Modelling Tourism Destination Energy Consumption and Greenhouse Gas Emissions: Whistler, British Columbia, Canada

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As awareness of tourism’s energy impacts on global environments increases, and as knowledge of energy consumption’s effects on tourism destination sustainability grows, so does the need for planners to develop proactive energy management strategies. However, the unique characteristics of energy consumption behaviour in resort destinations make it difficult to assess the relative merits of various energy management options. This research identifies a unique 'bottom-up' modelling procedure for assessing the relative effects of various destination planning strategies on energy use and GHG emissions. It then applies the model to energy management strategies being considered for implementation in Whistler, British Columbia – one of North America’s leading mountain resort destinations. The research suggests that the model’s dynamic character makes it a potentially valuable tool for quantitatively assessing what dimensions of various destination transportation, building design and community infrastructure development strategies have the greatest influence on energy use and greenhouse gas emissions. The research contributes to existing destination planning and sustainable tourism development theory and practice by developing a first generation forecasting model for identifying and assessing energy use and GHG emissions, and then illustrating its practical application in the context of emerging sustainable destination planning practices.

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Introduction

There is a growing recognition that the global tourism industry requires vast amounts of energy for the production of its products, services, and visitor experiences. Energy is needed to facilitate transportation of travellers, as well as to provide amenities and supporting facilities at the destinations visited (Becken, 2002; Becken & Simmons, 2002; Becken et al., 2001, 2003; Bode et al., 2003; Gossling, 2000; Gossling et al., 2002; Hoyer, 2000; Tabatchnaia-Tamirisa et al., 1997). The greenhouse gases (GHGs) and other air contaminants associated with some forms of energy consumption are regarded as significant causes of diminished air quality, reduced environmental health, and compromised visitor experiences at a growing number of tourism destinations (Andereck, 1995; Gossling, 2002; Holden, 2000; Hunter & Green, 1995). If not addressed in a proactive manner, these emissions can adversely influence subsequent travel demand and development opportunities for tourism destinations.
As awareness of tourism’s energy impacts on global environments increases, and as knowledge of energy consumption’s effects on tourism destination sustainability grows, so does the need for destination planners to develop proactive energy management policies and strategies. Given the pervasive character of energy consumption and its related impacts, assessing the relative effects of various energy conservation policies and strategies in tourism destinations represents a valuable step towards creating a more sustainable tourism industry. In many cases, these strategies involve the implementation of innovative planning, design, and management practices associated with transportation, building design and construction, and energy supply infrastructure to achieve reductions in energy consumption and GHG emissions associated with tourism destinations. However, before such initiatives are implemented, it is important to have tools for estimating the potential implications of various energy management approaches. This paper describes a modelling procedure that is useful in estimating the relative effects of various planning strategies on energy use and GHG emissions in tourism destinations.

The paper applies the forecasting model to a case study in Whistler, British Columbia, one of Canada’s pre-eminent destination resorts. Located about 120 kilometres from Vancouver, Whistler is a four-season mountain resort community with a permanent population of about 11,000 people participating in an economy largely fuelled by the tourism industry. Whistler attracts an estimated 2 million visitors annually to its mountains for a range of winter and summer activities. Recognising the importance of maintaining its high quality natural resources for visitor and resident appreciation, the community has made a strong commitment to becoming a more sustainable community via a range of environmental strategies reflected in its development plans (RMOW, 1999a, 2000). A significant impetus for accelerating the implementation of these environmental initiatives has been the community’s commitment to more sustainable practices in the development, operation, and post-event phases of its forthcoming co-hosting of the 2010 Winter Olympic Games. With its strong foundation of sustainable planning and management in place, Whistler provides a unique opportunity to systematically evaluate the implications of innovative planning options aimed at reducing energy consumption and GHG emissions.

**Tourism Resort Destination Energy Use**

Energy is supplied to tourism resort destinations through a series of extraction, conversion, and distribution systems. Some energy is derived from local systems, such as micro-hydro, local wind, or photovoltaic cells (Sweeting et al., 1999). These sources may be more viable in certain regions than in others (e.g. solar energy is more feasible in sunny destinations). However, in the vast majority of cases, energy requirements are met by importing energy from outside the destination in the form of fossil fuels such as natural gas, or electricity derived from hydro generation stations.

