1980s) will reach the end of their usable life between 2013 and 2022. The government asked the OPA to plan for nuclear power to meet base load requirements of up to 14,000 megawatts over the life of the plan, which is the current installed capacity. With the expected increase in demand, this will reduce the amount of power generated using nuclear facilities to about 40 percent of the total, down from the current level of 50 percent.

Nuclear generation is seen as necessary to meet Ontario's future electricity needs. This power source does not emit greenhouse gases, can be cost effective and has a lot of support in communities where nuclear plants are now located.

Greenhouse gases – emissions of carbon dioxide (CO_2), nitrogen oxides (NOx) and sulphur dioxide (SO_2) to the air from burning oil, gas or coal. Such gases contribute to climate change.

Refurbishing the Pickering B nuclear plant is being considered, as are options to develop new nuclear units at other existing nuclear sites. Bruce Power has applied for a license to develop new nuclear units at the Bruce site, and Ontario Power Generation has done the same for the Darlington site.

Nuclear plants can take anywhere from nine to 12 years to get approvals, build and start up. The long lead times and importance of nuclear power to our electricity future make it critical that we begin to plan for nuclear power now.

Transmission upgrades for better and reliable service

Crucial to a reliable power system will be strengthening existing transmission lines and building new facilities. Transmission is the backbone of Ontario's power system -- essential to the efficient operation of the entire system. The transmission network connects customers and their utilities to existing generation and provides access to electricity for new and growing communities.

Ontario's transmission system has not been expanded or enhanced much since the 1980s. Since then, electricity use has continued to climb. This has resulted in many bottlenecks around the province. This under-investment means that strengthening the network will be a major undertaking over the next several years. We need to invest in transmission for many reasons. It will ensure reliable service and enable generation from renewable resources to be added to the grid. Transmission will also make possible nuclear refurbishment and new development options, and give us chances to import power from sources outside the province.

Some areas of the province need modest transmission work in the near term to enable new generation, mostly from renewable resources, to be connected to the grid. Some examples are northwestern Ontario and eastern Ontario to the Greater Toronto Area (GTA).

The transmission systems in other areas – north and east of Sudbury, Algoma to Sudbury, Sudbury to Barrie, and Barrie to GTA – are adequate for today's power needs but will require new and upgraded lines to meet future requirements.

The transmission systems in two areas, namely Bruce/southwestern Ontario to GTA and transmission within the GTA, are already at or very near capacity and need immediate attention. In the Bruce/southwestern Ontario system, more transmission will be required when nuclear units at Bruce Power are restored and when new wind power comes on stream.

Because it can take several years to plan and build new transmission lines, work is already underway to address this need. The Ontario Energy Board will approve this work separately from its approval of the Integrated Power System Plan.

The GTA has a number of transmission issues, and ensuring reliability is a serious challenge. Local generation is only now being added, and, in downtown Toronto, the two major transmission corridors both have aging facilities. The plan will address what we need to do for this area.

Meeting Ontario's expectations

The OPA's approach to combining the many options available for the power system was guided by these considerations:

- Is it feasible?
- Will it be reliable?
- Is it flexible?
- How much will it cost?
- How will it impact the environment and Ontario communities?

The focus of the plan during the period from 2008 to 2015 will be on putting programs in place to achieve short-term conservation and renewable energy targets and on making sure we all have enough electricity. During this period, Ontario's coal-fired plants will be phased out. Installed natural gas-fired generation will double. The system's nuclear power will be restored to the current installed capacity level. We will see a steady increase in conservation and in the use of renewable resources. About 15,000 megawatts of conservation and new supply resources will be added to the system during this period.

We are planning new and upgraded transmission lines that will meet local demand and support near-term hydroelectric projects and the replacement of the coal-fired power plants. In addition, transmission work will begin so that later projects, including future new hydroelectric, wind and nuclear refurbishment or new development, can be added to the grid.

The longer forecasting time for the period from 2016 to 2027 means more uncertainty about electricity demand and what supply options will be available. The plan, therefore, will be less defined. During this later period, we will include a range of options to address future change and opportunities. These include greater use of renewable energy from both imports and Ontario-based renewable resources.

