

A Microeconomic Policy Perspective of IESO's Pre-Dispatch Forecasting Proposal

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Executive Summary

The purpose of this paper is two-fold, one general and the other specific.

The first is to set out a general framework for microeconomic policy decision making when the general objective is the enhancement of the aggregate well-being of a population. Although cost-benefit analysis (economic efficiency per the potential Pareto improvement criterion) is an important component of economic assessments, equity impacts and transactions costs should be considered. Of course, with more than one objective, conflicts among them can arise. These three economic considerations are discussed at length and a method for addressing any potential efficiency-equity trade-off is suggested.

The second is to apply this general framework to a specific policy proposal; forecasting pre-dispatch electricity demand using average demand data instead of peak demand data. The economic impacts of this proposed policy, especially with respect to efficiency and distributional concerns are examined. Three observations emerge. First, the proposed policy would enhance economic efficiency significantly and unambiguously. Second, there is no finding that the distributional impacts of the proposed policy would be egregious. Third, transactions (implementation) costs are considered to be negligible.

Therefore, the assessment of the specific policy proposal within the general framework leads to much confidence that implementation of the proposal would, indeed, increase aggregate well-being.

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1. Introduction

The Province of Ontario's Independent Electricity System Operator (IESO) is considering a proposal to use average demand instead of peak demand when forecasting pre-dispatch demand.² IESO has requested a discussion of this proposal from a microeconomic policy perspective, somewhat broader with respect to economic evaluation than most discussions of cost-benefit analysis yet focussed on the specific proposal.³

The purpose of this paper is two-fold. The first is to provide a general framework for considering policy proposals that would have economic impacts. This discussion is necessarily lengthy because this decision-making framework is meant to be applicable to a variety of proposals IESO may wish to consider. The second purpose is to assess the specific proposal within that framework subject to various information constraints. The balance of this section is devoted to a discussion of the main components of microeconomic policy assessment followed by a description of the structure of this paper.

1.a Three general concerns

Typically, economists are concerned with three aspects of any proposed policy, where by 'policy' we mean to be general enough to include legislation, market intervention, public

² Much of the development of this proposal and investigations of aspects of it can be traced chronologically through the following IESO documents: IESO (6 December 2006), IESO (19 July 2007), IESO (7 February 2008), IESO (13 May 2008) and IESO (16 May 2008).

³ Applied (economic) welfare analysis is broader than cost-benefit analysis, and that is the type of analysis contemplated here.

sector projects *et cetera*. They are efficiency, equity and transaction costs. A brief overview of these concepts will be useful.⁴

Economists distinguish three types of *efficiency*.⁵

- *Allocative efficiency* has to do with the least wasteful combinations of inputs being used to produce output, the least wasteful combinations of goods and services being consumed and the least wasteful combinations of supply and demand. If allocative efficiency is not being attained, it may be possible to re-arrange inputs to produce more of at least one good and no less of others, to re-arrange consumption so that more of at least one good is consumed at no sacrifice of another, or to re-arrange production in a way that improves social (economic) well-being.⁶
- *Technological efficiency* (also called technical efficiency or productive efficiency) simply refers to producing a given level of output with the least inputs or producing the most output possible from a given set of inputs. This is a physical concept.
- *Dynamic efficiency* has to do with the pace of innovation in a market or industry. In electricity markets, on the supply side, it could be research and development that leads to increases in technological efficiency. On the demand side, it could be

⁴ For a fuller discussion, especially with respect to market intervention, see Stringer *et al.* (1994).

⁵ See IESO (29 October 2007) for a similar discussion.

⁶ Various synonyms describe allocative efficiency — efficient, Pareto efficient or Pareto optimal. If allocative efficiency is not attained, a Pareto improvement is likely possible. More on Pareto follows.

innovations that cause electricity to be used more efficiently (e.g., less electricity to heat a home because of technological advances).

Usually two types of *equity* are considered, and trade-offs between efficiency and equity are usual in policy assessment.⁷

- *Horizontal equity* refers to the like treatment of people who are alike, and it corresponds to common notions of fair play and non-discrimination. In the context of hockey, equal-sized nets would be horizontally equitable. In the taxation literature, it would mean that two essentially identical families, with the same pre-tax income, would have equal after-tax incomes.
- *Vertical equity* is a more contentious concept, referring to how different people are treated differently. In economics, we are typically concerned with the distribution of incomes within an economy and how public policies affect people in different income groups. Views concerning ‘preferred’ distributions of income range from absolute equality to letting ‘the free market-determined chips’ land where they fall. Obviously, there is a political scale, from far left to far right, that corresponds to these views. What income distribution is preferred is a normative question, requiring a value judgement. As such, there is no ‘economic’ answer, and most economists would advise that, should a government determine a desired distribution of income, it is the task of economists to reach that target at least cost — with least loss of efficiency. The usual (optimal) solution is a tax-and-transfer

⁷ Depending on the circumstances, there may be consideration of inter-generational efficiency and equity. For example, inefficient pricing of electricity in the present will induce inefficient levels of current consumption and of current investment in domestic generation capacity. Some of the burden of these inefficiencies may be borne by future generations. For example, note that Ontario Hydro debt charges appear on current electricity bills.

system that minimizes losses due to distortions, thus involving few disincentives to labour effort, saving, risk taking and the like.

Policies can affect people of different income levels differently, and politicians are often concerned with the progressivity or regressivity of policy measures. In the context of taxation, a tax is regarded as progressive, proportional or regressive if taxes paid per dollar of income (the average tax rate) increases, remains the same or decreases, respectively, as income increases.⁸ Regarding commodity taxes, one on necessities would be deemed regressive, as the likelihood is that relatively poor households spend a greater proportion of their incomes on them compared to relatively wealthy households. In contrast, a tax on a luxury good is likely to be progressive. We note that some uses of electricity could be regarded as necessities by households, whereas other uses may be associated with the consumption of luxuries.

Depending on the nature of the policy, there may be various transactions costs incurred because of implementation, enforcement, measurement, compliance and so forth. For example, it is not so long ago that many municipalities changed from flat-rate water billing to metered (per litre) billing. In order to achieve the obvious efficiency gains of the policy, the cost of meters and collecting usage data regularly had to be considered in the analysis. Peak load pricing of electricity or water use requires ‘smart’ meters capable of recording or transmitting the necessary data. The lower the transactions costs the better. In the context of the current proposal, there is some confidence that it would not be costly to change from peak demand to average demand forecasting.

