Kai Millyard Associates

72 Regal Road, Toronto, Ontario, M6H 2K1, 416-651-7141
Fax: 416-651-4659
kai@web.net

August 1, 2008

Ms Kirsten Walli
Board Secretary
Ontario Energy Board
27th floor
2300 Yonge Street
Toronto, ON
M4P 1E4

RE: EB-2007-0707 Prefiled evidence Report # 7 of GEC-Pembina-OSEA

Dear Ms Walli,

I enclose three copies of the prefiled evidence prepared by Mr. Tom Casten on behalf of the Green Energy Coalition, Pembina and OSEA. It has been uploaded to the Board's RESS site and sent to all the parties by email as well.

Sincerely,

(Mr.) Kai Millyard
Case Manager for the
Green Energy Coalition
Pembina Institute
Ontario Sustainable Energy Association

encls.
EC: All participants

Green Energy Coalition

David Suzuki Foundation

eneract

GREENPEACE

Sierra Club Canada

WWF

the PEMBINA institute
Sustainable Energy Solutions

OSEA

EB-2007-0707
Exhibit L
Tab 8
Schedule 7

BEFORE THE ONTARIO ENERGY BOARD

IN THE MATTER OF sections 25.30 and 25.31 of the Electricity Act, 1998;

AND IN THE MATTER OF an application by the Ontario Power Authority for review and approval of the Integrated Power System Plan and proposed procurement processes.

The Role of Recycled Energy and Combined Heat and Power (CHP) in Ontario's Electricity Future

by Thomas R. Casten
Recycled Energy Development LLC

Filed August 1 2008

prepared for:
Green Energy Coalition
(David Suzuki Foundation, Eneract, Greenpeace Canada, Sierra Club of Canada, World Wildlife Fund Canada)
Pembina Institute
Ontario Sustainable Energy Association

The Role of Recycled Energy and Combined Heat and Power (CHP) in Ontario's Electricity Future

Evidence of Thomas R. Casten

1. What are your qualifications?

I am Chairman of Recycled Energy Development LLC (RED) headquartered in Westmont, Illinois. RED raised $500 million of equity capital last year for local electric generation projects that recycle waste energy into heat and electricity and profitably reduce greenhouse gas emissions. Since 1977, I have founded and led other companies with essentially the same mission that developed/built/enhanced and operated over 200 projects with a capital cost of $2.0 billion. These local generation projects continue to operate, generating roughly 11,000 megawatts of thermal and electric energy, roughly equivalent to one third of the electric generation in the Ontario system. Those local generation projects – all located at or near the source of industrial waste energy or the commercial or industrial user of thermal energy – avoid roughly 5 million tons of carbon dioxide emissions per year versus conventional central generation and save host facilities $500 million per year. These projects invert the conventional wisdom that reducing carbon emissions will raise costs. Instead, the projects generate $100 of savings for every ton of carbon they avoid.

Other relevant experience includes founding chairman of the World Alliance for Decentralized Energy or WADE, Chairman of the International District Heating Association, author of a 1998 book about profitably 'Turning Off The Heat' and frequent speaker on the benefits of recycling wasted energy. Finally, I have provided extensive advice on modernizing energy and environmental regulations to promote clean energy at every level of government. In 2006, I co-founded the Alliance for Clean Technology in Ontario, which joins various stakeholders in an effort to profitably replace Ontario's dependence on dirty coal.

2. Please summarize your evidence.

My evidence will show that the proposed IPSP has failed to identify and promote the least cost/lowest pollution approach to providing Ontario's heat and power. In summary, the IPSP:

- Fails to identify the potential to avoid T&D expenses and line losses by the local generation of both heat and power;
- Fails to address the substantial potential to recycle presently wasted industrial energy streams into useful heat and power that use no fossil fuel, emit no pollution, and have the local generation advantages noted above;

- Stacks the analytical deck in favor of the lowest return on capital resources - central nuclear generation - by applying a 4% 'social discount' rate to all choices, even though actual capital costs will range from 12% to 15%. By artificially ignoring the true cost of capital, the report favors the highest capital cost and riskiest option.
- Stacks the deck in favor of the 'no fossil fuel' nuclear approach by ignoring the 'no fossil fuel' recycled energy approach and then biasing analysis against 'low fossil fuel' combined heat and power (CHP); the IPSP assumes that local generation will perform significantly worse in efficiency and load factor than the least efficient local generation plant my companies have ever built;
- Bases recommendations on the wrong metric, costs of power at the generation plant, instead of the right metric, the delivered costs of power. This choice of the wrong metric automatically understates the value of local generation by:
    a. Ignoring the value of avoided T&D capital investment when generation is local;
    b. Ignoring the peak line losses associated with remote central generation that force the system to generate 18% to 20% more power at peak than the system demand;
    c. Ignoring the difference in redundancy requirements between a system of a few very large generating stations (18% to 21% redundancy of generation and transmission) and the redundancy required for a system of multiple smaller generators closer to load (3 to 5% to achieve comparable reliability);
- Refuses to test the market for clean energy by limiting long-term contracts to plants with generation capacity of less than 10 MW (and so far not offering contracts to any local generation).

Central planning is at best a poor substitute for the richness of competitive markets in finding optimal solutions and adapting rapidly to change. To make the IPSP even remotely optimal, the planning must be done without any bias, and the key assumptions must be tested wherever feasible. OPA has clearly applied the biases noted above to produce a plan that diverts resources from high-yield local generation to low-yield central generation and supporting T&D, locking in inefficiency, protecting old existing central generation, and building a false case for nuclear investment. Neither has OPA tested assumptions. Specifically, OPA has not made any attempt to identify the market for CHP, has ignored the waste energy recycling potential, and has offered no programs that would test either market.