Energy use in tourism destinations is normally disproportionately greater than what is typically associated with other similar sized communities. This is largely due to the extensive use of energy-intensive technologies that deliver tourist amenities (Tabatchnaia-Tamirisa et al., 1997). In addition to direct uses
Energy Consumption and GHG Emissions

of energy for cooking, heating, air conditioning, cooling, cleaning, lighting and travel, tourism destinations also rely on considerable amounts of energy for importing food and other material goods, transporting water, and disposing waste (Becken et al., 2003; Bode et al., 2003; Gossling, 2000; Gossling et al., 2002). In many tropical or arid regions, energy is also needed for the desalination of seawater (Gossling et al., 2002). A substantial quantity of energy is also required to construct new infrastructure, accommodations and other facilities (Buchanan & Honey, 1994).

Another major component of energy use at tourism destinations is the operation of accommodation facilities (Becken et al., 2001; Chan & Lam, 2003; Deng & Burnett, 2000). Hotels, motels, bed and breakfast establishments, backpacker facilities and campgrounds all use energy. Of these forms of accommodation, hotels generally require more energy per visitor because they are more likely to have energy-intensive facilities and services such as bars, restaurants, in-house laundries and swimming pools (Becken et al., 2001). Private homes – used by permanent or seasonal residents, as well as tourists staying with friends and family – can also account for significant amounts of energy use at destination areas.

Tourist attractions and activities also generate significant energy demands in destinations (Becken & Simmons, 2002). Certain mechanised tourist activities are particularly energy-intensive. These include scenic boat cruises, jet boat rides, charter fishing operations, scenic flights and heli-skiing (Becken & Simmons, 2002; Becken et al., 2003). Energy is also used in up- and down-stream business functions (e.g. tour office administration, marketing and goods transportation) that support the delivery of these activities (Becken & Simmons, 2002).

However, the biggest portion of tourism energy is associated with travel from tourist generating regions to host destinations (Gossling, 2000, 2002; Hoyer, 2000). As much as 90% of the estimated energy consumption by tourists is spent in getting to and from the destination (Gossling, 2002; Mastny, 2002). Air travel in particular accounts for a major share of tourism-related energy use. This is especially the case in developing countries and island destinations where the vast majority of tourists arrive by airplane (Becken, 2002; Gossling, 2000).

Destination energy requirements are largely met by transforming fossil fuels such as natural gas, coal and oil into various forms of energy. The transformation processes occur either at the destination (e.g. micro-energy production systems) or in other regions (e.g. centralised power plants). Many of these processes produce potentially harmful chemical compounds that are released into the atmosphere in the form of carbon dioxide (CO₂), carbon monoxide (CO), nitrogen oxide (NOₓ), sulphur oxide (SOₓ), and particulate matter (PM). If the fuels used in these processes are incompletely burned, additional chemicals referred to as volatile organic compounds (VOCs) also enter the atmosphere. All of these emissions can have significant environmental effects on the regions where they are produced and released (Gossling, 2000, 2002; Holden, 2000; Hunter & Green, 1995).

The potential cumulative effects of energy-related emissions associated with tourism destination developments can be significant at both local and global scales. At a local scale, air pollution and ozone-related smog is often caused by unburned hydrocarbons and nitrogen oxides released from motorised vehicles
especially in heavily congested destinations (Andereck, 1995). Smog reduces the
physical appeal of destinations by damaging vegetation species and lessening
the quality of scenic and visual resources. Smog makes participation in many
outdoor activities unpleasant and potentially causes health problems such as
headaches, dizziness and breathing difficulties (Bates & Caton, 2002).