⁸ Let the tax paid by an individual be a function of his or her income. Denoting the total tax paid by an individual as $T(Y)$ and his or her income as Y , and defining $T(Y)/Y$ as the average tax rate, the tax function $T(Y)$ is progressive, proportional or regressive depending on whether $\partial[T(Y)/Y]/\partial Y$ is > 0 , $= 0$ or < 0 , respectively.

1.b Trade-offs and/or pragmatism

The potential for conflicts between and among these economic objectives is obvious, as is the need for making trade-offs. For example, if all goods and services — everything that yields utility to households — could be taxed, the optimal commodity tax scheme from an efficiency perspective would be to tax all of them at the same rate. However, as leisure cannot be taxed, the efficient tax scheme is to tax goods according to their closeness as complements to leisure in order to tax consumption of leisure indirectly. For example, ski boots would be taxed at a higher rate than work boots. However, the costs of collecting and enforcing so many different tax rates would be outlandish, so much less complicated commodity tax systems are favoured. It seems quite reasonable to sacrifice allocative efficiency in return for lower transactions costs.

Another example is income taxation. Some people may favour very progressive income tax structures. However, high tax rates are disincentives to productive, income-generating activities. The trade-off is between allocative efficiency and vertical equity; the more a government wishes to redistribute income, the less income there is to redistribute.

Governments also intervene in well-functioning markets in order, at least in part, to pursue vertical equity objectives. Price ceilings and floors are examples of these and, despite a large literature concerning the negative efficiency consequences of them, governments continue to pursue such policies.

This last type of intervention is relevant to IESO's proposed policy. An economist's standard advice would be that if a market is functioning reasonably well, a government should not intervene. If the government wishes to pursue income redistribution, it should do so directly using the most efficient tax-and-transfer scheme available instead of indirectly by trying to control prices. Nevertheless, however sensible the economic view,

it appears that it can be politically dangerous. That is, although not economically sound, there may be a political constraint requiring efficiency, equity and transactions costs issues and trade-offs to be resolved within a single, narrow policy in isolation.

1.c Structure of the paper

In the next two sections, we describe the relevant economic aspects and impacts of the current forecasting method and the proposed one. In Section 4 we present various criteria for determining the economic viability of public sector policies and projects, and this is followed by a section concerning the measurement of economic gains and losses. The most usual trade-off in policy evaluation is between efficiency and equity (see above), and we address this directly in Section 6. There we present what has been dubbed the Balancing Weights Approach, and we discuss a number of facets of it. In Section 7 we raise two issues that constrain the evaluation of the proposed forecasting policy, and in Section 8 we list those who would gain or lose because of the proposed policy and the nature of their gains and/or losses. In Section 9 we assess the proposed forecasting policy within the economic decision-making framework previously developed.

2. The Current Policy

Electricity consumed in Ontario is supplied by out-of-province and in-province producers. Some in-province producers are also exporters of electricity. Some importers of electricity are also exporters.

Electricity imports and exports for a particular hour are scheduled one hour in advance (for a duration of one hour) on the basis of a forecast provided by IESO. Because of risk aversion with respect to adequate supply, current hour-ahead forecasts are based on expected peak demand. Once electricity imports and exports for a particular hour have

been scheduled or contracted in the one-hour ahead pre-dispatch, any unconsummated offers or bids cannot be revisited for that period regardless of the actual demand revealed an hour later. Those imports and exports that have been contracted are assigned an artificial (negative) price such that, if contracted, they are consumed regardless of the real-time, realized price. Importers receive the higher of their contracted offer price or the real-time price. Exporters pay the real-time price.

Domestic producers are scheduled in real-time on the basis of five-minute prices. Should actual (real-time) demand exceed pre-dispatch forecasted demand, the difference is typically made up by domestic producers (as additional imports cannot be contracted to make up the difference). In a portfolio sense, imports are certain whereas domestic production is used to compensate for variance around forecasted volumes.

That export and import volumes are determined and fixed at a different time and for a different duration than when other production and consumption decisions are made can result in inefficiencies given the improbability of perfectly accurate demand forecasting. That is, the volume of electricity actually consumed per time period will typically not have been produced at least cost. There are three potential outcomes.

(2.a) Actual demand is equal to forecasted demand

In this case, the pre-dispatch price will be equal to the real-time price.⁹ Importantly, the electricity consumed during the hour will likely have been produced by the set of lowest-cost producers, be they in- or out-of-province. The difference in time dimensions (one hour *versus* five minutes) is irrelevant, as is the fact that imports cannot be adjusted once contracted in advance.

⁹ This is assuming that no other event, such as a generation outage, occurs.

(2.b) Actual demand exceeds forecasted demand

This will cause the real-time price to exceed the pre-dispatch price, and domestic suppliers will respond by expanding output. Note, however, that out-of-province suppliers cannot respond because their ability to contract terminated at least an hour before the real-time activity. The economic problem is that the cost of this expanded in-province supply may be greater than that of additional out-of-province supply had the forecast been closer to the mark. Moreover, note again that importers receive the higher of their contracted offer price and the real-time price.

(2.c) Forecasted demand exceeds actual demand

Because peak demand data is used to formulate hour-ahead forecasts, we expect actual demand to be less than forecast most frequently. Higher-than-actual forecast demand is associated with a higher-than-actual pre-dispatch price. This situation is not desirable for a number of reasons.

First, the lower-than-forecast real-time price will have been caused by demand being lower than forecast. In order to maintain efficiency, the ideal would be to reduce supply accordingly by rationing supply to the (now) lowest-cost producers. This would entail reducing or eliminating the supply of the (now) highest-cost producer(s). However, the highest-cost producer might be an importer, whose contract to supply will be consummated. Thus, it could be a lower-cost, in-province producer whose potential supply is reduced or eliminated. Therefore, the total cost of satisfying actual demand at the real-time price is higher than what it would have been had the same demand been forecast initially.

Second, if in-province producers treat the pre-dispatch forecasted price as reasonably accurate, they may prepare for hour-later generation in advance. For some generators, there is a sunk start-up cost that is incurred when preparing for generation. This start-up cost, however, may be wasted if forecasted demand is greater than actual demand, such that the electricity they would have been capable of producing after start-up turns out not to be needed. The extent to which in-province producers react to forecasted demand may be important.