These biases and flaws undermine OPA's conclusions. The IPSP is an elaborate manipulation of assumptions to justify the preconceived preference to invest $26.5 billion in nuclear power. It is a travesty of misinformation designed to justify a demonstrably sub-optimal approach to supplying Ontario's heat and power needs.

Finally, I will show that even using OPA's deeply flawed assumptions local generation provides lower cost delivered power than any central option.

3. You stated that OPA has failed to test their assumptions about CHP and ignored recycled energy. Could you be more specific about these claims?

In 2006, Premier McGuinty called for the elimination of coal-fired generation in Ontario, and a group of diverse stakeholders (The Alliance for Clean Technology or ACT) responded, providing a unique message to the Premier that the province could profitably eliminate coal-fired generation by giving clean energy a chance. That group includes environmental NGOs, Enbridge, heat and power developers, industrial hosts, district heating companies, and regulatory attorneys. ACT sent proposals to the Premier and Minister of Energy suggesting a Clean Energy Standard Offer Program (CESOP) that would offer long-term contracts to clean energy plants priced at 80% to 85% of the honest cost of delivering electricity from the best new central generation plants. To be eligible, CESOP plants would be required to achieve 60% overall fossil efficiency or better (nearly double the grid's average delivered efficiency). ACT proposed that OPA limit the initial offer to 1500 megawatts or four years and then adjust the program based on market responses.

OPA responded with a draft CESOP that used a somewhat different methodology to calculate prices and ignored some of the costs of new central generation, but that was largely consistent with ACT's general thrust, but for one critical change. OPA proposed to limit the CESOP offer to rather small plants – limited to 10 megawatts or less of capacity. OPA issued final recommendations and sought public comment in June of 2007.

ACT submitted extensive comments. We pointed out that development of combined heat and power or of recycled energy is a long, complex and expensive process and would not be done in significant magnitude in anticipation of displacing only the subsidized retail prices of Ontario power. ACT estimated a potential for clean local power of 11,400 megawatts, of which 3,000 MW would be produced without added fossil fuel by recycling wasted energy from industrial activities such as steel mills, chemical plants, refineries, carbon black production, gas compressor stations and steam pressure drop. However, these opportunities involve many small projects with complex relationships between power plant developer/owner and industrial/commercial host and will not be developed without some certainty of a fair contract for power. ACT members, including premier independent power developers with vast experience, strongly refuted OPA's claim that energy project developers would respond to a 'Request for Proposal' process for projects that exceed 10 MW, the CESOP limit. The RFP process does not, in most cases, provide the certainty needed to justify 12 to 36 months of expensive project development prior to obtaining a power purchase OPA seems to think that a single offer by a monopsony purchaser represents a market, and would thus draw out the best options, even though this approach has failed in Ontario. Instead, this approach presents would-be developers with a 'crap shoot' option – invest resources to develop projects hoping that the monopsony will ask for the power and create a truly competitive process. ACT explained that local project development takes one to three years, often involves significant development costs, and is too risky to undertake without the certainty of a power sale at prices higher than the average subsidized retail electricity price for large industrial hosts (but still lower than OPA's alternative resource choice).

ACT held private meetings with OPA officials and were essentially told that the government had to exercise 'price discovery' as a top priority to ensure that no developer earned above-market returns. OPA's expressed fear was that the CESOP program, even though offering to pay significantly less than the cost of the best possible new central power, might allow developers to earn above market profits. Their solution was to stick with the failed RFP processes to achieve 'price discovery.' The predictable end result is the IPSP that totally relies on new central generation at higher prices than would result from a CESOP offer.

ACT, with strong help from World Wildlife Canada, then organized a conference in Toronto of developers, industrial hosts, environmentalists, and government and OPA officials. Speaker after speaker gave similar messages, saying that a CESOP that was limited to small, 10-megawatt plants would not induce strong local generation development efforts, that the RFP process had not been able to induce CHP capacity anywhere in the world, and that Ontario had an opportunity to become a center of excellence for energy efficiency if only OPA would lead.

Nearly one year later, OPA finally released a slightly revised CESOP draft, which is still not in effect. They ignored ACT's consistent advice and kept the 10 MW capacity limit. They also ignored ACT's advice to limit the CESOP offer to plants achieving at least 60% fossil efficiency.

OPA is now promising another draft CESOP for public comment in mid August (at the time of preparation of this evidence) that has responded to some issues, but still keeps the 10 MW capacity limit. The draft proposal seems to pay CHP plants on the basis of a 62% efficiency (5500 Btu/kWh) but does not limit eligibility to ACT's recommended 60% minimal fossil efficiency.