Between 2016 and 2022, we expect eight more nuclear units to be restored. Conservation will play an increasing role in the supply mix, and installed renewable generation will nearly double. New technologies may also come into play. Transmission upgrades during this period will connect in renewable resource developments, such as wind power and hydroelectric power from northern parts of the province, as well as new nuclear generation from the Bruce region.

The plan will be flexible enough to take advantage of opportunities as they arise, for example, new and emerging technologies, improved energy storage developments or additional imports when they can help contribute to a reliable power system.

It is important that Ontarians understand the plan. The purpose of receiving public input on the plan is so that concerns can be discussed and addressed while the plan is being developed. We want to develop a shared understanding of the issues.

Cost

We need new investments in conservation and generation. Energy from most of the new generation resources is more costly than the energy from existing generators, which were designed and built in an earlier era. In addition, important investments are required in transmission infrastructure to meet future needs.

Based on initial estimates of costs, the price of electricity could increase by up to 15 percent in 2025 in real terms (that is, in today's dollars). While per-kilowatt-hour costs will rise, Ontario electricity customers who take advantage of conservation opportunities could see no change in their bills.

Environmental performance

The plan will lay out what we must do to ensure Ontario's electricity future is reliable and flexible. It will also consider how to protect and maintain the environment. The companies that will build the needed electricity projects will complete a careful and thorough examination of impacts on the environment.

As part of the planning process, we conducted an environmental analysis, which considered greenhouse gas emissions, contaminant air emissions, radioactivity, water use, waste production and land use.

We developed a framework that can analyze data, evaluate different resource mixes or indicators, and test the sensitivity of the results to changes in assumptions.

We gained a number of insights from the analysis, including:

- Providing enough electricity supply to meet future demand growth will present a challenge to improving environmental performance.
- Changes in the supply mix, such as increased natural gas, wind and biomass and replacing coal-fired generation, will present opportunities to reduce or manage environmental effects.
- Land use will increase, mostly because of the development of renewable resources and the building of new transmission lines.

These insights were useful because they helped us, with guidance and advice from a group of technical experts, to find ways to work toward environmental sustainability.

Putting the Plan into Action

In an electricity environment that changes ever more quickly, the challenges we face in Ontario are becoming greater and greater. The next 20 years are likely to bring about more change in the way we use and produce power than we have seen in the last 50 years.

The Integrated Power System Plan will present our vision of Ontario's electricity future and the steps that we must take now to make it a reality.

For the plan to be feasible, many activities must get underway now. In developing the plan, we are careful to ensure that the various elements and resources can be put into action. These include, for example, conservation efforts, renewable resources, coal replacement, nuclear refurbishment and transmission upgrades.

The plan will be put into action once the Ontario Energy Board (OEB) approves it. The OPA will submit the plan in 2007 to the OEB, which will review it through an open process that includes public hearings. The OEB's role is to ensure that the plan complies with government policy and is cost effective.

The Integrated Power System Plan will be a road map to Ontario's electricity future. The route for the first three years of the plan (2008 to 2010) is mapped out by actions already taken. The route over subsequent years permits some change, while over the long term it only gives direction and can be adapted in response to events as they unfold.

The plan will offer guidance for the entire planning period, providing a certain level of detail and specifics while recognizing there will be many changes. A number of different groups – governments, investors, regulators, transmitters and other industry participants – will be involved in putting the plan into action. In the near term, the OPA will be responsible for acquiring many of the new conservation and supply resources. We will work closely as partners with project developers and product and service providers. In the longer term, the OPA will likely have a smaller and less direct role in putting the plan into action. Ontario's transmission companies, regulated by the OEB, will undertake the substantial transmission upgrades required.

At the same time as we file the plan with the OEB, the OPA will also file the proposed processes we will use to buy the needed generation and conservation resources that are called for in the plan.

We will use defined principles and policies to buy the demand and supply resources needed for Ontario's electricity system. The filing will include these principles and policies, as well as why, when and how these resources will be bought. We will aim to get what is needed quickly while still being able to respond to changing conditions. Our processes will be transparent, consistent, fair and enforceable.