Third, exporters buy or produce at the real-time price in order to fulfill earlier contracted sales to out-of-province other jurisdictions. In a probabilistic sense, the higher the pre-dispatch price, the lower the real-time price and, therefore, the greater the margin earned by exporters. Moreover, the lower the real-time price, the more they will wish to export, although the actual amount will depend on the demand forecasts (pre-dispatch prices) in other jurisdictions. To the extent that this additional low-cost, in-province generation for export could have displaced high-cost imports in different circumstances, the overall efficiency problem is exacerbated.

Obviously, the closer to situation *(2.a)* above, the more efficient the outcome. In that case, whatever the amount of electricity demanded in-province, it is produced at least cost. In the other cases, in-province supply either expands or contracts in order to accommodate under- or over-contracted imports, respectively, with the result that what is demanded in-province will likely not be produced at overall least cost because imports cannot be recontracted in response to actual conditions once pre-dispatch transactions have been scheduled. Therefore, any measure that would align better pre-dispatch forecasted and actual real-time volumes would enhance efficiency by decreasing the total cost of hourly production closer to its theoretical minimum (for every potential level of demand).

Ideally, for any volume, the (instantaneous) market mechanism ensures that only the lowest-cost producers actually produce. One can think of producers being ranked from lowest cost to highest cost. If price increases, the next highest-cost producer goes on stream. If price decreases, the highest-cost producer of those actually producing goes off stream. The highest cost producer is always at the margin. However, as long as importers and exporters make transactions at a different time and for a different duration than in-province producers for in-province consumption, inefficiencies will result because, when actual demand is not equal to pre-dispatch forecasted demand, it will not necessarily be the highest-cost producer at the margin at every moment of time.¹⁰ Any measure that reduces this possibility will enhance efficiency, and this will be realized in overall lower costs.

3. The Proposal

The IESO proposal is to use average demand rather than peak demand in order to forecast pre-dispatch demand for a particular hour, at least for those hours in which the risk of having to invoke control actions is not high. Compared to the current situation, lower demand will be forecast, thus a lower pre-dispatch price will be stated and fewer imports will be contracted. With less downward pressure on the real-time price, one expects, *ceteris paribus*, it to be higher than in the current situation. This will have the impact of

¹⁰ Another reason for this phenomenon was identified by the Ontario Energy Board (December, 2007) in the section of its “Market Surveillance Panel Report” concerned with the variety of contracts that exist in this industry. They state (p. 171), “Contracts that pay fixed prices can lead to externalities where a generator has a financial incentive to run even if the market price is lower than its incremental cost. This could lead to an efficiency loss because a lower cost supplier may be displaced and the market price may be less than the incremental cost of generation.”

stimulating in-province generation for in-province consumption and diminishing the returns from exporting. One expects more instances of *(2.b)* above and fewer of *(2.c)*. The number of instances in which the producer at the margin is *not* the highest-cost producer will be smaller, and overall costs will be lower. This proposal will mean fewer imports and exports and increased domestic production compared to the current situation. Moreover, other costs, such as unnecessary generation start-up costs, should be reduced in part because of the expected convergence of pre-dispatch and real-time prices. Although one would not expect this policy to have a significant impact on dynamic efficiency (the pace of innovation in this industry), the price and risk impacts of the proposal would enhance incentives for earlier-than-otherwise entry.¹¹

4. Economic Viability Criteria

There is much agreement that efficiency gains would be realized if IESO were to switch from peak to average pre-demand forecasts. IESO (13 May 2008, p. 7) states:

“Estimates of the annual efficiency improvements range from approximately \$1.3 million for off-peak hours to \$8.7 million for all hours. Given that the IESO has determined, for reliability reasons, that a peak forecast will continue to be used for ramp-up hours, it is estimated that the efficiency improvements of using an average forecast in the remaining hours would be in the range of \$3.4 million annually.”

Setting aside specific measures of these cost savings and which parties to these transactions would gain or lose and by how much, a discussion of the measurement of

¹¹ ICF Consulting (3 March 2006) discuss technological improvements in the consumption of electricity, which may be viewed as demand-side dynamic efficiency.

(social) welfare change is warranted.¹² Ultimately, whether a policy or project is deemed economically viable or not depends on the choice of decision criterion, and that typically requires a value judgment.

Governments may state that they favour policies and projects that enhance the aggregate well-being of their citizens and do not support projects and policies that would diminish economic welfare, but distinguishing one from the other is often not straightforward. Contrast this to an individual's decision: He or she likes things that make him or her better off and does not like things that him or her worse off. An individual need only rank affordable choices, and the ranking need only be ordinal, not cardinal. Unlike a government or agency, for an individual neither measurement nor aggregation is required. Various criteria are distinguished by the complexity of both factors.

(4.a) The Pareto Improvement Criterion

A policy or project satisfies this criterion if it makes at least one person better off and no person worse off. If individuals' preferences are independent (lack of envy or altruism), it is quite obvious that aggregate well-being must increase if a policy or project satisfies this criterion. Of course, if a single person would be made worse off, this criterion would not be met. Note that, in order to employ the Pareto improvement criterion, it is not necessary to measure any person's gain or loss. It follows, then, that this criterion involves no aggregation of gains and losses.

For example, a policy of offering residential consumers the choice of staying on the regulated price plan or switching to an hourly pricing plan (i.e., where they pay the HOEP for their hourly metered consumption), such that suppliers are either indifferent or favour

¹² 'Social welfare' is synonymous with 'aggregate well-being' in this context. For a complete discussion, see Townley (1998).

the policy — is likely to cause a Pareto improvement. If a person thinks he or she would be better off by switching to an hourly pricing plan they do so. People who prefer the existing regulated pricing plan stay with it. Switchers are better off and stayers are no worse off, so social welfare necessarily increases.

Still, traditionally, economists usually opine that this criterion is too restrictive to be used as a strict criterion for much public sector policy and project evaluation. For example, a proposal could make one million people better off and just one person worse off, and dismissing it on the basis of this criterion would not be in the public interest. Nevertheless, for reasons below, it is too soon to dispose of this criterion.

(4.b) The Potential Pareto Improvement Criterion

This criterion is also called the cost-benefit analysis test or the Kaldor-Hicks criterion. Consider a policy or project that would fail the Pareto improvement criterion because of the existence of potential losers. This criterion sets out one way to treat this situation. It is a double (hypothetical) compensation test.

An act (policy, project *et cetera*) satisfies the Potential Pareto Improvement Criterion if the gains of the gainers exceed the losses of the losers such that the gainers could, hypothetically, compensate the losers for their losses and still be better off, and that the losers could not, hypothetically, afford to compensate the gainers such that the gainers would agree to forgo the act.