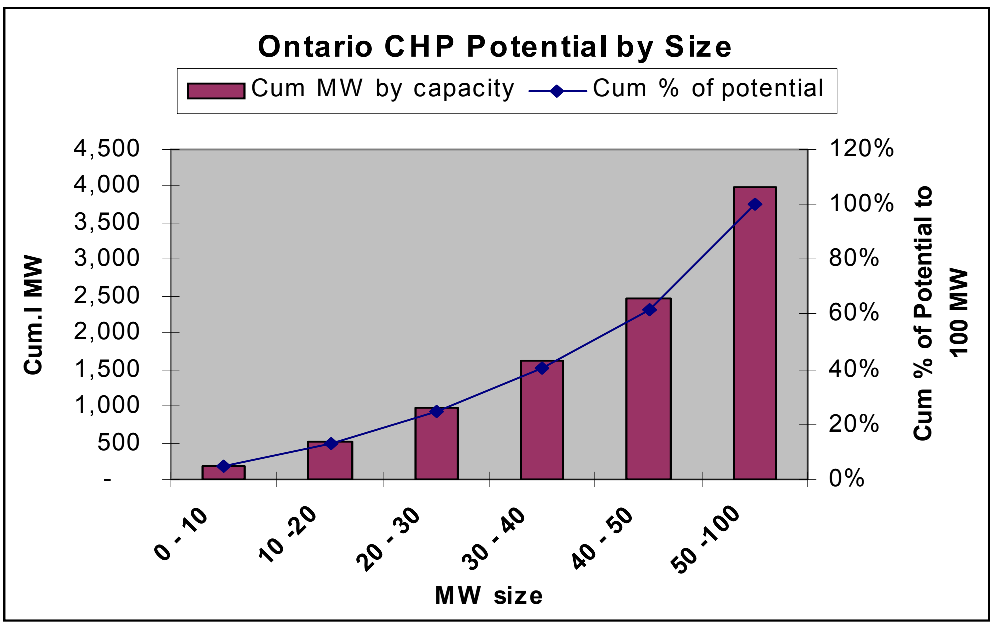
OPA offers this IPSP favoring new central power after analyzing a straw man concept of CHP that is less efficient than the proposed payments from the CESOP draft. OPA admits in I-31-111 that they assume the CHP plants will average 54% efficiency and operate at a 58% capacity factor. This is a lower efficiency and lower load factor than ACT specified as the minimum CESOP plant, and is less than typical CHP efficiency and load factor, and makes CHP look less economic than the reality. The IPSP ignores the potential for waste energy recycling that uses no fossil fuel.

Conclusion: OPA failed to test their assumptions about CHP and ignored recycled energy.

4. In its planning process OPA has assumed a further 586 MW of CHP will be installed. What are your estimates of Ontario's CHP potential and what size are the projects?

ACT estimated total CHP potential at 11,400 megawatts, of which 4.0 gigawatts would have been from plants with less than 100 megawatts of capacity. This is 19 times the capacity from local clean energy capacity that OPA assumed possible. Put another way, **the IPSP calls for utilizing only 5.1% of the CHP and recycled energy potential that ACT identified**.

The following chart shows the probable distribution of the smaller plants.



5. What other data would support ACT's claims that Ontario has potential for 11.4 gigawatts of local generation from energy recycling and CHP?

In the early 1980's, Denmark embarked on a program to promote local generation and now produces 54% of the nation's power by recycling otherwise wasted energy. A comparable 54% of Ontario's generation would be 16.2 gigawatts. ACT's 11.4-gigawatts estimate is a lower percentage of total loads than has been achieved in Denmark, Finland, or the Netherlands.

6. You state that OPA used the wrong metric in the entire IPSP by looking at the costs of power at the generation station instead of comparing options against the delivered costs of power. Please explain further.

During the past century of monopoly protection of power generation and distribution, local generation was ignored and the electric system came to rely almost exclusively on remote or central electric-only generation. This approach led to a widely held, seldom questioned assumption that all power must flow through the transmission and distribution system. Since nearly all power generation was central, OPA's analysis simply ignored transmission costs, since these costs applied to all central power rather equally, and instead, used the shorthand of cost at the power plant to pick winners.

However, the price consumers pay includes the cost of generating **and the cost of delivering power, including the amortization of the capital cost of the wires, transformers, capacitance and inductance banks, the losses of power in the lines and transformers, and the costs of maintaining the lines**. The only way to calculate the best options for electricity consumers is to look at the cost of power delivered to those consumers. Comparing prices at the generator has as much value for determining delivered power costs as comparing corporate revenues has value for determining their profits. Both are exercises in one-hand-clapping[1].

In addition, local generation that recycles otherwise wasted thermal energy, achieves 200% to 250% higher fossil efficiency than the average central generator, which vents two thirds of the input energy into lakes or cooling towers and wire losses. Local generation, by slashing the total amount of fossil fuel per delivered kilowatt-hour, would substantially reduce air pollution in the province and cut the overall demand for fossil fuel. These benefits must be considered to properly select the optimal generation mix.

Local generation has even more benefits. Because CHP requires use of nearby thermal energy and because recycled energy plants require a nearby supply of waste energy, (thermal energy will not travel economically very far) the power that these plants generate is at or near electric use. Regardless of contract terms, the resulting power flows to the nearest users, thus reducing the power flows from distant plants, the load on the wires and transformers, the need for new wires, and the average and peak-period line losses. Local generation also can supply active power factor correction, which is significantly more effective than the passive power factor correction supplied by the conventional inductance and capacitance banks.

Line loss savings are not linear. Line and transformer losses are related to the square of the current flow and to the degree that the phase angle of power at the user differs from the phase angle of the power at the generation plants. Local generation has very small

[1] OPA does include transmission line costs in the one case of remote renewable generation, but fails to do so when comparing nuclear with other options.

direct line losses, which reduces the losses on the rest of the system by lowering the current that is flowing in transmission wires and correcting the phase angle at the user end. The savings can be quite significant, as further explained below.

Furthermore, a system of relatively small generators with 3% to 5% redundant generation capacity can supply the same system reliability as the present system of large generators with 18% to 21% redundant generation and distribution capacity.

For these reasons, OPA cannot possibly arrive at intelligent decisions for society by considering only the cost of power at the generator and ignoring the T&D costs, line losses, and need for 3 to 7 times more redundancy from a central generation system than from a system dominated by smaller local generation.

7. You stated that a system of relatively small local generators could provide the same system reliability with only 3% to 5% redundant capacity than is supplied by the current system of large remote generators with 18% to 21% redundant capacity. Please explain.

The principal is easy to grasp. When a 1,000 megawatt power plant fails, there must be a spare 1,000 megawatts of idle generation to fill the gap. In a system of 30 such generators, there is a significant statistical probability that two or three will be out of service at peak times. Area restrictions and transmission bottlenecks mandate further redundancy investments for any system based on a few large central plants, as do the high forced outage rate and long startup/shutdown cycles that are both innate to big, complex power plants. Adding all of the factors, the present system of large generators requires 18% to 21% redundant generation and transmission capacity to achieve reliability levels acceptable to the public.