On a global scale, CO$_2$ generated by destination tourism activities contrib-
utes to the cumulative impact of travel on global warming. Aircraft emissions
are particularly important given the vast amounts of aviation fuel consumed in
bringing travellers to and from tourism destinations. Aircraft emissions of CO$_2$
contribute to climate change in the same way as CO$_2$ emissions from ground
sources, whereas the impacts of other aircraft exhaust gases are not yet fully
understood (Olsthoorn, 2001; Schumann, 1994). The effects of tourism energy
requirements extend well beyond the destination where they are consumed and
spill over into much broader geographic environments.

Method

This research used a three-phased method to measure the extent of energy
consumption and GHG emissions in tourism destinations and assess the
potential effects of various energy conservation strategies on such areas. The
phases involved: (1) developing an overriding framework and approach for
inventorying energy flows and GHG emissions in destination areas; (2) identi-
fying key strategic policy and planning options for reducing such energy flows
and emissions; and (3) forecasting the effects of these options using a ‘bottom
up’ modelling procedure. A description of these methods and how they were
applied in the context of a Whistler case study follows.

Energy and GHG inventory

To estimate the extent of energy consumption and related GHG emissions,
it was initially necessary to establish a systematic framework for inventory-
ing the key drivers of energy use associated with tourism destinations. Based
on a review of existing community energy planning literature (Jaccard et al.,
1997; Sadownik & Jaccard, 2001) and energy-related tourism publications
(Becken, 2002; Becken & Simmons, 2002; Becken et al., 2001, 2003; Gossling,
2000; Gossling et al., 2002) three primary dimensions and associated drivers
of energy consumption and GHG emissions were identified. The framework
included energy drivers related to: (1) internal destination energy con-
sumption (e.g. buildings, infrastructure, and transportation); (2) employee
commuting to and from the destination; and (3) visitor travel to and from the
destination (Figure 1). This framework was used to establish standardised and
comparable measures of energy consumption expressed in terms of gigajoules
(GJ) and GHG emissions measured as carbon dioxide equivalent (CO$_2$e). The
metric CO$_2$e is used to calculate the impact of various gases involved in global
warming using a single unit of measurement. For example, a tonne of methane
(CH$_4$) produces 21 times the atmospheric impact of one tonne of carbon dioxide
(CO$_2$), so was expressed as 21 CO$_2$e.

(1) Internal destination energy and GHG estimates

Energy consumption for all buildings, infrastructure, and transportation
Figure 1 Resort destination energy consumption and emission model

internal to Whistler was calculated by synthesising existing data from the Resort Municipality of Whistler, local resort corporations, and transportation, gas and electricity utilities. These data detailed records of electricity and propane consumption for residential, institutional, commercial, industrial, and municipal buildings and infrastructure, as well as estimates of wood use for space heating in residential homes. The data also included gasoline and diesel fuel consumption volumes for commercial and municipal vehicle fleets and public transportation, as well as estimates of gasoline consumption for all personal transportation within the resort destination.

GHGs were calculated for two main processes: the use of energy and the disposal of solid waste. Energy-related GHGs were calculated by multiplying energy consumption estimates by established emission factors for each fuel
type. The emission factor for electricity generation in British Columbia (0.0069 tCO$_2$e per GJ) was obtained from BC Hydro (2003). The emission factors for propane (0.0599 tCO$_2$e per GJ), wood fuel (0.1243 tCO$_2$e per GJ), gasoline (0.0701 tCO$_2$e per GJ), and diesel (0.0714 tCO$_2$e per GJ) were taken from Environment Canada (2002). Direct GHG emissions (methane) from the Whistler landfill were estimated by multiplying the amount of solid waste disposal by a recognised emission factor (0.382 tCO$_2$e per tonne of waste) attained from Environment Canada (2002).

The effects of the tourism industry on Whistler’s internal energy and GHG emissions were estimated by disaggregating energy consumption in each sector between tourism and non-tourism components. The tourism share included both direct effects (e.g. energy consumed by hotels in providing accommodations to tourists) and indirect effects (e.g. energy consumed by businesses in providing office services to tourism operators). Induced effects (e.g. domestic energy use by resort employees and their families) were not considered part of tourism’s contribution (Table 1).