In simpler terms, the benefits exceed the costs. This, clearly, would be the case should the IESO change from peak demand to average demand pre-dispatch forecasting.

Nevertheless, satisfaction of the Potential Pareto Improvement Criterion is neither a necessary nor a sufficient condition for a welfare improvement. Similarly, failure to satisfy this criterion is neither a necessary nor a sufficient condition for a welfare reduction. The problem is that what is being measured may not be a good proxy for what economists would actually like to measure such that the net benefit dollar aggregate may lack economic meaning. Implicit assumptions are being made when this criterion is invoked, and they may or may not be palatable or realistic.

(4.c) Social Welfare

The initial question was: Would a particular policy or project enhance or diminish social welfare? That is, would it make society better or worse off? Obviously, this will depend on the impact of the action on individuals. Although we will postpone the measurement of these impacts until Section 5, let \mathbf{b}_i denote the net benefit of the policy or project — measured in dollars — to person i . If the action would make person i better off, then $\mathbf{b}_i > 0$. If it would make person i worse off, then $\mathbf{b}_i < 0$.

The Pareto Improvement Criterion is satisfied, for a n -person economy, if $\mathbf{b}_i \geq 0$ for all people ($i = 1, 2, 3, \dots, n$) and $\mathbf{b}_j > 0$ for at least one person j . Note that it is not necessary to measure any individual's net benefit, because it only matters if it is zero, positive or negative. Magnitude does not matter. Also, it is not necessary to make inter-personal comparisons. That is, it is not relevant if $\mathbf{b}_i > \mathbf{b}_j$, $\mathbf{b}_i < \mathbf{b}_j$ or $\mathbf{b}_i = \mathbf{b}_j$ (for all $i, j = 1, 2, 3, \dots, n$).

Now consider the Potential Pareto Improvement Criterion. It is satisfied, for the same n -person economy, if $\mathbf{b}_1 + \mathbf{b}_2 + \mathbf{b}_3 + \dots + \mathbf{b}_n > 0$, some positive dollar value. These \mathbf{b}_i are dollar values that are meant to represent individuals' changes in well-being (utility). However, it only makes sense to aggregate them as the total change in utility (social

welfare) if the units have the same value to all individuals. That is, an extra dollar would have to be valued equally in utility (or well-being) terms if they are to be meaningfully summed. In the summation, inter-personal comparisons of utility are being made, and this requires rather strong assumptions.

Here, the implicit assumption being made is that individuals' marginal utilities of income are identical. Consider a two-person economy where the project or policy, according to the individuals, would make Person 1 better off by 10 dollars ($\mathbf{b}_1 = \$10$) and Person 2 worse off by four dollars ($\mathbf{b}_2 = -\$4$). This project would fail the Pareto Improvement Criterion (since $\mathbf{b}_2 < 0$), but it would satisfy the Potential Pareto Improvement Criterion because $\mathbf{b}_1 + \mathbf{b}_2 = \$6 > 0$. That is, Person 1 could afford to compensate Person 2 for his or her loss of four dollars and still be better off, and Person 2 would be better off accepting the project or policy instead of paying Person 1 ten dollars in order to forgo the project. If the project were to proceed, society as a whole would be \$6 better off. This is an efficiency gain.

Of course, if Person 1 actually compensates Person 2, a post-compensation Pareto Improvement would be achieved. However, this compensation need only be hypothetical. Assume that actual compensation is not paid, so that Person 2 would actually lose if the project or policy were to proceed. Does this matter from a social perspective? The key is the degree to which these dollar values reflect changes in utilities (individuals' levels of well-being) which are not directly measurable. (Utility measures are ordinal, not cardinal, so only statements such as better off, worse off or indifferent are meaningful.) What most people accept is the concept of diminishing marginal utility of income (wealth). That is, the wealthier and wealthier a person is, additional dollars generate less and less additional utility. Thus, we expect an additional dollar to a relatively poor person to cause a large increase in utility compared to that generated by an extra dollar to a relatively wealthy person.

In our simple example, suppose that Person 1 is relatively wealthy and Person 2 is relatively poor. Whereas Person 1's monetary gain may generate much extra well being, Person 2's loss may be quite painful given his or her already low level of income. Even though the policy or project satisfies the Potential Pareto Improvement Criterion, it may cause social welfare to decrease. However, if wealth levels were reversed, Person 1's gain might add significant utility whereas Person 2's loss may be considered fairly painless by him or her. If this were true, proceeding with the project or policy would increase social welfare.

If Persons 1 and 2 valued extra dollars equally (had identical marginal utilities of income), satisfaction of the Potential Pareto Improvement Criterion (without actual compensation of losers) would indicate an increase in welfare in that utility gains would exceed utility losses. (This, of course, is little comfort to losers!) In essence, an efficiency gain would be realized without causing major concern with respect to vertical equity (income inequality).

Presumably, a decision maker would wish to be assured that a project or policy that would enhance efficiency would not have egregious distributional impacts. In practical terms, if gainers and losers have similar income levels, or if gainers are less wealthy than losers, distributional (equity) impacts are of little concern, and satisfaction of the Potential Pareto Improvement Criterion will accurately signal an increase in aggregate well-being.¹³

¹³ In many circumstances, an increase in aggregate well-being will show up as an increase in GDP or average incomes. However, this need not be so. Consider a by-law that reduces the speed limit on a busy residential street. The criterion will be satisfied if the gains of residents (from reduced noise and increased safety) exceed the losses of drivers (from reduced speed), but we would expect neither GDP nor incomes to increase.

Concerns arise when losers are poor relative to gainers such that proceeding could result in a decrease in social welfare. Note above the situation where Person 1 pays actual compensation to Person 2. After compensation, at least one person is better off and no person is worse off; a Pareto improvement is achieved. To what extent actual compensation of potential losers is feasible is important. In many public sector scenarios actual compensation is paid and/or potential losses are mitigated. For example, if property is required for a new road or roadway expansion, expropriation legislation provides relief to landowners. If a bridge over water would affect marine life, damages to those who fish are mitigated. If expansion of a roadway would increase noise levels, sound barriers are erected. The potential to pay actual compensation and/or to prevent actual losses is peculiar to specific policies and projects.