By contrast, a system of many small generators, all close to load, is significantly more robust. The relatively simple systems of typical CHP and recycled energy plants have random forced outages in the range of 2% to 3%. As the number of local generation plants increases, the statistical probability of outage approaches the same value – a 2% to 3% overall outage rate. Since most of the power flows directly to users, such a system is far less dependent on transmission towers and less exposed to systematic transmission failures that result from ice storms or cascading failures of an overloaded transmission system such as occurred across the northeastern U.S. and Canada in 2003.

A recent Carnegie Mellon University study modeled a system of smaller local generators and concluded that 3% to 5% redundant capacity would produce the same system reliability as 18% to 21% redundancy for a system of large remote generation.[2]

[2] Zerriffi, H.: 2004, "Electric power systems under stress: an evaluation of centralized vs. distributed systems architectures," *Ph.D. Thesis*, Carnegie-Mellon University

Hence, any proper evaluation of local versus central generation must factor in the significantly lower redundancy requirements for relatively small local generators. In other words, 1.05 MWs of local generation, before considering line losses, provides comparable system reliability to 1.18 to 1.21 MWs of central generation and supporting transmission. Peak line losses of 20% increase the need for central generation to 1.44 MWs per 1 MW of actual peak use of power.

In this 20-year plan, the process should recognize that a mix of CDM and smaller, dispersed CHP and renewable generation will lead to a lower required reserve margin.

8. How can one generalize the impacts of lower peak line losses and lower redundancy in examining electric system planning?

We have examined these factors in published papers and found that a configuration of large central generators requires 1.44 MW of generation capacity for each MW of system peak load, while a configuration of smaller local generators requires about 1.06 MW of generation for each MW of system peak load.[3]

The benefits of reduced line losses and redundancy requirements begin when a system like Ontario's, which largely depends on transmission from remote central generation, adds local generation. The local generators reduce the peak current flow on existing wires and provide active power factor correction, both of which reduce line losses disproportionately to the addition of local generation. Remember that line losses are related to the square of current flow on any specific conductor or transformer, so a small reduction in current flow has a disproportionate impact on line losses.

In other words, each megawatt of average local generation displaces 1.36 MWs (1.44/1.06) of central generation. A proper study by OPA would compare the capital costs of 1.36 units of central capacity against 1 unit of local capacity.

9. What does this explanation of the need for 1.44 megawatts of generation capacity for each megawatt of system demand mean for Ontario?

The answer is complicated by the fact that there are no records of actual peak of electric use, or of peak generation by local plants. What is tracked is the supply of power from large remote generators and imports at each moment. The power from local generators that is not sold to the grid is usually not tracked, and there is no simultaneous tracking of the peak use. It's wrong, therefore, to assume average line losses for system capacity requirements. The combined transmission, transformation and distribution losses

[3] See chapter 9, section 9.1.2 of 'Energy and American Society – Thirteen Myths' edited by Benjamin K. Sovacool and Marilyn A. Brown, Springer, 2007

fluctuate from a low of 3% or so during lowest system loads to over 20% during the peak system loads. At the absolute peak load, less than 80% of generation capacity reaches users.

An example will help explain. Last summer when the newspapers reported that Ontario peaked at 30,000 megawatts, this did not mean that people were using 30,000 MWs of power. It meant that the central generation throughout the province plus imports of power rose to 30,000 megawatts. What was the total use of power by consumers at the time of peak system generation? To be clear, there is insufficient data to provide an incontrovertible answer. Some large customers have time of use meters, but most meter data is read only monthly. The system operator does not know the peak usage by consumers; only how much power must be supplied into the transmission system.

Other utilities have done studies of line losses during peak loads and produced figures for rate cases in the range of 18% to 20% peak losses.[4] Let's assume that on that hot summer day last year when the Ontario system required 30,000 megawatts of input power, the total line losses were 20%. In other words, 6,000 megawatts were lost by overheated transmission lines, transformers and distribution wires during peak capacity. The system usage peak was thus about 24,000 megawatts.

Now assume that after ten years of enlightened policies that give local clean energy a chance, developers have installed 6,000 megawatts of local generation (just over half of the 11,400 MW ACT estimates of CHP and recycled energy potential). The direct line loss on the 6,000 megawatts of local generation would be in the range of 2 to 3%, or conservatively 180 megawatts. However, by reducing the flow of useful power after losses from 24,000 to just over 18,000 megawatts, and assuming no new T&D wires or transformers, the local generation would cause a further reduction of line losses of perhaps 10%, or roughly 2,000 megawatts.[5] The system load of 24,000 megawatts is thus supplied by 6,180 megawatts of local generation and 20,000 megawatts of remote generation (18 gigawatts use divided by 0.9 to calculate a 10% line loss). The new system, therefore, needs only 26,180 megawatts of total on-peak generation, compared to the 30,000 megawatts of generation input required to cover last summer's peak.

---

[4] See Boston Edison Company DPU 92-92, Exhibit BE-RDS-6, Marginal Cost of Service Study, Schedule 4, page 1 that remains in effect and based rates on an estimated 18.02% peak line loss during summer peak. Since 1992, new transmission has not kept up with load growth resulting in higher line losses.

[5] Assume the system of wires is, on average at 90% of maximum capacity with 24,000 megawatts of delivered power. Then delivering only 18,000 megawatts will drop the system to 67.5% of maximum capacity. The square of .90 is .81, while the square of .675 is .456. Thus, from just the lowering of current flow, the line losses should drop by .35/.81 or by 43%. Supplying 18,000 megawatts of end use with 20% line losses would require 22.5 gigawatts of central generation, but the loss would drop to 11.4%, and thus require only 20.3 gigawatts, saving 2.18 gigawatts. Because the local generation of 6 gigawatts would automatically correct the power factor, we can expect further reduction of line losses, but the calculation is hugely complex and system specific. To be conservative, we have credited the power factor correction with another 1.4% savings, dropping the total line losses from 20% to 10% as the result of adding 6 gigawatts of local generation.

