Recommendation to the Associate Minister on the Direct Use of Gas

December 2009

GAS INDUSTRY COMPANY LIMITED

152277.1

About Gas Industry Co.

Gas Industry Co was formed to be the co-regulator under the Gas Act.

As such, its role is to:

- recommend arrangements, including rules and regulations where appropriate, which improve:
  - the operation of gas markets;
  - access to infrastructure; and
  - consumer outcomes;
- administer, oversee compliance with, and review such arrangements; and
- report regularly to the Minister of Energy and Resources on the performance and present state of the New Zealand gas industry, and the achievement of Government's policy objectives for the gas sector.

Authorship

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Executive summary

Gas Industry Co is required by the April 2008 Government Policy Statement on Gas Governance ('GPS') to provide the Minister with advice on the extent to which policies to enhance the direct use of gas in various applications could result in the mitigation of greenhouse gas emissions.

This task, when considered alongside the Government's other objectives for the gas industry, resulted in Gas Industry Co examining direct use of gas applications that would result in the greatest economic benefit to New Zealand.

Concept Consulting Group Limited ('Concept') was engaged to consider the efficiency of various gas end-use applications and their substitutes. Concept was also asked to consider whether there were any externalities or barriers to the direct use of gas resulting in a less than optimal use of the fuel (from a national perspective).

The Concept study focussed on the three end-use applications most likely to provide national economic benefits: space heating, water heating, and boilers for industrial/commercial heat.

The results of the analysis show that the strongest case for promoting the direct use of gas is in relation to water heating. This is because instant gas water heating is usually the most economic choice for consumers and for New Zealand, but there may be barriers to consumers choosing this option.

The decision whether it is appropriate for Gas Industry Co to recommend any policies to promote the increased use of gas in relation to water heating is a finely balanced decision. It primarily rests on the assessment of barriers for the uptake of gas by consumers. Based on its understanding of those barriers, Gas Industry Co recommends extending the $1,000 water heating incentive available under the ENERGYWISE programme to include instant gas water heaters.

In relation to the other end-use applications, the Concept study shows that the most appropriate energy choice is very customer specific and depends upon a range of factors that are not always easy for consumers to understand. Gas Industry Co therefore recommends that an independent agency be tasked with giving consumers good information about the energy choices relevant to their industrial, commercial or domestic consumption needs so there are lower information barriers to their making efficient energy choices.

Contents

1 Introduction

The purpose of this paper is to provide information and analysis on the direct use of gas, and to provide advice to the Associate Minister on policies relating to the direct use of gas. In particular, this paper considers whether the direct use of gas should be promoted for some end-use applications.

The Government Policy Statement on Gas Governance (GPS) requests Gas Industry Co:

> ... to provide advice on the extent to which policies to enhance the direct use of gas in industrial, commercial and residential applications would mitigate greenhouse gas emissions and the likely costs of implementing those policies.

The GPS also outlines that:

> ... the Government's objective for the entire gas industry is as follows: to ensure that gas is delivered to existing and new customers in a safe, efficient, fair, reliable and environmentally sustainable manner.

Gas Industry Co has considered these two objectives and has concluded that, in the context of direct use of gas, it should seek to identify outcomes that provide an overall economic benefit to the nation. The analysis needs to identify the efficiency and cost of using different fuels, any capital costs involved, and any indirect costs, including external factors, such as greenhouse gas emissions. The analysis also needs to take into account possible barriers to the direct use of gas that may be working to prevent good outcomes.

This paper identifies three key energy services where direct use of gas might be preferred to alternative fuel options, and explores:

- which fuel option to provide that energy service is likely to yield the greatest benefit to the nation;
- the extent to which current market arrangements might be preventing such outcomes; and
- possible policy responses in areas where outcomes appear to be less than optimal.

2 Background

The direct use of gas is not a new issue, and there have been two previous studies on this topic:

- a 2004 report by Charles River Associates (CRA) for Energy Efficiency and Conservation Agency (EECA): *Increasing the Direct Use of Natural Gas in New Zealand*; and
- a 2007 report by the New Zealand Centre for Advanced Engineering (CAENZ) for Gas Association of New Zealand (GANZ): *Understanding the Contribution of Direct Use of Gas to New Zealand's Future Energy Efficiency Objectives*.

The following table summarises the outcomes from the two studies and highlights that they produced different results, and came to conflicting conclusions.

	CRA study - 2004	**CAENZ study - 2007**
Key result	'The net national benefit from the increased direct use of natural gas was always negative' [Emphasis added] However, it didn't consider space and water heating separately, and didn't consider industrial energy use	Quantitative analysis showed the best options were: • Electric heat pumps for space heating • Solar or electric heat pumps for water heating • Gas for commercial / light industrial water heating (although coal and renewables were not considered) • Gas for cooking • Gas for commercial heating, ventilation and air conditioning
Policy conclusion	'Only a modest role, if any, is likely to be justified for government. Such involvement, if undertaken, would most usefully focus on ensuring that the market has independent and accurate information about the reserves and future availability of gas supplies and the potential benefits and costs of its use'	'When considered in terms of the total fuel supply chain, the direct use of natural gas in the residential, commercial and industrial markets has considerable merit'. [Although this seems inconsistent with the quantitative results outlined above] 'New Zealand has a strong strategic interest in ensuring a robust domestic gas industry is in place for the medium to long term as the country looks to respond to the emergent risks of climate change, supply security, and sustainability. This requires that consumers, industry and government think more broadly about the role of natural gas and LPG in meeting New Zealand's future energy needs'

Certain aspects of the methodologies applied by CRA and CAENZ have been questioned by some parties and there have been suggestions that the analysis was not sufficiently comprehensive to provide the robust information necessary for good policy decisions. In particular:

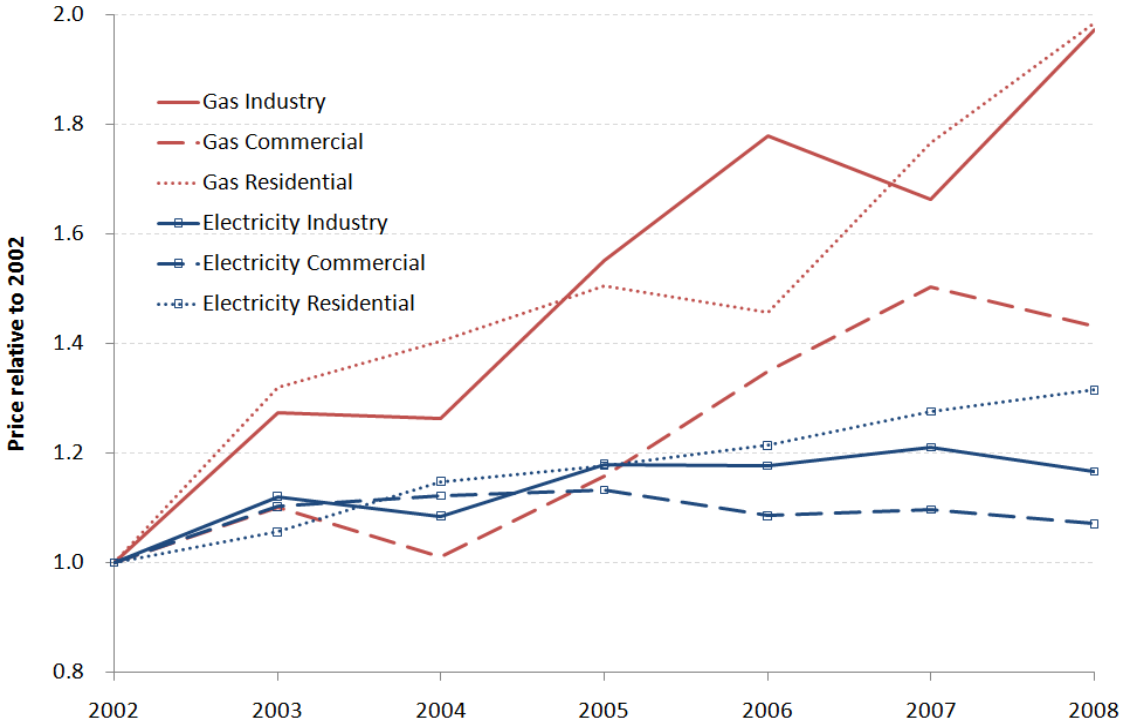
- not considering capital costs for the relative economics of different fuels (CAENZ);
- not differentiating between the private benefit to consumers based on prices and costs, and the public benefit to the nation based on underlying resource costs (CRA and CAENZ);
- not considering all the potential energy end-use options (CRA and CAENZ); and
- not differentiating between the many different customer situations - particularly size of heat load, new-build versus switching from existing appliances, and whether gas would be used for more than one application (CRA and CAENZ).