5. Measurement of Gains and Losses

Ideally, the gains or losses of economic agents (\mathbf{b}_i in the last section) would be their individual compensating or equivalent variations. These are willingness to pay measures, and we are seeking the dollar value of a person's gain or loss of utility because of the proposal.

For an agent who would gain from the proposed policy, the relevant compensating variation question would be, 'What is the maximum amount you are willing to pay to have the proposal implemented?' The answer would be expressed in dollars and, for person i , $\mathbf{CV}_i > 0$. The relevant equivalent variation question for this person would be, 'What is the minimum amount you would be willing to accept to forgo the proposed policy?' Again, the answer would be expressed in dollars and, for person i , $\mathbf{EV}_i > 0$.

For an agent who would lose because of the proposed policy, the relevant compensating

variation question would be, ‘What is the minimum you are willing to accept in order to tolerate having the proposal implemented?’ The answer would be expressed in dollars and, for person j , $CV_j < 0$. The relevant equivalent variation question for this person would be, ‘What is the maximum amount you would be willing to pay in order to prevent the proposed policy?’ The answer would be expressed in dollars and, for person i , $EV_i < 0$.

Of course, if all $CV_i \geq 0$ ($i = 1, 2, 3, \dots, n$) with at least one person’s compensating variation strictly positive, and if all $EV_i \geq 0$ ($i = 1, 2, 3, \dots, n$) with at least one person’s equivalent variation strictly positive, proceeding with the proposal would cause a Pareto improvement. If we define aggregate compensating variation as CV ($CV = CV_1 + CV_2 + CV_3 + \dots + CV_n$) and aggregate equivalent variation as EV ($EV = EV_1 + EV_2 + EV_3 + \dots + EV_n$), a proposal satisfies the double criterion for a Potential Pareto Improvement if $CV > 0$ and $EV > 0$, fails it if $CV < 0$ and $EV < 0$, and is non-determinative if CV and EV have opposite signs.¹⁴

Aggregate compensating and equivalent variations are known as ‘exact’ measures of welfare change, but note that they may be difficult to determine. They are described here because another measure, which can be calculated from market data, is a good estimate of both exact measures when the phenomenon in question involves a single price change (per independent market). For consumers, this is the change in consumer surplus caused by a price change.

In a well-functioning market, at some initial price and the corresponding quantity

¹⁴ Although an individual’s compensating variation and equivalent variation will always have the same sign (or be zero), this need not be true of aggregate values. When they have opposite signs, the phenomenon is known as a Scitovsky Reversal or Paradox. See Townley (1998).

demanded, consumers are willing to pay more for the number of units desired than what they actually pay. This is their consumer surplus at that price. If the price of the good or service in questions decreases, typically they will demand a larger quantity, and their consumer surplus will increase. This change in consumer surplus is a measure of their net gain and can be a good proxy for the **CV** and **EV** of the same price change.¹⁵ On the supply side, a price change would typically cause firms to expand or contract production, and the level of their profits would change. This change in producer surplus is the measure used for firm owners' change in well-being because of a price change.

6. The Balancing Weights Approach to the Efficiency-Equity Trade-off

Satisfaction of the Potential Pareto Improvement Criterion indicates an efficiency gain, but it does not guarantee an increase in social welfare because it does not account for the distributional (equity) impacts of the policy or project when it creates both gainers and losers. If individuals have identical marginal utilities of income (wealth), or if the losers are wealthy relative to the gainers, common economic wisdom would be to proceed with the project or policy without further ado because the efficiency gains would be enough to signal an increase in aggregate well-being. A problem arises if the potential losers are less wealthy than the potential gainers, such that any efficiency gain would be at the expense of equity considerations. The purpose of this section is to present a method for dealing with this efficiency-equity trade-off.¹⁶

¹⁵ An algebraic derivation of consumer surplus can be found in Trebilcock *et al.* (June, 2007). Denoting by ΔCS the change in consumer surplus, $EV > \Delta CS > CV$ for normal goods and $EV < \Delta CS < CV$ for inferior goods.

¹⁶ Much of the following discussion draws on Townley (1999) and Duhamel & Townley (2003).

The potential impacts of IESO's proposal are very similar to those of efficiency-increasing mergers, and the method of handling efficiency-equity trade-offs in that setting was first introduced in Townley (1999) in the *Superior Propane - ICG Propane* merger. Townley's method was given qualified support by the Federal Court of Appeal¹⁷ in the first appeal of that merger decision, and it has since been adopted by the Canadian Competition Bureau in its *Merger Enforcement Guidelines*.¹⁸ It is called the 'balancing weights approach' and it is likely that it has found favour because it is straightforward way to focus on potential efficiency-equity trade-offs.

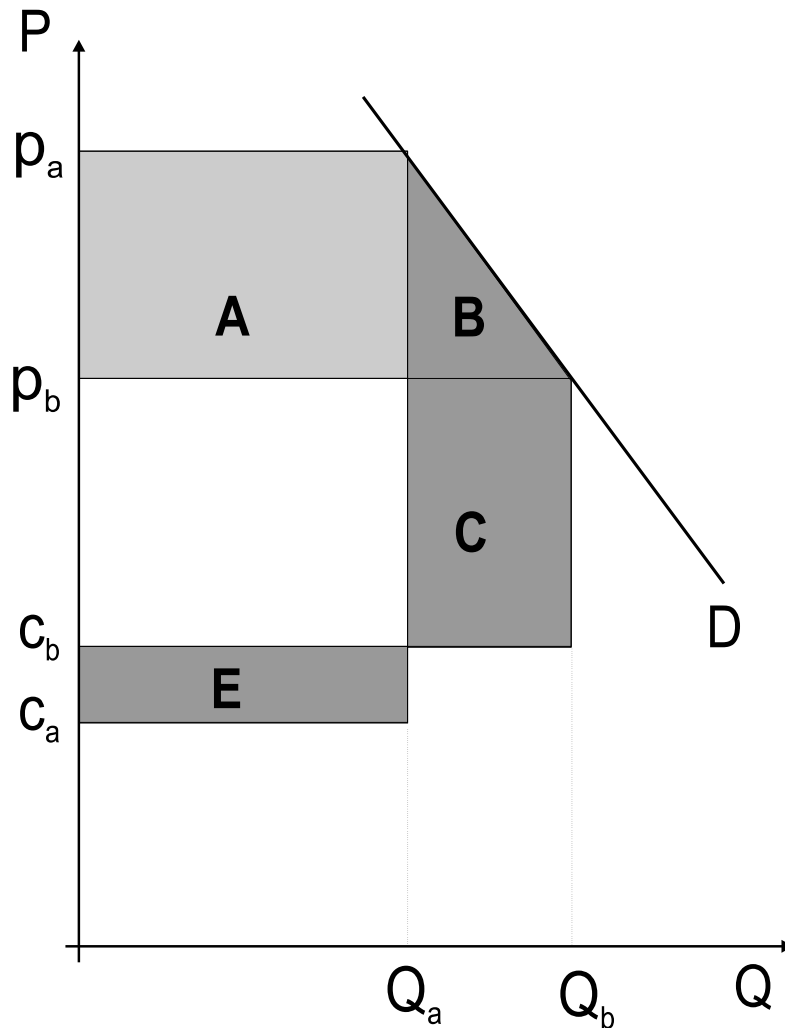
Consider the figure below. The subscripts 'b' and 'a' stand for 'before' and 'after', respectively. **D** is the demand curve for the good or service in question. Initially, producers have some market power, selling Q_b units per time period at price p_b , even though marginal cost is c_b . (For simplicity, constant marginal cost will be assumed throughout.) The policy or project causes marginal cost to decrease to c_a and price to increase to p_a for whatever precise reason.¹⁹ This causes demand (and production) to contract to Q_a units per time period. The diagram can be used to identify gainers and losers and their net gains and losses.