Since existing energy consumption data were not disaggregated between tourism and non-tourism elements, various secondary data sources had to be used to factor out the effects of tourism. In the residential sector, for example, secondary data from local visitor surveys were used along with population statistics to determine the percentage of residential dwelling occupants who were...
tourists. This proportion provided an estimate of tourism’s share of residential
energy consumption (assuming that the per person per day energy require-
ments for domestic end-uses were the same for tourists who stayed in residential
dwellings as they were for residents). Another example is the restaurant sector,
where tourism’s share of overall energy usage was based on the percentage
of total restaurant visits made by tourists. This proportion was derived from
existing survey information. Similar types of calculations were used to estimate
tourism’s contribution in other sectors.

(2) Employee destination commuting

Estimates of energy consumption and GHG resulting from employee
commuting were calculated using a three-step process. The first step established
vehicular travel flows expressed in ‘person kilometres travelled’ (PKT) for both
permanent and seasonal Whistler employees living outside of the destination.
PKTs were calculated for three main modes of commuting (private automobile,
car pool and bus) and the two major places of employee residence (Pemberton
and Squamish). Total PKT for each mode was calculated as follows:

\[
PKT_i = \sum_{j=1}^{n} (Employees_j \times Working\ Days \times Return\ Distance_j \times Modal\ Split_{ij})
\]

where \( Employees_j \) is the number of employees commuting from place of origin \( j \); \( Working\ Days \) is the number of commuting days in the year (240 for permanent
employees; 80 for seasonal employees); \( Return\ Distance \) is the two-way distance
to the resort from place of origin \( j \); and \( Modal\ Split \) is the proportion of employees
commuting by mode \( i \) from place of origin \( j \). The modal split for Squamish
commuters was approximately 33% private automobile, 65% car pool, and
2% bus. For Pemberton commuters, the transportation mode distribution was
about 50% private automobile, 33% car pool and 17% bus. These modal splits
were derived from employee surveys conducted by the Resort Municipality of
Whistler.

The second step involved calculating the ‘vehicle kilometres travelled’ (VKT)
for each mode of transportation. This was estimated by dividing PKT by the
average occupancy rate of the mode. Based on consultation with municipal
planning staff, the occupancy rates were assumed to be 1.0 for private (single-
occupancy) automobile, 2.5 for car pool, and 45 for bus. Energy consumption
for each mode was then determined by multiplying VKT by the fuel efficiency
of the mode. The fuel efficiency for automobiles (0.1235 litres per VKT) was
assumed to equal the national average given in Natural Resources Canada’s
National Energy Use Database. The fuel efficiency for buses (0.328 litres per
VKT) was provided directly by Greyhound Canada, a primary supplier of bus
transportation services in British Columbia. Since fuel efficiency is typically
reported in litres per VKT, a conversion factor is necessary to convert litres
of fuel to GJ of energy. The conversion factors for gasoline (0.03466 GJ per
litre) and diesel fuel (0.03868 GJ per litre) were attained from the Voluntary
Challenge and Registry (2003). In the final step, GHG emissions were calcu-
lated by multiplying energy consumption by established emission factors
(Environment Canada, 2002).
Visitor destination travel

Estimates of energy consumption and GHG resulting from visitor travel to and from the resort were derived in a similar manner to that for employee commuting. The first step was to estimate PKT for three modes of travel (automobile, bus and airplane). This was determined using the following calculation:

\[ PKT_i = \sum_{j=1}^{k} (Visitors_j \times Return\ Distance_j \times Modal\ Split_{ij}) \]  

where Visitors\(_j\) is the number of visitors from place of origin \(j\); Return Distance\(_j\) is the two-way distance to the resort from place of origin \(j\); and Modal Split\(_{ij}\) is the proportion of visitors travelling by mode \(i\) from place of origin \(j\). It was assumed that all visitors arrive in Whistler by ground transportation, either directly from their place of origin or via the Vancouver International Airport. The modal split for visitors arriving in Whistler was assumed to be 73% automobile and 27% bus (rmOW, 2003b). It was also assumed that visitors from British Columbia and Washington only use ground transportation to travel to Whistler; half of the visitors from Oregon use ground transportation while half fly to Vancouver then use ground transportation; and all other visitors fly to Vancouver then use ground transportation to travel to Whistler. The travel distances were generally calculated from only one major centre in each region (e.g. Calgary in Alberta, Toronto in Ontario, Seattle in Washington, London in the United Kingdom, etc.) The analysis did not account for distances travelled to get to and from airports in the places of origin.