There have also been significant changes since the first report that materially impact on the analysis and conclusions, including:

- changes in gas supply with the decline of Maui;
- gas prices having increased at a faster rate than electricity;
- the introduction of greenhouse gas emission charges; and
- technology development, particularly the significant improvements in electric heat pump efficiencies and costs.

The relative change in prices between gas and other fuels has been particularly marked. Figure 1 illustrates that gas prices for residential and commercial consumers have almost doubled (in real terms) since 2002, while electricity prices have risen by 20-30%.

Figure 1: Real change in gas and electricity prices for industrial, commercial and residential consumers relative to 2002



Source: Concept analysis based on MED 2009 Energy Data File

Accordingly, Gas Industry Co commissioned Concept to undertake a comprehensive study on the direct use of gas using up-to-date information and addressing some of the possible deficiencies with the earlier work.

3 Policy goals and the role of Government

Focus on markets

The emphasis of government policy for the energy sector is on enhancing competition as the principal means of providing benefits to consumers. There is an expectation that consumers will benefit over the long-term from the pressures on competitors to minimise costs, and that price signals will generally allocate energy resources to where they have the highest value. Much of the work of Gas Industry Co is therefore designed to facilitate and encourage competition.

Government policy also recognises, however, that there may be situations where a reliance on competition and price signals does not always lead to the right outcomes from a national perspective. Where there are particular external factors that do not feed directly into energy prices or where there are other barriers preventing positive outcomes, it may be necessary to intervene with particular policy initiatives. An example of such intervention is the financial incentives currently available for home insulation.

Grounds for intervention

Before intervening with particular policy initiatives, it is important to identify any external factors or barriers that may be preventing good outcomes, and to establish whether they are sufficiently problematic to justify intervention.

Appropriate policy intervention to rectify possible market failures in these areas could take several forms including:

- making better information available to consumers in order to facilitate better decisions;
- pricing externalities into markets in order to provide price signals that facilitate private decisions more in line with national benefit;
- providing some form of financial incentive to help counteract the effect of externalities or other barriers; and

- mandating certain outcomes through regulatory action.

The most appropriate form of intervention will depend upon the particular circumstances and the degree of market failure. There would need to be significant national benefit, and a lack of other credible interventions, to justify mandating particular outcomes through regulatory intervention.

The benefits of policy intervention can be particularly material where there is a significant market failure. For example, most developed economies have chosen to implement policies and incentives designed to encourage efficient energy end-use in order to overcome well-identified barriers. Many of the intiatives introduced by EECA through the ENERGYWISE programme fall into this category.

In the gas sector there are several barriers that tend to make it difficult for gas to be chosen by consumers for particular end-use applications. These include the capital cost of particular gas appliances, perceptions about the health and safety risks of gas as a fuel, concerns about security of supply, lack of information about the cost of different fuels, and the need to apply for consents for particular gas installations. Changes to the structure of the energy sector, in particular the progressive separation of energy retailing from distribution, may also have raised some barriers to the direct use of gas. These are factors that need to be taken into account in deciding the appropriate form, if any, of policy intervention.

However, the first step is to assess the relative efficiencies of different end-use applications.

Concept comparision of end-use applications

The Concept study compares the costs of providing particular energy services from direct use of gas, relative to other fuels, from two different perspectives:

- from an end-consumer perspective based on the prices consumers face for fuels and appliances (the **private benefit** of gas); and
- from a national perspective based on the underlying resource cost implications for New Zealand, including externalities (the **national benefit** of gas).

This analysis helps to identify market arrangements where the price signals that consumers face may be resulting in a different energy choice from that based on a national perspective.

The Concept study has also examined whether there may be other barriers that are preventing consumers from choosing the best energy option.

4 Approach to analysis

Identifying key market segments

In order to determine which energy end-uses should be analysed, Concept adopted the following selection criteria:

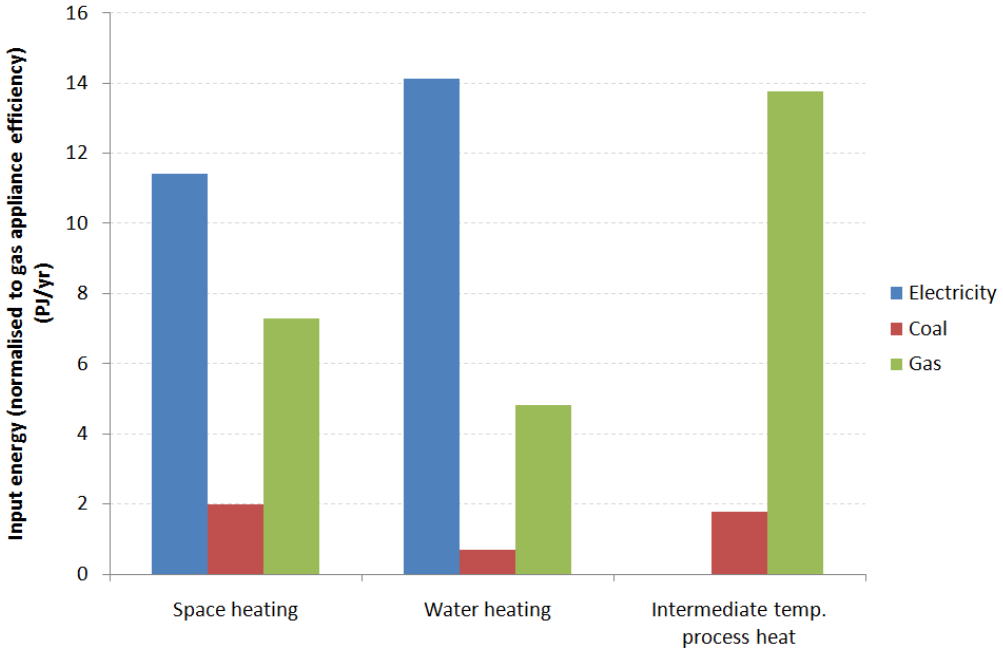
- *The end-use should represent a non-trivial quantity of energy*. Thus, cooking and many low-and intermediate-temperature process heat requirements were excluded;
- *Gas should be a practicable alternative to other fuel choices*. Thus, end-uses that have highly process-specific drivers behind fuel / technology choices were excluded (for example many high temperature process heat applications); and
- *The end-use analysis should be tractable given the scope and timeframe of the study*. In this respect, consideration of compressed natural gas (CNG) for transport was excluded.

Appendix A summarises the application of this selection methodology. The overall conclusion was that the analysis should focus on three particular end-use applications:

- space heating;
- water heating; and
- boilers for industrial/commercial heat.

These three end-uses collectively provide the best opportunities for the direct use of gas to substitute for other fuels. Figure 1 illustrates the scale of energy use represented by these three applications and identifies the opportunity for direct use of gas to substitute for other fuels.

Figure 1: Annual quantities of electricity, coal, and gas consumption to deliver space heating, water heating, and intermediate process heat in the North Island



Source: Concept analysis based on EECA energy end-use database

This chart identifies significant opportunities for direct use of gas to substitute for electricity in space heating and water heating, in particular. In the process heat area, the chart suggests that direct use of gas is already the preferred means of firing industrial boilers in the North Island and the opportunity to substitute for coal is limited to 2 petajoules (PJ) per annum. If every North Island consumer that used electricity or coal to provide space, water, or intermediate process heat switched to gas, this would represent a total of approximately 30 PJ per annum. This compares with a total annual gas consumption of approximately 150 PJ – 45 PJ reticulated to residential, commercial, and industrial users, 25 PJ converted to methanol/urea, and 80 PJ used in electricity generation.

The potential for increased direct use of gas is therefore reasonably substantial. Having identified the three areas worthy of closer examination, the Concept study focussed on whether it would be beneficial from a private perspective and a national perspective for further direct use of gas in these areas.