¹⁷ See *Commissioner of Competition v. Superior Propane Inc. and ICG Propane Inc.*

¹⁸ See <http://competitionbureau.gc.ca/epic/site/cb-bc.nsf/en/02720e.html> and <http://competitionbureau.gc.ca/epic/site/cb-bc.nsf/en/01245e.html>.

¹⁹ Mergers that increase market power can be efficiency-increasing. An efficiency-enhancing change in forecasting methods can raise price because the initial price is artificially or arbitrarily low.

Consumers lose consumer surplus in the amount illustrated by **A + B**. Firm owners gain **A + E + F - C** where the symbols represent the following: **A** is the increase in revenues earned on Q_a units; **E** is the decrease in variable costs to produce those same units (the



efficiency gain); **F** represents any fixed cost savings due to the phenomenon (and is not shown as this type of efficiency would have no impact on the profit-maximizing price and quantity; and **C** is the loss of profits that are no longer earned on units $Q_b - Q_a$ because of the contraction of output. This policy, merger or project does not satisfy the Pareto

Improvement Criterion because consumers would lose, but it would satisfy the Potential Improvement Criterion if $A + E + F - C > A + B$; that is, if firm owners' gains exceed consumers' losses. (Note that dollar amount A per time period is a transfer from consumers to firm owners.) There is a net efficiency gain.

There may be a concern that negative distributional impacts of the policy would outweigh this efficiency gain. The balancing weights approach makes this comparison stark, causing decision makers to focus on it. In the example above, one would calculate the value ω that would cause $A + E + F - C = \omega \cdot (A + B)$. Here, ω is the distributional weight by which one would have to augment the absolute value of consumers' losses to make them the same magnitude as producers' gains. It is a relative weight; producers' implicit weight is 1 and $\omega > 1$ in the above scenario.²⁰ For example, if the project or policy would cause producers to gain by \$75-m and consumers to lose by \$50-m, $\omega = 1.5$. The question policy makers would ask is the following: Is there sufficient reason/evidence to inflate consumers' losses by at least this factor? If not, the efficiency gains outweigh equity concerns and the policy should proceed. If so, the policy fails this weighted Potential Pareto Improvement Criterion and should be abandoned. The decision maker's problem is narrowed to the type of information or evidence that would cause the balancing weight to be tipped or not. In the absence of clear evidence of egregious distributional impacts, the balancing weights approach, as originally conceived for the assessment of efficiency-enhancing mergers, would favour the Potential Pareto Improvement Criterion.

The following are likely to be among the most important factors for employing the balancing weights test.

²⁰ The approach can be expanded to accommodate more than two groups of economic agents.

- (i) Gainers and losers should be easily identifiable and there should be some confidence in the accuracy of their estimated their gains and losses. (It would make little sense to dissipate potential efficiency gains attempting to discover a non-existent equity problem.)
- (ii) Gainers and losers should be distinct. That is, the picture becomes muddled if individuals are gainers on one hand and losers on another, like the firm owner who consumes his or her own good. Similarly, distributional concerns fade when gainers and losers are widely distributed across income groupings.
- (iii) The essential characteristic that distinguishes groups for vertical equity considerations is income because the important unknown, individuals' marginal utilities of income, is a function of income (wealth). Therefore, it is unlikely for equity concerns to be triggered if groups' income levels are similar.

7. Two Additional Issues

Two additional issues have to be addressed before we attempt to apply all of the above to IESO's policy proposal. They are (a) the economic properties of electricity prices in Ontario and (b) who counts and who does not for the purpose of assessing distributional impacts.

7.a Prices

In a well-functioning market, observed prices can reveal much valuable economic information. On the demand side, the number of units of a commodity demanded by a

utility-maximizing consumer is expected to increase as long as its marginal benefit to him or her — the maximum he or she is willing to pay for an incremental unit — is greater than the price he or she pays. On the supply side, a profit-maximizing competitive firm is expected to expand production as long as its marginal cost — the minimum it is willing to accept in return for producing an incremental unit — is less than the price it receives. In this manner, the market mechanism ‘brings together’ marginal benefit and marginal cost such that all units of the commodity that are valued more than their cost are produced and no unit that costs more to produce than what it is valued in consumption is produced.

For prices to have full economic meaning, consumers and firms have to make decisions based solely on them. That is, a meaningful price is the one paid and received per unit. This is not so in Ontario electricity markets because of various side-payment or correction schemes that cause the various prices of electricity observed to lack full economic meaning. All of them involve rebates or extra payments depending on the relationship between predicted and actual market outcomes. These schemes have implications for optimizing behaviour and measurement of policy impacts.

First, for example, for residential consumers there is the ‘Provincial Benefit’. The following description of it has been taken from one of the author’s own electricity bills.

“The price of generation is set by a competitive market. Certain generators receive payments through regulation or contract that differ from the market price. Your portion of the net adjustment arising from these different payments is included in your bill.”

The ‘Provincial Benefit’ impacts all Ontario consumers, and it is likely one of the least distortionary add-on schemes. Nevertheless, if IESO’s policy proposal causes wholesale rates to increase, would ‘Provincial Benefit’ levels decrease? If so, Ontario customers’ change in consumer surplus would overstate the impact of the policy on them.