This new system represents a net savings of 3,820 megawatts from reduced line losses. Yet this new system also reduces the need for redundant capacity. Assuming a ratio of 5% redundancy for the 6,000 megawatts of local generation and 20% redundancy for the remote generation, the required redundant generation is now 4,300 megawatts versus 6,000 megawatts needed by the all-central system. Thus, deploying 6,180 megawatts of local generation, and assuming no change in peak electric use by consumers, would avoid the need for 1,700 megawatts of redundant generation capacity.

All together, the deployment of 6,180 megawatts of clean local generation reduces the need for central generation at peak by an astonishing 11,520 megawatts, due to saved line losses and reduced need for redundant capacity. Each new MW of local generation avoids the need for 1.86 MW of total generation.

10. Are you saying that deploying 6,180 megawatts of local generation would reduce the need for central generating capacity in Ontario by 11,520 megawatts? Would this provide the same reliability as the present system?

Yes to both questions. The present system requires about 36,000 megawatts of generation capacity, including imported power, to deliver 24,000 megawatts of end use power at acceptable reliability. The new system, with only 30,480 MW of total generation (6,180 megawatts of local generation and 24,300 megawatts of central generation – which includes 20,000 megawatts of peak generation and 4,300 megawatts of redundant generation) will supply the same 24,000 megawatts of end user peak with the same reliability as the present system. This new system would creatively destroy the need for 11,520 megawatts of existing central generation, effectively replacing the province's dirty or risky power plants with cleaner local generation.

11. What do you mean 'Creatively Destroy' 11,520 megawatts of central generation?

Economist Joseph Schumpeter observed that entrepreneurs in a free market do not wait for the production capacity of a good or service to be fully utilized before building new production capacity. Instead, whenever an entrepreneur believes that she can build new production capacity with lower costs, and/or a better value proposition than the existing production, she builds new production. The new plant, by lowering its prices or offering more value, will take away sales from the least-efficient facility and thus 'destroy' some of the value of the highest-cost or lowest-value existing production capacity. However, Schumpeter argued that the process creates more savings than it destroys by introducing added production efficiency, and that this efficiency lowers the overall costs of that good or service. The public wins with lower costs and/or better-value goods. Schumpeter called this process '*creative destruction*' and said it explained the general improvement of income in a free market system.

By contrast, centrally planned electric systems do everything in their power to block the addition of new production capacity – of new generation – until the existing generation is fully utilized. The false planning idea is that the public will be best served by continuing to operate yesterday's technology until it wears out, even when it is less efficient than new technology. The current system's unquestioned assumption is that overall costs will rise if markets are allowed to build new generation capacity in excess of system demand for power. This central planning bias in favor of blocking 'creative destruction' explains most of what is wrong with today's electric systems all over the world. As a result of blocking creative destruction, the citizens of Ontario still receive much of their power from ancient, dirty coal plants, precisely because the planning process blocks deployment of new clean energy plants. Nothing in the IPSP studies subjects existing capacity to any competitive tests or analysis. Instead, the plan avoids new production if it threatens the old, less-efficient plants. The public and the environment pay dearly for this mistake, which is endemic to every centrally planned electric system.

For the coal-fired plants targeted by the premier, if you add the true health and environmental costs that the Ministry of Energy found to be $112 per MWh, as well as the fuel and operating expenses of roughly $40 per MWh, these plants cost consumers $152 per MWh (15.2 cents per kWh). If OPA would remove policy barriers and give clean energy a standard, albeit discounted offer, entrepreneurs would build clean energy and drive the societal cost down to half of the current level.

Since Premier McGuinty pledged to shut down all of Ontario's 6,400 megawatts of coal-fired generation, a rational IPSP would call forth at least enough new generation to 'creatively destroy' the need for these old and dirty coal plants. Providing standard offers, at a discount to the best central generation options, would induce a combination of new local generation and line loss/redundancy savings sufficient to retire the 6,400 megawatts of dirty coal generation. Since, as noted above, each megawatt of new local generation eliminates the need for 1.8 megawatts of central generation capacity, a CESOP that called forth 3,500 megawatts of new clean local generation would completely eliminate the need for the present coal-fired generation. An effective CESOP, therefore, would enable the closure of coal-fired power plants in Lambton, Nanticoke, Thunder Bay and Atikokan, which have combined capacity of 6,434 megawatts. This modest 3,500-megawatt CESOP, coupled with CDM and renewables would go a very long way to 'creatively destroy' the present system's sub-optimal generation.

12. The OPA report proposes to build 550 MW of simple cycle peaking with variable costs of $79.50 to $146.00 per MWh plus capital amortization. Do you believe CHP and recycled energy plants would be offered at or below these prices if given a chance?

In my experience, developers will deploy recycled energy plants and CHP for contracts that pay 85% of the true delivered capital cost per kWh for the best new central generation and associated T&D, plus 85% of the delivered cost per kWh of fuel and variable costs for the best new central plant. Such a CESOP would provide the public with a 15% savings versus the best new central option and profitably reduce fuel use and greenhouse gas emissions. Assuming, for example, the lowest cost of delivered power from any new central generation is $100 per MWh; clean local generation would receive $85 per MWh and be less exposed to fuel fluctuations. Purchasing this new clean base-load capacity would push other existing generation into intermediate or peak-shaving duty. Purchasing enough clean energy would lead to the retirement of the worst central plants. Remember that some of the need for peak-shaving capacity is to provide the 20% system redundancy needed by a system of large central generators, and new base-load clean local generation will cut this need, allowing existing peak shaving plants to balance system load.