Approach and key assumptions

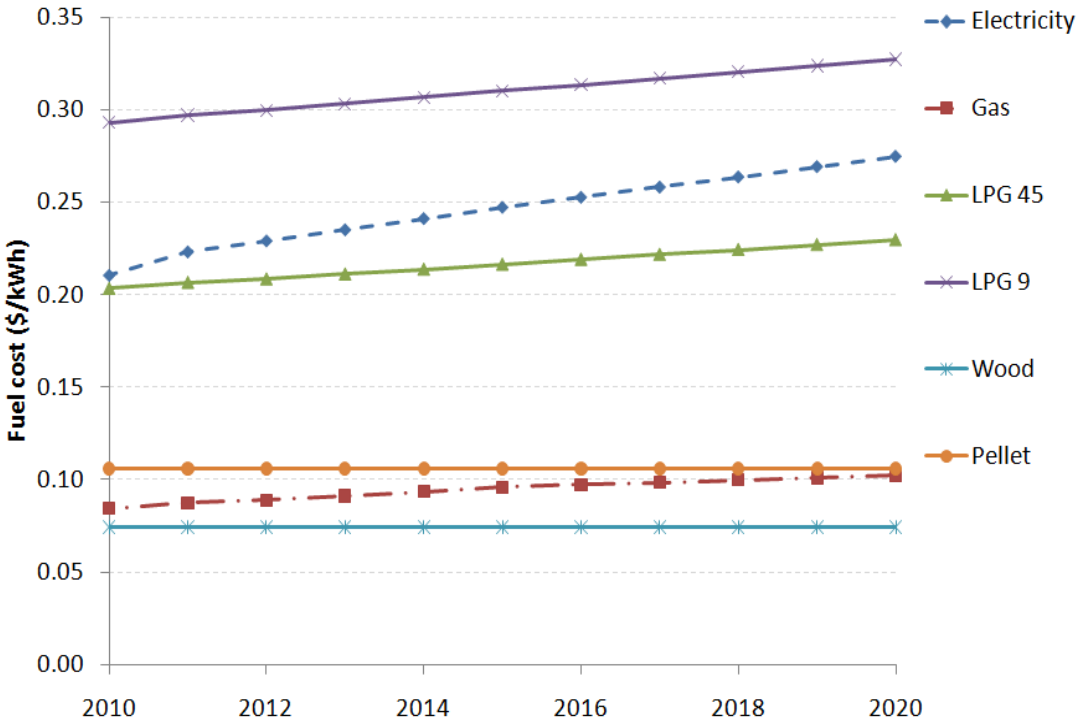
The Concept study included detailed quantitative analysis to determine the costs of providing the three energy services (space heating, water heating, and process heat from boilers) for a range of different fuel and technology options in order to work out which was most economic.

Importantly, for space and water heating, the analysis took account of the fact that the economics of heating are very situation specific. In particular, the size of the customer heat load, the location, and whether there is an existing appliance, can all have a material bearing on which option is the best in a certain situation.

The factors that have the greatest bearing on the relative economics are fuel prices, fuel CO_2 emissions intensities, appliance capital costs, and appliance efficiencies.

The fuel price assumptions Concept used are illustrated in Figure 2. It shows that wood, pellet, and gas prices are all much lower than electricity and LPG prices.

Figure 2: Variable fuel price projections[1]



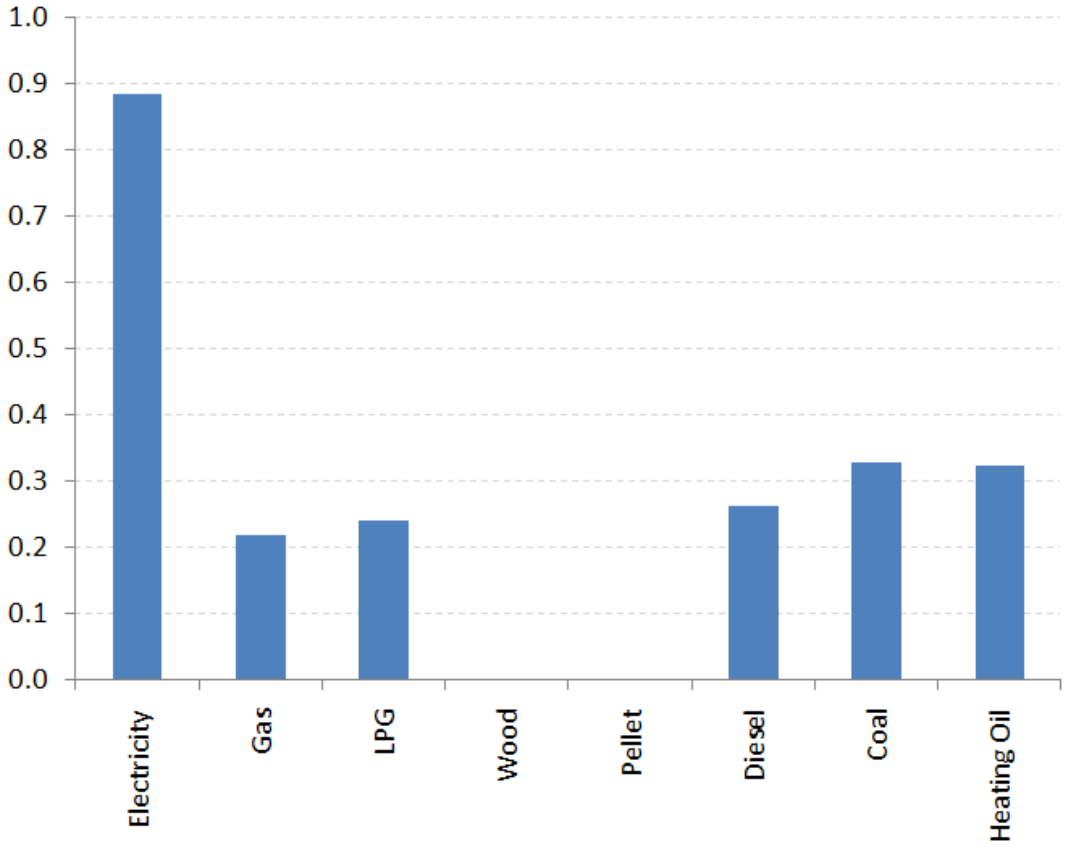
Source: Concept analysis based developed from a range of forcasts

Critical to the Concept study is the assumption about the emission intensity for the various fuels. For the emission intensity of electricity, Concept used an electricity market simulation model to determine what type of electricity generation would be used to meet an increase in electricity space or water heating, taking into account the very 'peaky' shape of space and water heating load[2].

[1] 'LPG 45' and 'LPG 9' refer to the price of 45kg and 9kg bottles (with the 9kg bottles only being used for cabinet space heaters).
[2] Thus, compared with electricity used for an industrial or commercial use, electricity for space heating is relatively infrequently called upon, and is dominated by winter periods and the morning and evening peaks. Similarly, there is greater water heating in winter than in summer, plus a greater use of water heating in the morning and evening peaks.

This analysis indicated that an increase in electricity-based space or water heating load would predominantly be met by an increase in Huntly coal-fired generation, with very little being met by an increase in renewable generation. The resulting input fuel emissions factors are shown in Figure 3.

Figure 3: kg CO_2/kWh emissions intensity of delivered fuels used as *inputs* to end-consumer appliances



Source: Concept and CAENZ analysis

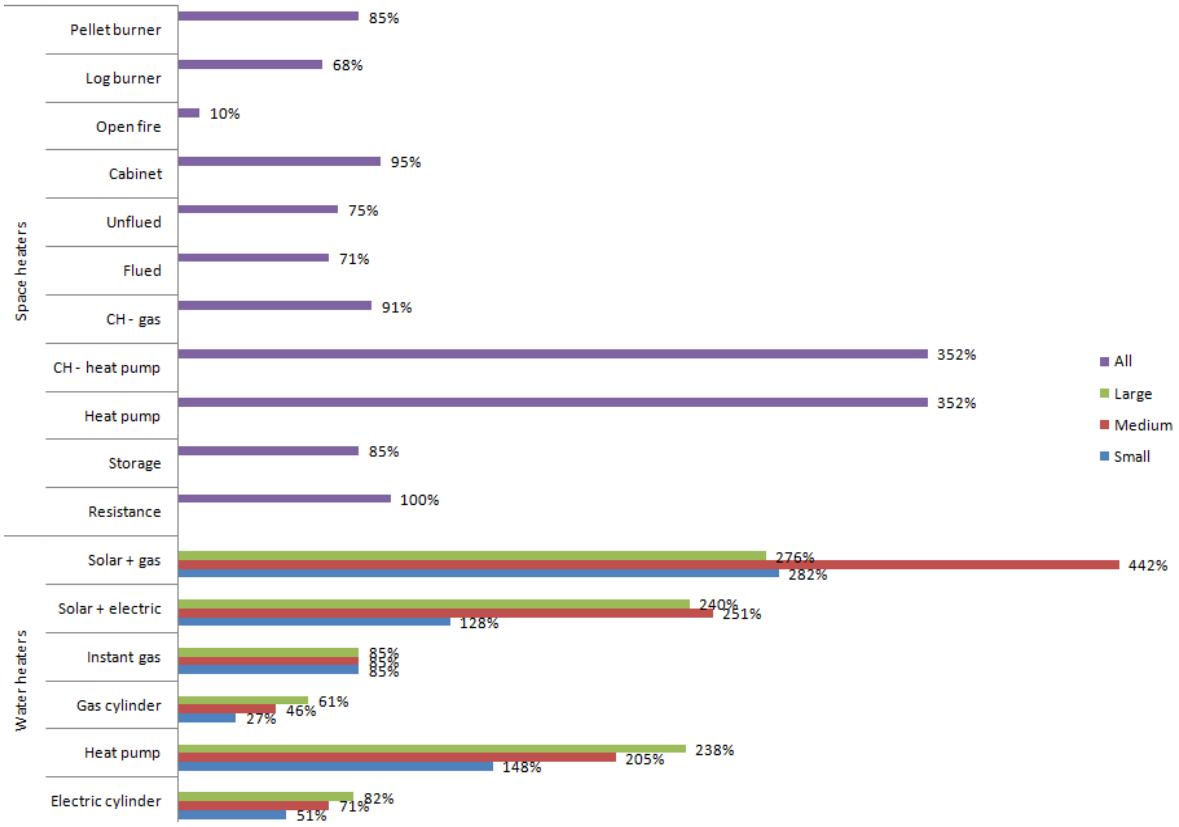
This chart indicates that the use of electricity for space and water heating produces more than four times the emissions than the direct use of gas. It is important to note that the use of wood in log burners and pellet burners is assumed to produce no net emissions, based on an assumption that the fuel is provided from a renewable source (ie, replanting will absorb the CO_2 produced by combustion).