Second, Intertie Offer Guarantees from 2002 to 2007, chronologically, have amounted to \$229.5-m, \$53.8-m, \$49.2-m, \$86.8-m, \$28.8-m and \$34.7-m.²¹ If the real-time price increases because of the proposed policy, is it likely that these payments will increase, decrease or be unaffected relative to the status quo? The same applies to the Global Adjustment, the OPG Rebate and any other similar scheme that may exist.²² A history of such rebates can be found in Angevine & Hrytzak-Lieffers (September, 2007) who state, “Since the Ontario electricity market was opened in May 2002, the market has been overlaid with a complex set of rebates or subsidies that has raised doubts regarding the validity of the HOEP or HOEP plus Uplift variables as effective market price signals.”

Both Angevine & Hrytzak-Lieffers (2007) and Deal & Mountain (2008) find low price elasticities of demand for Ontario electricity users. It is worrisome that they may have found this not because of demand behaviour with respect to ‘prices’ but, rather, because of responses to price changes *plus* off-setting changes in other payment schemes. That is, the impacts of price changes on quantity demanded may have been dampened by off-setting rebates or charges.

It also means that it is not sufficient to measure the gains and losses of gainers and losers using price data only. If these other side payment or rebate schemes change because of the proposed policy, their impacts must be accounted for as well.

²¹ Source: IESO by e-mail, 12 August 2008.

²² See http://www.ieso.ca/imoweb/b100/b100_GA.asp and http://www.ieso.ca/imoweb/b100/b100_ONPA.asp, respectively.

7.b *Who counts?*

Throughout we have mixed the terms ‘social welfare’ and ‘aggregate well-being’. Let us add ‘public interest’ and acknowledge that we need to define the composition of ‘the public’. It would not be surprising if the Government of Ontario were primarily interested in legal residents of Ontario. Certainly, place of residence or citizenship could be used as a criterion for defining the public. However, such a definition might have unintended and undesirable consequences.

For example, we know that the import-export market for electricity would be affected if the proposal were to proceed. Out-of-province producers would provide less electricity to Ontario consumers and out-of-province consumers may face higher prices depending on the importance of Ontario exporters to them. If the impacts on them are to be ignored, are we to ignore the impacts on in-province producers who happen to be owned in whole or in part by non-residents?

Sometimes conflicts can arise between political geographic areas and economic ones. They seem to get resolved for the most part in the context of public sector projects when a dam, bridge or other structure would have impacts on two nations. If the project is in the interest of both countries, they often enter into explicit agreements for the sharing of costs. This type of agreement poses no problem for a cost-benefit analyst because he or she is usually not very interested in borders in the first place. That is, it would be the breadth of economic impacts that would define the geographic area of interest.

There are other ways to avoid border complexities. For example, in the cost-benefit analysis of the Rafferty-Alameda Dams in southeastern Saskatchewan, there was the problem that the flood control afforded by one of these dams would be a benefit to residents of Minot, North Dakota.. The American Congress allocated \$41.1-million (U.S.)

to the project, and this amount was assumed to be the present value of their benefit from flood control.²³ If the Canadian analyst were to assume that the present value of the cost of providing flood control to Minot was \$41.1-million (U.S.), the values would cancel and the complication of borders would be no more.

Regarding the distributional impacts of the current proposal, it may be best to align them to IESO's efficiency analysis.²⁴ If so, we will care about the impacts of the proposal within the province regardless of the personal characteristics of gainers and losers. If this view is accepted, only impacts on economic agents in Ontario would count.²⁵

8. Winners and Losers

We now describe the expected impacts of the proposed policy on various participants in the Ontario electricity market.

8.a Exporters

In IESO (13 May 2008) it is noted that exporters of electricity will lose if the proposal is implemented. The reasoning is that the (pre-dispatch) price they contract with other jurisdictions is not expected to change, whereas the in-province, real-time price will increase, thus reducing their profit margins and willingness to export. However, this loss

²³ See Townley (1999).

²⁴ See IESO (13 May 2008)

²⁵ A drawback of this method is that it ignores Ontario's 'portfolio' approach to the provision of electricity. That is, out-of-province producers, in a sense, provide insurance against in-province shortages.

of expected export surplus may overstate the impact of the proposal on particular exporters.

Consider a firm that produces electricity for export and for in-province use. If the real-time price of electricity increases, it will gain on the in-province market and lose on the out-of-province market. In order to exploit the proposal (or to ameliorate its negative impacts), the firm would likely allocate sales from out-of-province to in-province.

Because the firm is both a producer for export and a producer for domestic consumption, it is not clear whether the proposal would cause it a net gain or loss.

8.b In-province producers

In the current situation, when actual demand is less than forecast demand, it is possible for potentially lower-cost in-province generation not to displace previously contracted higher-cost imports. If the proposal is implemented, this will be a less likely occurrence, representing a gain to in-province producers. (Presumably, guarantee payments for baseload production will decrease.) Moreover, one expects the real-time price, the one relevant to in-province producers, to increase. The proposal, thus, would yield a net benefit to the owners of in-province producers. It is noted that these firms appear to be widely held.

If returns to these producers increase with the price, we would expect entry into this industry, which in itself would dampen the increase (and the gains of existing producers). We have discussed how in-province exporters may switch to production for in-province consumption. Also, new entrants may be attracted. This may be important given other ongoing policies. According to Beaugard-Tellier (2005, page 7) of the Library of Parliament,

“What is increasingly clear is that wholesale and retail electricity prices will have to rise if relatively inexpensive coal-fired generating capacity is to be replaced in the near term by cleaner-burning, but more expensive to operate, gas-fired power plants, renewable sources of power, and energy conservation measures. This will come as a shock to Ontario consumers and taxpayers, who have long been artificially sheltered from increases in the price of electricity.”

8.c Residential Consumers

Although we are not sure if residential consumers would pay more in total for electricity because the ‘price’ of electricity is not the lone form of payment or compensation or if, indeed, the price would be allowed to change, assume for the sake of argument that residential rates (only) would increase. Also, assume like other IESO analyses that the price elasticity of residential demand for electricity is zero, an assumption which exaggerates both the short- and long-term impacts of a price increase on householders. That is, assumptions have been made that would cause the proposal to have the worst possible impacts on households.