13. The IPSP includes 586 MW of planned CHP. In response to I-31-111, OPA stated their assumptions of capital costs ($1413/kW), capacity factor (58%), operating life (20 years), and efficiency of 54%. The IPSP further assumes a societal cost of capital of 4% for all generation. In your view, are these numbers realistic?

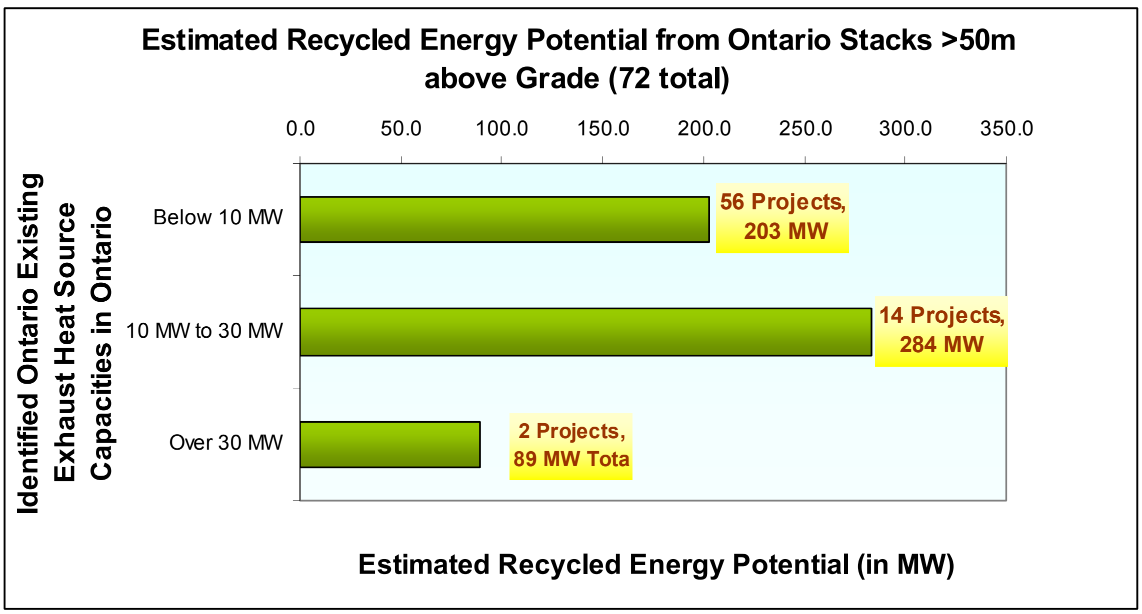
First, no generation – from centralized reactors to localized CHP units – will be built for the 4% return OPA uses for planning. A more realistic return is 12% to 15%, in which case the relatively lower capital costs of local generation will be properly compared to high-capital nuclear power. Developers of local plants will seek 15% and higher returns to compensate for the risk of development and the risk that the host industrial or commercial facility will cease production, etc. Developers of nuclear power have so far refused to proceed at all without government guarantees of the risks.

ACT proposed that OPA require clean energy plants to achieve a minimum 60% efficiency to qualify for CESOP, with the expectation that the average efficiency of all CESOP plants would be higher. Why did OPA assume less than the proposed minimum? ACT argued the average efficiency of fueled CHP plants should be in the 75% to 85% range, and that the energy recycling units at industrial plants would have infinite efficiency, given that they use no incremental fossil fuel. OPA completely ignores the potential for power from recycling industrial waste energy, in spite of ACT spelling out that substantial opportunity. This oversight appears to be a conscious stacking of the deck against CHP and recycled energy.

Most of the 250 CHP plants built by organizations that I have led achieve 90% to 96% availability, while those that follow thermal load in district heating and cooling operate at 75% to 85% load factor. The OPA's 58% capacity factor is lower than any CHP plant I have ever developed and operated during the past 32 years. By using these low efficiency and capacity factors, OPA 'calculates' that local generation will cost more than power from its preferred nuclear plants.

The problem of 'calculating' best options has deeper problems. The OPA's estimate for average CHP plant capital costs per kilowatt is neither possible nor useful. CHP and recycled energy plants are all unique and cannot be characterized by one average number as supplied to OPA by Navigant Consulting. If offered a standard contract and price of power, developers will preferentially focus on opportunities to build new local generation for as little as $800 to $1000 per kilowatt of capacity. They will look for places to install backpressure turbine generators that converts steam pressure drop to power by replacing a pressure-reducing valve. They will look for opportunities to use gas turbine exhaust as combustion air for a thermal process, such as producing gypsum wallboard, manufacturing plate glass or fiber glass, or drying any product. In these cases, the new plants require no heat recovery steam generator and consist of only a gas turbine generator, yet achieve 95% incremental efficiency of electric generation.