The Concept study established detailed appliance efficiency assumptions, which are illustrated in Figure 4. The key points to note with respect to appliance efficiencies are:

- The development of heat pump technology for space heating has led to very high coefficients of performance (high efficiency);
- The development of solar water heating technology has also led to very high efficiencies;

- Cylinder based water heaters (that is, all water heaters apart from instant gas water heaters), suffer considerable degradation to their overall efficiency as a result of cylinder standing losses – particularly for small water heating loads.

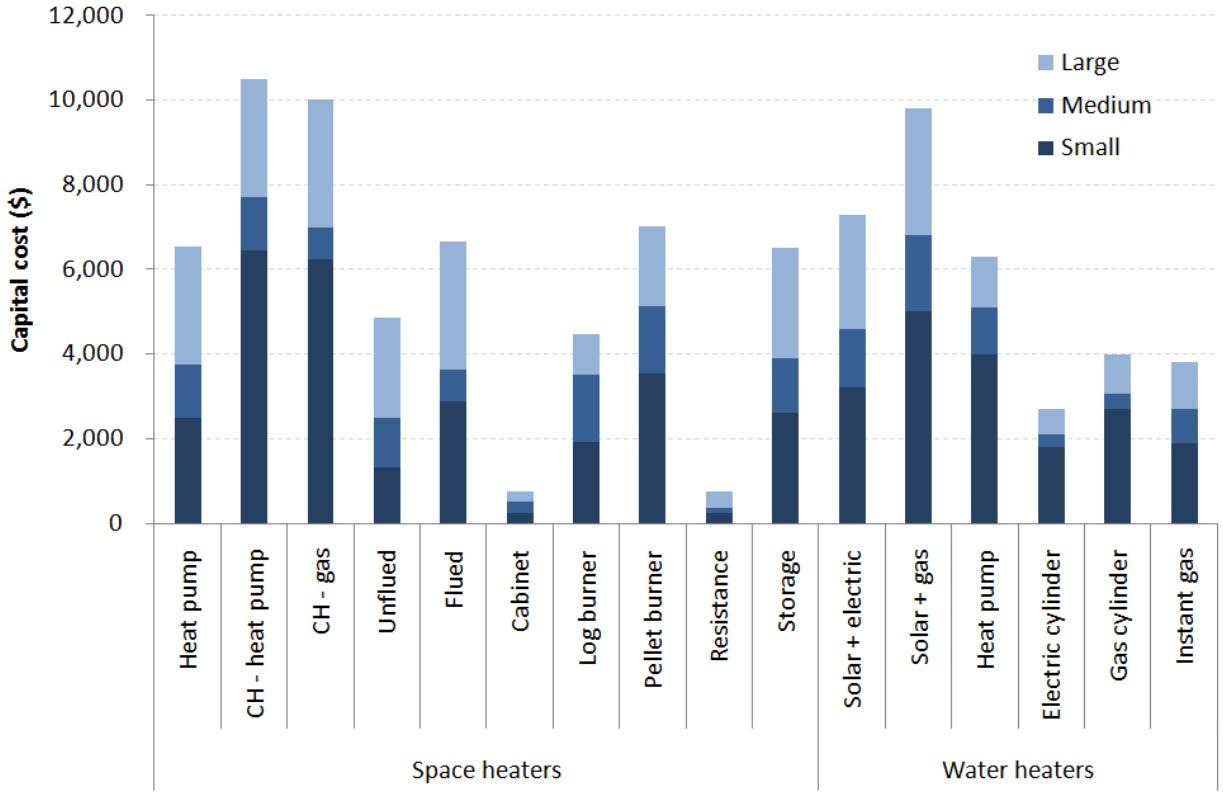
Figure 4: Comparison of space and water heater coefficients of performance



Source: Concept research

With respect to appliance capital costs, the Concept study assumed an appropriately sized appliance for the heating load (for example, it is assumed that a 'medium Wellington' space heating load would require a materially larger appliance than a 'medium Auckland' heating load). Figure 5 summarises the appliance capital cost assumptions for Wellington customers of varying sizes:

Figure 5: Appliance capital costs for small, medium, and large Wellington customers



Source: Concept research

The key points to note include that:

- for small heating loads, appliance capital costs can represent a disproportionately large amount of overall heating costs, making capital intensive technologies relatively less attractive; and
- there is considerable variation in the capital intensities of the different heating options, with gas cabinet heaters and electric resistance heaters, in particular, having very low cost relative to other space heating options.

Analysing private and national benefits

If there were no external factors, then the price signals to consumers would exactly reflect the resource opportunity costs from a national perspective, and the private benefit of a heating option would equal the national benefit. In many cases (particularly the price of fuels other than electricity or gas, and appliance capital costs) the price signals to consumers are very close to the underlying resources costs to the nation. However, there are a number of situations in the energy sector where external factors can result in the price signals to consumers being materially different to the cost to the nation. Each of these is briefly described below.

CO_2 emissions

The cost to the nation from CO_2 emissions is assumed to be the international price of CO_2 for which the New Zealand Government is liable via the Kyoto Protocol and its successor. However, under the current design of the New Zealand Emissions Trading Scheme (ETS), it is proposed that a cap be imposed on the price of CO_2 faced by New Zealand companies at least until 2012. The level of this cap is NZ$12.50/t CO_2 compared with expected international prices in the NZ$30-50/t CO_2 range.

While a cap is in place, the price signal to consumers of electricity, gas, coal, and diesel will be lower than the underlying resource cost to the nation. To address this, Concept's national benefit analysis assumes that the cost of each fuel includes the full international price of CO_2.

The cap is assumed to be progressively removed after 2012, thereby reducing the difference between national and private benefits, as a result of emissions, progressively over time.

Time-of-use drivers of electricity and gas systems

Most mass-market consumers receive a flat all-year tariff for their electricity. However, the underlying electricity system costs are strongly driven by the need to have sufficient supply-side resources (generation and network) in place to meet periods of peak demand. The Concept study takes account of this for the national benefit analysis by introducing a strong time-of-use element to electricity costs. Thus, costs at times of winter peak are assumed to be almost four times greater than at times of low demand.

This has a significant impact because the demand for space (and to a lesser extent water heating) is very strongly concentrated in peak periods. This can materially increase the cost of electricity heating options when considered from a national perspective.

Gas supply suffers much less from these peak period issues, in part because of the linepack inherent in the pipelines, and in part because of the flexibility of gas supplies. However, it is noted that, as the Maui gas field declines, the lack of flexibility in new gas fields could lead to greater differentiation between Summer and Winter prices.

Treatment of sunk costs

The 'true' cost of an energy option should reflect the resources that would be consumed that are associated with its use. Thus the resources associated with manufacturing an appliance should be reflected in its capital costs, and the variable costs of fuel consumption should be reflected in the price of the fuel.

However, the price to consumers of electricity and gas also includes a significant component to recover the cost of sunk network assets. From a national perspective, the only network costs that should be taken into account when considering the economics of electricity and gas options are any

increases in network costs that would be a direct result of such consumption. Thus any sunk costs should be ignored. For most gas networks, there is a significant amount of spare capacity such that an extra gas customer will not result in extra gas network costs. Accordingly, for the analysis from a national perspective, only approximately 10% of gas network charges were considered to be driven by increases in consumption. Electricity networks, on the other hand, are generally more capacity constrained such that extra electricity consumption will increase the need to make extra electricity network investment. Accordingly, for the analysis from a national perspective, approximately 50% of electricity network costs were considered to be driven by consumption.

The impact of this approach is to increase the cost of electricity options relative to gas options from a national perspective.

Treatment of fixed costs

A key driver of the economics of gas to consumers is whether they view the fixed charges from gas retailers as avoidable. Thus, if they only use gas for one use (ie space heating or water heating or cooking), then the relative economics of direct use of gas compared with non-gas options should include gas fixed charges. On the other hand, electricity fixed charges should be excluded when considering electricity heating options because consumers will always need to be connected to the electricity network.