If we likened this forecasting proposal to a tax reform proposal, we would be interested in its regressivity, proportionality or progressivity. This depends on household expenditures on electricity as a function of income, thus the income elasticity of demand for electricity.

One expects electricity demand to be a monotonically increasing function of income. Starting from the lowest income group, we expect the homeless not to be affected by the proposal. However, as income increases, we expect expenditure on electricity to increase simply because we expect expenditures on electricity-using appliances (and house size) to be positive functions of income. However, because electricity is essential for many uses, we expect the proportion of income spent on electricity to decrease as income increases. Thus, we expect a *ceteris paribus* increase in the real-time price of electricity to be

somewhat regressive. However, a number of factors have been either ignored or assumed away.

- (i) There is the question of to what extent the real-time price per kilo-watt-hour reflects the amount residential consumers actually pay. To assess the impact of the proposal on them, information concerning all charges and how they might be affected by the proposal are required.
- (ii) In simulations, it was assumed that the quantity of electricity demanded was completely insensitive to price changes. Although it may be difficult for households to react immediately to a price increase, one expects this capability to increase with time, much as it has in response to various oil shocks. This will dampen negative impacts on households as their consumption of electricity decreases. Moreover, with the eventual implementation of ‘smart meters’ and time-of-use pricing programs, many consumers will be able to lessen the impacts of the policy by increasing their responsiveness to peak-load pricing.
- (iii) In **8.b** above, it was noted that the owners of in-province producers would gain and that these firms are widely held. To the extent that in-province households own in-province producers, residents will be worse off as consumers but better off as producers. We note, however, that many residents may be largely ignorant of what firms they have an ownership stake in unless they are familiar with the composition of mutual funds they may own or the portfolios of pension plans in which they are members. That is, they may be better informed of their potential losses than their potential gains.

8.d Industrial Consumers²⁶

Again, although the real-time price of electricity may not reflect totally what consumers pay or what producers receive, we will assume that it does for the purpose of discussion. The impact of an electricity price increase on industrial users will depend on the degree to which electricity has substitutes in their production processes and the market structure in which they exist. The first has to do with how difficult or easy it may be to avoid impacts on costs, and the second will be a determinant regarding the degree to which the electricity price increase might be passed backward onto other factors of production and/or forward onto consumers (thus further complicating the distributional impacts of the policy). Time to adjust is another factor.

No doubt some users will incur greater net losses than others, but the task of identifying and calculating the impacts on every commercial user would be enormous. A further complication arises when one considers that at least part of the ownership of these firms is by in-province residential consumers.

8.e Commercial & Institutional Consumers

Qualitatively, we expect the impacts on these users to be similar to those on industrial users. However, it is likely that elasticities of technical substitution among inputs differ significantly. Also, there may be significant differences in the ownership structures of these users and industrial consumers that would affect the intensity and spread of the proposed policy's impacts.

²⁶ We follow ICF Consulting (November, 2005) by separating commercial customers into Industrial (which includes transportation and agriculture) and Commercial & Institutional.

8.f *Importers*

Out-of-province producers are currently guaranteed the higher of their offer price and the real-time price. On average, the former will decrease and the latter will increase, and the volume of electricity imported into Ontario will fall. However, part of their payment is compensation for taking risks that will no longer be taken and another part is for electricity that will no longer be produced by them.

8.g *Government*

Impacts on the Government of Ontario (and its agencies) are likely to be several and complex given its roles as producer, consumer, regulator, debt holder and tax collector.²⁷ We expect the composition of the tax revenues it collects from businesses to change as the proposal would make some firms more profitable and others less so. Also, its rebate-recovery schemes will be affected.

A major change could be in the area of imports. Currently, out-of-province producers are guaranteed the pre-dispatch price or the real-time price, whichever is higher. If the proposal is implemented, the pre-dispatch price will decrease and the real-time price will increase. This should mean that the cost of the guarantee per unit will decrease. Moreover, the volume imported will fall. Therefore, the cost of the guarantee will decrease for two reasons. Our thinking is that at least some of this cost saving will accrue to government, thus improving its financial position and allowing it to pursue other activities in this market or elsewhere.

²⁷ To give a rough idea of its importance in electricity markets, the Ministry of Energy budgeted expenditures on the aggregate of IESO, OEB and OPA operating and capital expenditures for 2007-2008 of \$222,783,000. Source: <http://www.fin.gov.on.ca/english/budget/estimates/2007-08/volume1/ene.html>.

9. Assessment

The distributional impacts of the proposed policy are not clear-cut. Indeed, they are rather blurred for several reasons.

- The various prices of electricity in the Province of Ontario are not the only forms of payment or compensation in this regulated market. If prices change, various rebates and refunds may change, and this must be accounted for in any assessment of gains and losses.
- Some parties may be both gainers and losers. For example, an in-province producer who currently produces for both in- and out-of-province consumption will gain on one hand and lose on the other, respectively. Similarly, a residential customer who also owns shares (knowingly or not) in an in-province producer would lose as a consumer but gain as an owner. In such cases, being part of a particular group does not clearly identify one as a net gainer or net loser.
- Gains and losses appear to be spread across all income groups.
- A major transfer appears to be from out-of-province producers to in-province producers.

On the basis of the above observations, we are reluctant to associate a significant premium to any group's gain or loss per the balancing weights approach. We lack evidence of egregious distributional impacts. In fact, the various adjustment schemes appear to redistribute any wealth impacts of a price change, thus mitigating potentially egregious distributional impacts. Indeed, the most apparent transfer is from out-of-province producers to in-province producers.

Because of this, and subject to informational constraints, we advocate applying the Potential Pareto Improvement Criterion to the proposed policy. Thus, in the absence of evidence of significant equity issues or implementation-transactions costs, the proposed policy can be seen as economically viable because of its expected efficiency impacts.²⁸

To summarize, (1) the proposed policy would enhance economic efficiency significantly and unambiguously, (2) there is no finding that the distributional impacts of the proposed policy would be egregious, and (3) transactions (implementation) costs are considered to be negligible. Therefore, the assessment of the specific policy proposal within the general framework leads to much confidence that implementation of the proposal would, indeed, increase aggregate well-being.

²⁸ We have left aside the entire issue of the environment. If there is a divergence of private and social costs and/or benefits of electricity production and consumption, there is a case for government intervention. That issue exists regardless of the proposed policy, but it may be seen as a rationale for favouring higher electricity prices. That is, the proposed policy may cause additional allocative efficiency gains.

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