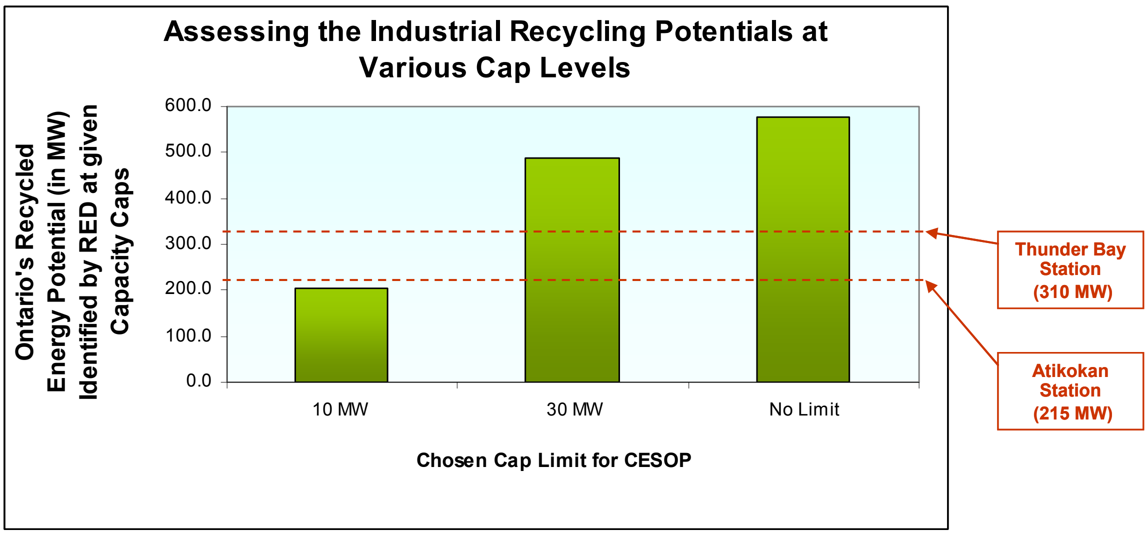
OPA's failure to even acknowledge Ontario's waste energy recycling opportunities calls into question the entire plan. We show in the table below opportunities to recycle hot exhaust into 576 megawatts of clean local power, which would burn no incremental fossil fuel or emit any incremental CO_2. This potential capacity is based on just the data from the small number of Ontario industrial facilities that have exhaust stacks higher than 50 meters and are required to report to Environment Canada.



Capacity Range	# of Projects	Net Incremental Power Potential (in MW)	Average size per project (in MW)	Cumulative Ontario Power Capacity (in MW)
Below 10 MW	56	203.1	3.6	203.1
10 MW to 30 MW	14	283.5	20.3	486.6
Over 30 MW	2	89.2	44.6	575.8

We estimate the actual potential power from presently wasted energy streams at 3,000 megawatts, including all of the sources that have shorter stacks and are not required to report to Environment Canada. The 576 MW of capacity is based on hard data from industrial plants that have stacks in excess of 50 meters tall. Most industrial sites have shorter exhaust stacks.

ACT presented the hard information (for the 50 meter stack subset of opportunities) to OPA in another form to show how just known recycled energy opportunities could eliminate coal-fired generation, if the 10 MW capacity limit was changed to 30 MW or, as ACT recommends, to no limit.



Size of CESOP Recycled Energy Capacity Cap	# of Projects	Incremental Fuel-Free Power Potential for Ontario (in MW)	Average size per project (in MW)
10 MW	56	203.1	3.6
30 MW	70	486.6	7.0
No Limit	72	575.8	8.0

Again, the numbers in the chart are only for opportunities with high stacks (that report to Environment Canada). Many other unique examples of clean energy from local generation that recycle wasted energy will be developed in Ontario if given a fair chance. The beauty of giving clean energy a chance is that creativity will be unlocked and inevitably produce solutions that no planner could ever identify in advance. These few examples illustrate the futility of using a single point estimate for the cost and performance of a CHP plant.

Consequently, I am quite confident that a standard offer with a fair price that is not limited to small projects will induce a great deal of clean local generation in Ontario.

14. What recommendation would you offer in order to induce more optimal supply of Ontario's electricity?

A Clean Energy Standard Offer Program, like the CESOP that OPA has devised, but without the 10 MW individual project capacity limit will call forth significant generation and eliminate the need for new central generation construction, new T&D, and the use of the existing coal fired stations. OPA is tantalizingly close to a program that will call forth cheaper and cleaner power, but must lift the CESOP 10 MW capacity limit per project. OPA already has done most of the work needed to calculate the cost of delivered kWh from the best new central generation options. Yet these numbers must be adjusted to reflect the true cost of power from the best new central generation. Amongst others, these adjustments include[6]:

- Use true market rates for the cost of capital for all options
- Add in the cost of line losses and the capital cost of transmission, distribution and power factor control
- Factor in the relative amounts of redundancy.

With these new numbers in hand, OPA should make a standard offer, not an RFP, for a significant quantity of clean energy and keep the offer open long enough for developers to complete the 12 to 30 month process of weaving together complicated energy recycling projects. We would suggest the following specifics of a standard offer:

- Keep the offer open until OPA either signs contracts for 1,500 megawatts of clean energy or until four years from the initial offer.
- Determine the full delivered cost of new base-load electric only central power for the best life cycle cost option currently available and then offer clean energy contracts that will pay:
  - 85% of the capital amortization per delivered kWh of the best new central plant and required T&D, and
  - 85% of the heat rate of the best plant, multiplied times the average fuel prices during the prior month for the fuel the best electric-only plant would have burned, and
  - 85% of the operating cost of the best new central generation
- Offer 20-year contracts for CESOP power.
- Limit eligibility to plants that annually achieve at least 60% fossil efficiency on a delivered basis. Give credit for recycled thermal energy from CHP plants equal to the delivered thermal energy divided by an assumed 75% seasonal boiler efficiency and deduct this amount of fuel from the gross fuel to determine if the CESOP plant meets the efficiency targets.

---

6. Resource Insight Inc. and others comment upon other elements of the OPA's estimates of central generation costs.

    - All new local generation that uses presently wasted energy from industrial plants would qualify.
    - All renewable energy would qualify, but would not receive payment for avoided T&D unless it was at or near load centers.
    - Only good CHP that was essentially sized to the base thermal loads of the host or district energy network could meet this tough 60% efficiency test.
- The only limit on capacity of an eligible clean energy plant should be the total megawatts of capacity that OPA will purchase under the first tranche of long-term contracts.
- If a project qualifies with regard to the 60% fossil efficiency but exceeds 150% of the design capacity of the distribution node, it should receive lower T&D benefits for the generation that will often flow into the transmission system (We assume that the actual loads will be at least 50% of design capacity and that the new local plant could supply these loads and export the full distribution capacity without significant capital investment in new T&D.)