The analysis also considered the economics in situations where consumers use gas for more than one use. In these situations, the fixed charges for gas were excluded when considering the relative economics of heating options.

Timescale over which options are evaluated

Some energy options have high appliance capital costs and low variable costs (for example, solar water heating), while others have low capital costs and high variable costs (for example electric resistance heaters and LPG cabinet heaters). Accordingly, the timescale over which the Net Present Value (NPV) calculations are undertaken can have a material impact on the relative performance of the measures.

The evaluation from a private consumer perspective used a timescale of 10 years (because this was considered to be a reasonable estimate of the timescale that consumers apply in making such decisions), whereas from a national perspective 15 years was used (because this is a more typical timescale for considering energy investments). Using the different timescales has the impact of favouring capital intensive options more from a national perspective relative to a private perspective.

Health impacts

There is an increasing appreciation that there are significant health costs associated with people living in cold homes. To the extent that a space heating option results in homes being heated more, then considerable health benefits can be realised.

However, because the Concept analysis calculates how much it would cost to heat homes to the same level, it would not be appropriate to award health benefits to some heaters over others.

Where an impact has been included is in the treatment of unflued gas heaters, where a cost of poor indoor air quality[3] is accounted for.

[3] Noting that some overseas jurisdictions, including many Australian states, have banned some unflued gas appliances (principally LPG cabinet heaters) on health and safety grounds.

5 Space heating

Results of space heating analysis

The Concept study revealed that the best space heating option is very situation specific, with the answer particularly depending on the size of the customer heating load, and whether the customer has an existing workable heating appliance.

However, in general[4], the following predominant energy options were consistently 'best' from a private benefit perspective:

Space Heating	New build	Existing workable appliance
Low user	Resistance electric heater	Stick with existing appliance, except for LPG heaters or open fires[5]
Medium user	Electric heat pump or log burner	Stick with existing appliance, except for LPG heaters or open fires
Large user	Electric heat pump or log burner	Consider converting to electric heat pump or log burner

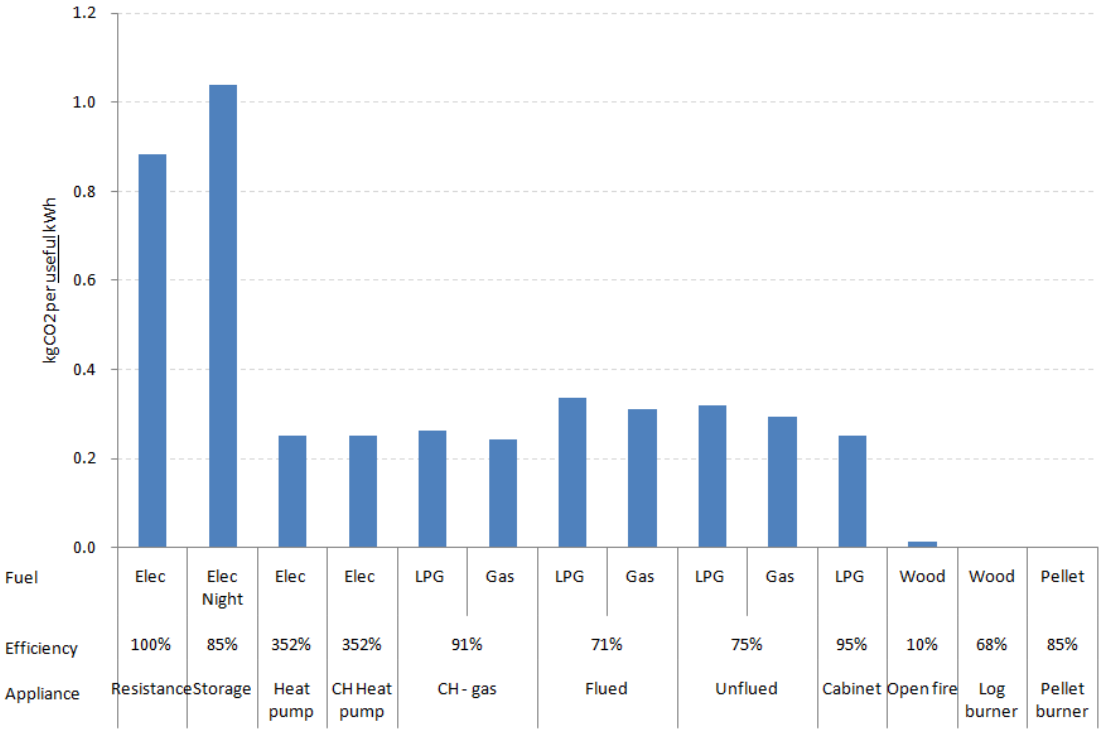
Although electricity is a more expensive fuel, and is more emission intensive than other fuels, the low capital cost of an electric appliance (for low users) and the much higher efficiency of a heat pump (for medium to large users), makes electricity the cheapest option in a new build situation. For existing large users it is also worth considering switching to electric heat pump or log burner.

From a national benefit perspective, the outcome is similar, despite the higher emission intensity of electricity and despite the spare capacity inherent in the gas networks, relative to the electricity networks. Thus, from a national benefit perspective, electric heat pumps and log burners remain the best option for medium and large users. For small users it is less clear cut, and moving away from resistance electric heating is desirable from a national benefit perspective.

[4] Noting that there were a variety of exceptions for particular circumstances.
[5] For small heating loads provided by gas heating, the consumer may also benefit from switching away from gas and avoiding the gas fixed charges.

When considered purely from an emissions perspective, even though electricity is very emission intensive when used for space heating, the high efficiency of heat pumps means the CO_2 emissions per useful kWh is less than for direct gas space heating. This is illustrated in Figure 6.

Figure 6: CO_2 emissions associated with different space heating options



Source: Concept analysis

A further issue considered in the Concept study is whether gas space heating may deliver superior 'utility' to consumers relative to heat pumps. In particular, there have been suggestions that consumers have been finding that heat pumps have not worked as well as expected. The key points noted by Concept are:

- Gas heating can heat the home from cold faster than a heat pump, particularly if the heat pump is not well-sized to the space. However, the value associated with the extra time to heat a house from cold is hard to quantify. Further, in a well insulated house, this should not be a material issue;
- Problems with heat pumps not providing sufficient heat in very cold situations is largely a result of purchasing heat pumps that are too small, and these problems have principally been in the lower part of the South Island (where natural gas is not an option). An appropriately sized heat pump for the load and the climate should be a good option – particularly if it is one of the heat pumps credited with an Energy-Star performance label by EECA;

- Problems with consumers finding their heating bills are larger than they expected have generally been a result of purchasing heat pumps which are too small and / or using an inappropriate heating regime; and
- Heat pumps deliver additional utility in summer through air conditioning - this appears to be of increasing value to consumers.

Exploring policy options for space heating

The data that is available[6] suggests that many consumers are choosing heat pumps as their preferred means of space heating, rather than flued gas heating. This appears to be a logical consumer choice given the results of the Concept study. Unflued gas space heating has undesirable health-related side effects and conversion to a flued system of gas space heating incurs significant capital costs, which cannot be ignored in a private or national benefit analysis. Further, the Concept analysis suggests that electric heat pumps may provide the highest national benefit, particularly for new build situations, and potentially for large user existing situations. This is because the high coefficients of performance available in modern heat pump applications make them efficient and relatively low in carbon intensity.

The Concept study highlights that the decision about which space heating option is the right one for a particular situation is not straight-forward and that consumers will likely face difficulty in obtaining good quality information and making the right choice about the energy appliance most suited to their home. Successive consumer forums have persuaded Gas Industry Co that many consumers find home heating to be a complex decision and not all of them have access to the right information to make the right choice for their needs. Therefore, Gas Industry Co considers that an independent agency (such as EECA) should be tasked with making information available so that consumers have simple, up to date, and accurate information that will enable them to make an informed decision about their space heating requirements.

It is also worth noting that consumers considering flued gas space heating can apply for an incentive of $500 towards their gas appliance under the Warm Up New Zealand fund administered by EECA. This $500 is also available for the other technologies classified as ‘clean heat’, including log burners, pellet burners, and electric heat pumps. The policy justification for this incentive is understood to be based on improving indoor air quality (where people have an existing unflued gas heater) and outdoor air quality (both local air quality issues associated with ‘dirty’ solid fuel combustion and greenhouse emissions).

[6] In particular the data from uptake of different heating options under the EECA Warm Up New Zealand scheme.

6 Water heating

Results of water heating analysis

The Concept study revealed that the best water heating option is very situation specific, with the answer particularly depending on the size of the customer heating load, and whether the customer has an existing water heating appliance.

However, in general, the following predominant energy options were consistently 'best' from a private benefit perspective.