The OPA may need to buy conservation and generation resources to meet the needs of the plan where other industry participants have not invested. Where possible, we prefer to buy these resources through competitive

bids. However, there are also times when we will buy through non-competitive bids or by offering standard contracts. We want to make the process as efficient as possible.

Expected Actions over the Planning Horizon

Near term – 2008 to 2010	- ramp up conservation programs - develop prioritized hydroelectric projects - progress connection with Quebec - complete a major portion of coal phase-out - develop gas-fired generation in York Region and Kitchener-Waterloo - reinforce transmission in GTA and Windsor-Essex

Mid-term – 2011 to 2015	- complete coal phase-out - add more renewable resources - pursue Pickering B refurbishment or alternative - decide on refurbishment of Darlington - decide on transmission upgrades for west of Sudbury, south of Barrie and Sudbury to GTA - decide on a third supply line to Toronto - decide on wind developments for eastern Lake Superior, eastern Lake Nipigon, Manitoulin Island and the Bruce Peninsula - decide on renewable energy imports from neighbouring provinces
Long term – 2016 to 2027	- refurbish or retire active nuclear units - develop hydroelectric projects in northern Ontario as transmission permits - continue to evaluate changes in demand, technology and socio/economic contexts

Looking ahead

Affordable and reliable supplies of electricity have long powered the Ontario economy. However, with our population and economy continuing to grow, the demand for power is steadily increasing -- even with our best efforts at conservation and energy efficiency.

The challenge we now face is both critical and exciting. It is critical because electricity plays such an important role in our economy and lifestyles. It is exciting because we will be reshaping our power system for a future that protects the environment.

There is a tremendous future for Ontario's power system, limited only by imagination, ingenuity, innovation and entrepreneurship. Tomorrow's electricity system will support a future of new capabilities, new technologies and new sources of economic wealth for Ontario society as a whole.

We at the OPA look forward to our role in planning and building this future. We ask for the support of all Ontarians in seeing the plan put into action.

IPSP Discussion Papers

Scope and Overview – released June 29, 2006
http://www.powerauthority.on.ca/ipsp/Storage/24/1922_OPA_-_IPSP_Scope_and_Overview.pdf

Load Forecast – released September 6, 2006
http://www.powerauthority.on.ca/ipsp/Storage/26/2132_Load_Forecast.pdf

Conservation and Demand Management – released September 22, revised December 21, 2006
http://www.powerauthority.on.ca/ipsp/Storage/33/2856_CDM_REVISED_Discussion_paper.pdf

Supply Resources – released November 9, 2006
http://www.powerauthority.on.ca/ipsp/Storage/31/2715_DP4_Supply_Resources.pdf

Transmission – released November 13, 2006
http://www.powerauthority.on.ca/ipsp/Storage/32/2716_DP5_Transmission.pdf

Sustainability – released November 10, 2006
http://www.powerauthority.on.ca/ipsp/Storage/31/2712_DP6_Sustainability.pdf

Integrating the Elements – a Preliminary Plan – released November 15, 2006
http://www.powerauthority.on.ca/ipsp/Storage/32/2734_DP7_IntegratingTheElements.pdf

Procurement Options – released January 5, 2007
http://www.powerauthority.on.ca/ipsp/Storage/34/2938_DP8_Procurement_Options.pdf

Role of the Ontario Power Authority

The Ontario Power Authority (OPA) is a non-profit, independent, public organization created to take the necessary steps to ensure that Ontario will continue to have reliable, sustainable electricity supply well into the future.

In pursuit of this mandate, the OPA's activities are focused on:

- leading and coordinating electricity conservation efforts across the province
- ensuring investment in needed new electricity supply resources occurs
- preparing a comprehensive long-term power system plan that includes conservation, supply resources and transmission
- facilitating a commercial structure for the industry that over time will transfer financial risk from Ontario's electricity ratepayers to willing investors.

The goal underpinning all of these activities is serving the best interests of Ontario's electricity consumers.

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