This approach moves from theory to market reality. OPA has used a series of assumptions, as discussed in response to question I-31-111, to conclude that CHP is not the best economic option for added power in Ontario. Rather than argue about assumptions, this approach tests the market for clean energy. If our extensive development experience holds true for Ontario, and it should, then an offer of only 85% of the true and full cost of delivering power from the best electric-only option will attract a great deal of interest from power plant developers. If the initial contracts for clean energy are filled rapidly, OPA might offer a second tranche of CESOP contracts at a deeper discount, say 75% of the best new central power. If the market is slow to fill the first tranche of 1,500 megawatts, then OPA might consider reducing the discount.

Note the essentially entrepreneurial nature of this proposal. Over two centuries ago, Jean Batiste Say, the French economist, defined 'entrepreneur' as a person who moves resources from a less productive area to a more productive area. By opening the market to clean energy plants, entrepreneurs will find the most productive ways to deploy the scarce capital resources needed to provide the public with required heat and power. Ontario, as a result, will experience significant cost reduction and economic growth.

This approach will unleash a flood of innovation and will attract a wide variety of solutions. We believe the gas companies will respond by adding staff to promote good CHP. Other businesses will develop projects to recycle the exhaust heat from the many gas pipeline compressor stations. We expect several hundred megawatts of recycled energy from steel companies that use blast furnace gas, heat from coke ovens, reheat furnaces, and other waste energy sources. We expect developers to descend on the industrial processes that need significant thermal energy, such as wallboard manufacturing, glass manufacturing, pulp and paper mills and chemical factories. Other developers will add CHP for district heating. Toronto's Enwave, an ACT member, has said it could deploy 150 megawatts of thermally matched CHP to provide base-load waste heat for its existing system. We think the resulting savings from CHP would help the district energy system lower its thermal prices and help the system expand further.

This is a partial list. Nearly every large industrial plant in the province generates steam at pressures well above the requirement for end use. A CESOP will call forth many relatively small back-pressure steam turbine generators that convert that steam pressure drop into electricity with over 80% efficiency. In other cases, similar technology will be deployed to recycle the pressure energy in the gas transmission pipelines into power and chilling, as has been demonstrated by Enbridge recently.

All of this activity will provide added revenues/reduced costs for Ontario's manufacturers, who will either receive value for energy they presently waste or will purchase thermal energy at lower costs than from their existing fossil-fueled boilers.

Each new local generation unit will lower the flow of power through the transmission system and avoid both line losses and the requirement for new capital. Modest deployment of new local generation in Toronto will eliminate the need for the very expensive new transmission wires being planned.

By inducing new clean local generation, OPA will create many other benefits. First, Premier McGuinty's plan to eliminate coal-fired generation will be achieved profitably – in a way that lowers the overall cost of power in Ontario. In addition, the estimated $3.4 billion of health care and environmental costs associated with present coal-fired generation will disappear.

The availability of a standard contract with a reasonable, albeit discounted, price for clean local energy will unleash a flood of creativity that will spawn new centres of excellence and create multiple benefits, including:

- Development of new technology to recycle more of the waste energy
- Creation of new local industries to manufacture the various forms of equipment needed to capture waste energy and to export such equipment from the province
- Significant reduction of the costs of manufacturing at most provincial manufacturers, inducing added production, jobs, and provincial tax collections
- Slashing of CO_2 emissions, while improving the provincial economy, making Ontario a focal point of world climate change policy.

By contrast, the IPSP plan will keep relying on dirty and costly coal generation, add costs for new T&D, add inefficient peak shaving, greatly deepen Ontario's bet on nuclear, and raise the cost of local manufacturing. The IPSP plan, if followed, will drive jobs and profits out of the province.

Thomas R. Casten,
Chairman, Recycled Energy Development, LLC

Thomas R. Casten has spent 30 years developing decentralized energy recycling projects. He was founding president and CEO of Trigen Energy Corporation, a New York Stock Exchange corporation and its predecessors from 1977 through 2000; and he served until 2006 as founding chair & CEO of Primary Energy Ventures LLC, an Oak Brook, Illinois-based firm with a Toronto Stock Exchange traded subsidiary, Primary Energy Recycling Corp.

Tom also has served as the president of the International District Energy Association, received the Normal R. Taylor Award for distinguished achievement and contributions to the industry, and has been named a "CHP Champion" by the U.S. Combined Heat and Power Association. He is the co-founder and former chairman of the World Alliance for Distributed Energy (WADE), an umbrella organization of national CHP and distributed energy associations, equipment vendors, government agencies, and foundations that promote distributed generation to optimize the world's power system. In 2006, the WADE board inducted Tom as the first member of the WADE Hall of Fame.

Tom serves on the Board of Directors/Advisory Boards of the Carnegie Mellon Electric Industry Center, Oregon Climate Trust, Climate Institute, and the Center for Inquiry. He is a nationally recognized expert on energy and environment issues, and his articles have been widely published. Tom has presented energy recycling at the International Association of Energy Economics, Aspen Energy Policy Forum, Bordeaux Energy Colloquium, World Technology Network, and Clinton Global Initiative. He has testified on several occasions before the energy committees of the U.S. Senate and House of Representatives, and he has advised Indian, Chinese, and Brazilian government officials on power industry governance.

Tom's book, *Turning off the Heat,* published by Prometheus Press in 1998, explains how the world can save money and pollution. He recently co-authored a chapter in *Energy Myth and American Society, Thirteen Myths* (Sovacool & Brown), challenging the assumption that the U.S. electric system is optimal.