Water Heating	New build	Existing workable appliance
Low user	Instant gas*	Stick with existing appliance
Medium user	Instant gas*	Stick with existing appliance
Large user	Instant gas*	Consider switching to instant gas if gas is going to be used for more than just water heating

*Instant gas is clearly favoured where gas is used for other purposes within the household. If gas is to be used only for water heating, electricity and LPG become more competitive water heating options.

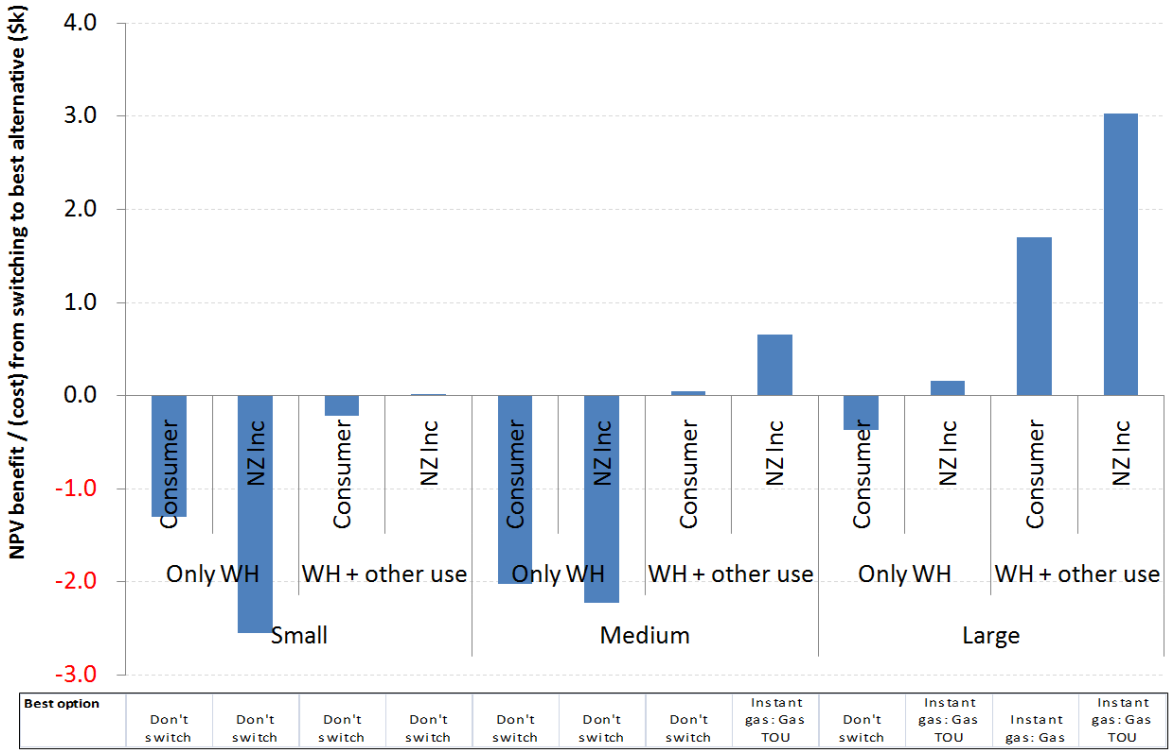
In new build situations instant gas is the preferred fuel, particularly if gas is used for other purposes within the household. When considered from a national benefit perspective, the results are clearer, with instant gas favoured in most new build situations.

For situations where the consumer has an existing appliance, the answer as to what is the cheapest option is less conclusive. Figure 7 illustrates the net benefit of switching from an existing electric cylinder (which is the predominant water heating option for the vast majority of existing homes) to instant gas water heating, from both a private and a national benefit perspective. This suggests that from both a private and national perspective, it is economical to switch to instant gas water heating for large consumers where gas is already used on the premises. From a national perspective, there is also a case that supports medium consumers switching if they have gas already used on the premises.

Overall, it appears that the private benefit aligns reasonably well with the national benefit, although there is a slightly stronger national benefit associated with instant gas.

The Concept study also suggests that there are likely to be additional customer utility benefits associated with instant gas water heating compared with electric and gas cylinders, since the hot water supply is never exhausted.

Figure 7: Economics of switching away from an existing electric cylinder water heater in Wellington[7]



Source: Concept analysis

There is no reliable public information on the extent to which consumers are responding to the private economics and installing instant gas water heating in new build situations. There is also no reliable public information on the rate of conversions to instant gas from existing appliances. However, informal feedback from gas distribution companies suggests that instant gas water heating may be installed in between 50-65% of new properties where gas is available. Further, the number of conversions from existing water cylinders to instant gas water heating also appears to be relatively low.

Where consumers are not choosing instant gas water heating (indicatively 35-50% of new build), this may be because instant gas is only marginally better than the next best alternative in some situations (particularly where gas is only going to be used for water heating), and worse in many situations where a consumer has an existing electric cylinder. Alternatively, it may be a result of other barriers.

[7] The analysis for Auckland is very similar to that for Wellington.

As a measure of how material the savings available from instant gas water heating could be, we note:

- each instant gas water heater provided in a new build situation will save $3200 (on average in net present value terms) relative to a conventional electric cylinder[8];
- each instant gas water heater provided in place of an existing electric water cylinder supplying a large water heating load will save $2900 (on average in net present value terms);
- if all 14 PJ of existing electric water heating was converted to instant gas, the saving in CO_2 emissions would be approximately 430,000 tonnes per annum, reducing New Zealand's CO_2 emissions by 0.6%.

Exploring policy options for water heating

Although the Concept study suggests that there is a reasonably close alignment between the private benefit of direct use of gas in water heating and the national benefit of direct use of gas in water heating, it appears that the private benefit available to consumers from direct use of gas may not be translating into instant gas water heating as the dominant form of water heating. The factors that could be contributing to this outcome include:

- in new build situations it is often the architect and / or builder that determines the form of water heating installed and they do not necessarily have the same interests as the owner;
- there are transaction costs associated with conversion of existing water heating appliances to instant gas (including meeting local council requirements);
- consumers may not be aware of the relative economics of converting an existing installation to direct use of gas;
- even if consumers are aware of the relative economics, they may not have access to capital, or may not be sufficiently motivated by the economics to incur the transaction costs involved in a conversion; and
- the structure of the energy sector has created a situation in which there is no obvious and natural advocate for the direct use of gas as a fuel for water heating.

Some stakeholders suggest that it would be most appropriate for gas industry participants to promote instant gas water heating to consumers. This was essentially the conclusion of the CRA report.

However the separation of energy retailing from distribution appears to have diluted the incentives amongst industry participants to promote the direct use of gas. There are four potential industry participants that may have a commercial incentive to support the installation of instant gas water heating:

[8] Provided gas is used for other purposes on the premises.

- gas retailers are unlikely to have strong incentives since they are largely neutral as to whether they supply electricity, gas, or LPG to customers. It would be hard for them to gain returns on any money spent on promoting one fuel over another;
- appliance retailers may have an incentive to promote instant gas water heaters, but may lack the information to make a compelling case to the consumer; and
- upstream gas companies are unlikely to have strong incentives because water heating load represents a relatively small proportion of national gas sales, and the within-year consumption profile of water heating requires a significant level of swing.

It is noted that, before the separation of retail and distribution, it was relatively common for gas companies to fund marketing and information campaigns, subsidise customer gas connection costs, and to provide incentives for the purchase of gas appliances. As this is no longer occurring to the same degree it is suggested that the Government should charge an independent agency (such as EECA) with responsibility for providing better information to consumers in order to facilitate better consumer choices in relation to both installation in the new build situation and conversion from existing electric and gas water cylinders.

It is a finely balanced decision as to whether the barriers to instant gas water heating are sufficiently material to warrant some form of additional government policy intervention, such as providing some form of financial incentive to facilitate the installation and/or conversion of water heaters to the direct use of gas. However, Gas Industry Co notes that, through the EECA ENERGYWISE program, it is already possible to apply for a $1,000 water heating incentive. Currently, this is limited to solar water heating and a pilot program to support heat pump based water heaters. Using an existing programme of this kind is likely to be the lowest cost way to deliver an incentive for instant gas water heating.

7 Industrial process heat

Results of analysis

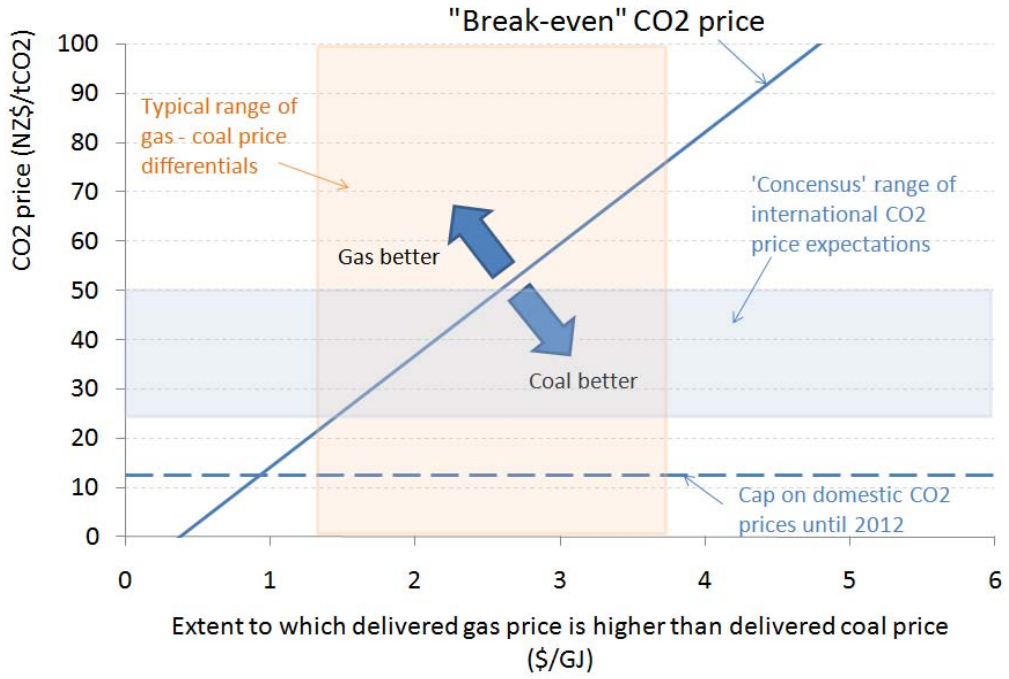
The Concept study suggests that industrial boilers are the predominant use of energy for process heat. The opportunities for direct use of gas are essentially limited to coal-fired boilers in the North Island used in the dairy and meat processing sectors; a market estimated at about 2PJ per annum.

Fuel costs are a much greater proportion of overall costs for industrial users relative to residential users (where network, retail, and appliance costs make up a considerable component of the overall costs to consumers). The significant increase in the cost of gas over recent years has made the economics of gas relative to coal a lot more challenging for boiler installations. For large industrial users in the North Island, delivered coal prices are estimated to be in the $5.5-6.5/GJ range, whereas delivered gas prices are believed to be in the $8-10/GJ range. Thus gas is typically $2-3/GJ more expensive than coal, although the price differential can vary considerably according to circumstance.

From a consumer perspective, therefore, the private economics generally do not support switching from coal to gas. Indeed, the rise in gas prices relative to coal suggests that there may be a significant risk that the 14PJ per annum direct use of gas to fire boilers in the North Island could be under challenge from coal. Gas Industry Co is aware of anecdotal evidence that some existing industrial consumers are contemplating a possible shift from gas to coal firing.

Coal-fired boilers produce about twice as much CO_2 as gas for the same heat output. Accordingly, the national benefit of gas will be greater than coal if the cost of CO_2 is sufficiently high. Figure 8 illustrates how the breakeven CO_2 price (above which gas is better than coal) varies with the gas – coal price differential. This chart suggests that, for example, if gas is $3/GJ higher than the price of coal, then coal will be favoured if CO_2 price is less than $50/t$CO_2$.

Figure 8: Break-even price for coal-gas boiler conversions



Source: Concept analysis

Under the proposed ETS, the price of CO_2 that New Zealand industry will face is capped at NZ$12.50/t CO_2 until the end of 2012. This will likely be a material discount to the international cost of CO_2 faced by New Zealand, and as such will drive a 'wedge' between the private benefit of gas to consumers and the national benefit.

The current international price of CO_2 is approximately NZ$25/t CO_2, although it has typically ranged between NZ$30-50/t CO_2. Accordingly, it may be unlikely that the CO_2 price cap, on its own, will result in 'incorrect' fuel choices from a gas/coal perspective – at least while international CO_2 prices are in the NZ$25-50/t CO_2 range.

The other area where the private and national benefits can diverge relates to the pricing of sunk gas network assets. It is estimated that the gas network charge for a large industrial is approximately $2/GJ, the majority of which is for the recovery of sunk gas network assets.

In some situations the private economics may favour an alternative fuel (eg coal, biomass, or geothermal), whereas a national perspective may favour gas because the sunk network assets are not regarded as an avoidable cost.

The combined impact of CO_2 charges and the treatment of sunk costs are explored in the following table. In this table, the short term refers to the period prior to 2012 when the New Zealand price for emissions is capped at $12.50/GJ.

Cost of useful energy in industrial boilers	Short Term	Long Term	
Cost of CO_2	**$12.50/t private $25/t national**	**$25/t**	**$60/t**
Private benefit of DUoG	Coal $8.9/GJ Gas $11.4/GJ	Coal $10.4/GJ Gas $12.1/GJ	Coal $14.3/GJ Gas $14.3/GJ
	Net ($2.5/GJ)	Net ($1.7/GJ)	Net $0.0/GJ
National benefit of DUoG	Coal $10.4/GJ Gas $9.8/GJ	Coal $10.4/GJ Gas $9.8/GJ	Coal $14.3/GJ Gas $12.0/GJ
	Net $0.6/GJ	Net $0.6/GJ	Net $2.4/GJ

This table suggests that there may be a long term national benefit associated with supplying industrial boilers in the North Island with gas rather than coal (depending on the international price of emissions). However, in the short term there is a dislocation between the private benefit and national benefit, and there is a risk that existing gas-fired boilers could convert to coal-firing.

We understand that in order to deter boiler conversions back to coal, some gas network companies offer discounts on network charges to industrial consumers who are considering switching. To the extent that this is happening, this should avoid poor national benefit outcomes.

Exploring policy options for industrial boilers

There is risk that existing gas-fired boiler installations may consider a shift to coal and that this outcome may not be in the national interest. However, this risk appears to be mitigated by the following:

- The incentive to shift to coal is only short term and may disappear by the end of 2012 when the cap on emission charges is removed;
- International CO_2 prices are currently relatively low; and
- Network companies may offer incentives to industrial customers considering a switch away from gas.

These factors suggest that the need for policy action is not strong. However, it may be prudent for EECA to ensure that dairy and meat industry participants with process heat requirements have good information on the likely medium term implications of the ETS on boiler economics.

8 Conclusions

Government policy in the energy sector emphasises the importance of enhancing competition as the primary means of improving consumer outcomes. However, Government also recognises there may be situations where particular external factors do not feed directly into energy prices or other barriers exist which prevent positive outcomes. In such situations it may be necessary to intervene with particular policy initiatives.

In the gas sector there may be several barriers that tend to make it difficult for the direct use of gas to be chosen by consumers for particular applications. These include the capital costs of gas appliances, perceptions about health and safety risks of gas as a fuel, concerns about security of supply, lack of information about the cost of different fuels, and the need to apply for consents to particular gas installations.

Gas Industry Co engaged Concept to analyse the three end uses that collectively provide the best opportunities for gas to substitute for other fuels. These were space heating, water heating, and process heating. If every North Island customer that uses electricity or coal to provide space, water, and intermediate process heating switched to gas, this would represent a total of approximately 30PJ per annum out of a total annual gas consumption of approximately 150PJ per annum.

The Concept study examined whether it would be beneficial from a private and a national perspective for further direct use of gas in these areas. The factors that have the greatest bearing on the relative economics are fuel prices, fuel CO_2 emission intensities, appliance capital costs, and appliance efficiencies.

The private benefit and national benefits analysis in the study suggests:

- That electric heat pumps and log burners are the preferred means for space heating and the arguments in favour of promoting the direct use of gas for space heating are not strong;
- That instant gas is the preferred means for water heating and there may be a case for a low level of policy intervention in support of instant gas water heating, particularly if it is possible to extend an existing scheme; and
- There may be a short-term private incentive to convert industrial boilers from gas-firing to coal-firing and this may not be in the national interest. However, given that the cap on CO_2 prices under the

New Zealand ETS is due to be lifted post-2012, it is not believed that this will result in material levels of fuel switching.

The decision whether it is appropriate for Gas Industry Co to recommend any policies to promote the increased use of gas in relation to water heating is a finely balanced decision. It primarily rests on the assessment of barriers for the uptake of gas by consumers. Based on its understanding of those barriers, Gas Industry Co recommends that a modest financial incentive should be made available for the installation of instant gas water heating either in a new build situation or for conversion from an existing water cylinder.

9 Recommendations

Gas Industry Co recommends that the Associate Minister:

1. Notes the analysis undertaken by Concept on the different direct use of gas applications in New Zealand.

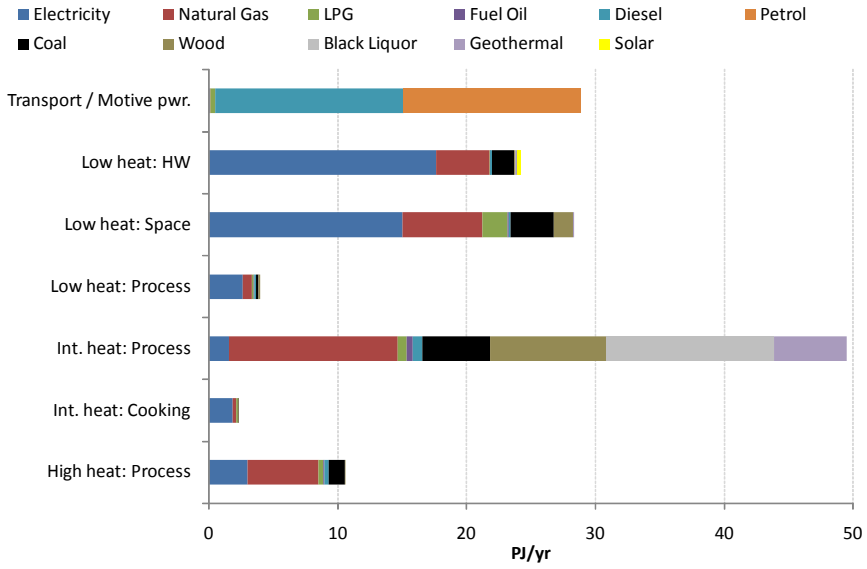
2. Agrees that an independent agency (such as EECA) should be tasked with making information available so that consumers have simple, up to date, and accurate information, that will enable them to make better informed decision about their space heating and water heating requirements.

3. Agrees that the most efficient and cost effective way to implement the financial incentive is for EECA to extend its $1,000 water heating incentive under the ENERGYWISE programme to include instant gas water heaters.

Appendix A Selection of end-uses for study

The figures presented in this Appendix demonstrate how the three end-uses that were analysed in detail in this study (i.e. boilers for intermediate process heat, space heating, and water heating) were selected. All the figures use data from EECA's Energy end-use database, with additional Concept analysis.

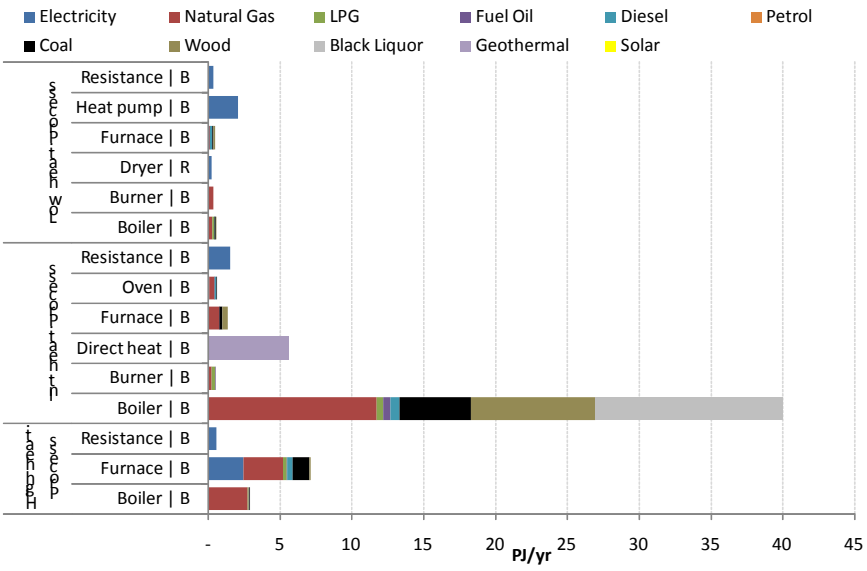
Figure 9: Split of end-use (i.e. useful) energy by fuel for end-use types where gas / LPG is a practicable option (PJ/yr)[9]



Key message:
Transport was excluded from detailed analysis because it would require a major piece of analysis in its own right.
Cooking was excluded from detailed analysis because it represents a relatively trivial amount of end-use energy.

[9] Low Heat = <100 □C, Intermediate = 100 – 300 □C, High = > 300□C

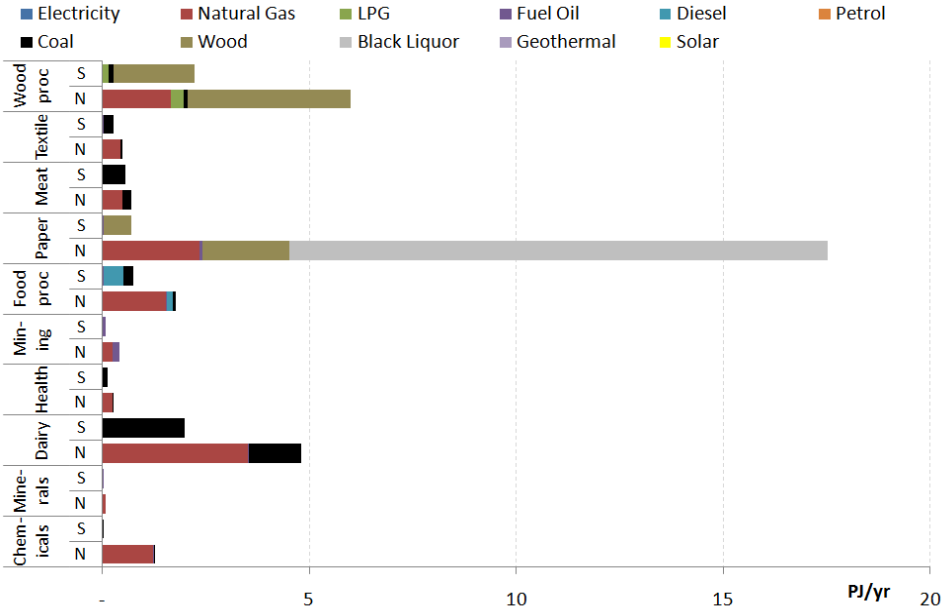
Figure 10: Split of end use (i.e. useful) energy by fuel, energy conversion technology, and Business / Residential customers for process heat uses (PJ/yr)



Key message:
Boilers were the only end-use selected because:

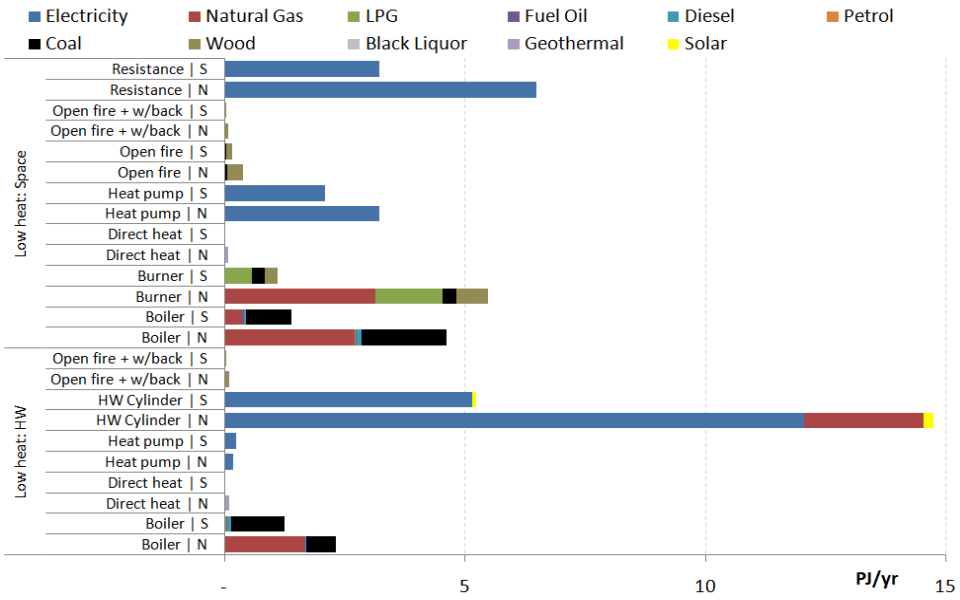
- High temp resistance and furnace heat has highly process-specific drivers which make gas an impractical option in many situations.
- The other end-uses represent a relatively trivial amount of energy

Figure 11: Split of end-use (i.e. useful) energy by industrial sector and North / South island for boiler-fired intermediate process heat applications (PJ/yr)



Key message:
Gas is only available in the North Island, limiting its potential market.
Material fuel switching considerations are limited to a handful of large industrial consumers, predominantly in the dairy, wood & paper, and meat / food processing sectors.

Figure 12: Split of end use (i.e. useful) energy by fuel, energy conversion technology, and North / South island for space and water heating (PJ/yr)



Key message:
Gas is only available in the North Island, limiting its potential market.
The main type of water heating is electric cylinders (with some boiler heating for business users)
The main types of space heating are:

- resistance electric
- gas and LPG heaters
- heat pumps
- boilers (only for business users)