The second step involved calculating VKT for each mode. This was estimated by dividing PKT by the average occupancy rate of the mode. The automobile and bus occupancy rates for visitor travel were taken from the 2002 Whistler Traffic Monitoring Program (rmOW, 2003b). An average occupancy rate for airplanes was used assuming a Boeing 747–200 with 350 seats at 80% occupancy. The VKT was then multiplied by the fuel efficiency factors for each mode to estimate overall energy consumption levels. The fuel efficiency for airplanes (19.8 litres per VKT) was based on research by Murty (2000). Finally, GHGs were calculated by multiplying energy consumption by established emission factors. The emission factor for aviation gasoline (0.0728 tCO\(_2\)e per GJ) was obtained from Environment Canada (2002).

Identification of planning strategies

Once procedures for developing inventories of energy consumption and GHG were established, opportunities existed to forecast the effects of various proposed energy conservation strategies in destination resort communities. The study’s literature review identified a range of fundamental strategies for reducing levels of energy consumption and related emissions. The strategies primarily involved actions associated with transportation, building design and construction, and energy supply systems (Bode et al., 2003; Dorward, 1990; Gunn, 1994; Holding, 2001; Inskeep, 1987, 1991; Quilici, 1998). They were used to select resort destination energy conservation strategies that might be modelled for their effects on overall energy flows and emissions.

In the case of Whistler, numerous options for conserving energy have been
identified in the community’s *Integrated Energy, Air Quality and Greenhouse Gas Management Plan* (RMOW, 2003a). In this research, five strategies were selected as options that might have the most influential effects on the resort’s internal energy consumption and associated GHG emissions. These strategies are not intended to address the energy impacts associated with visitor travel to and from destinations because these are largely beyond the control of destination planners. A brief description of each strategy follows.

**Strategy 1: Implement comprehensive transportation strategy**

The community’s Comprehensive Transportation Strategy is based on a package of initiatives recommended by Whistler’s Transportation Advisory Group (RMOW, 1999b). Their recommendations include implementing land use plans and policies that promote compact forms of development which minimise travel distances and encourage walking and cycling; initiating improvements to the community’s public transit system to make transit a more attractive transportation option; introducing Transportation Demand Management (TDM) programmes to provide individuals with viable transportation alternatives accompanied with incentives to use these alternatives; developing networks for bicycles and pedestrians; managing parking supply more effectively to encourage the use of travel modes other than private automobiles; and improving Whistler’s road system and traffic operations to reduce congestion on local roads and improve neighbourhood accessibility. As a result of implementing these initiatives, total VKT travelled in Whistler is projected to be about 20% lower in 2011 than would have occurred in the absence of such actions (Tsi Consultants, 2001).

**Strategy 2: Increase municipal vehicle fleet fuel efficiencies**

The municipality maintains a large fleet of gasoline and diesel vehicles for its operations. It has been proposed to gradually convert this fleet to more efficient vehicles. This involves: transitioning fleet passenger vehicles (and larger vehicles where appropriate) to hybrid models; using smaller engines in the vehicles; using fuel additives to improve fuel economy and reduce emissions; and using exhaust scrubbers for large engines and trucks (RMOW, 2003a). These strategies are expected to increase the overall efficiency of the gasoline fleet by 50% and the diesel fleet by 15% by 2020 (RMOW, 2003a).

**Strategy 3: Increase new and redeveloped building energy efficiencies**

Significant opportunities exist to improve the energy efficiency of new and existing residential and commercial buildings in Whistler (RMOW, 2003a). Such improvements can be achieved by implementing energy conservation programmes for building contractors (e.g. LEED, CBIP) as well as for homeowners and property owners (e.g. EnerGuide). These programmes are expected to improve the energy efficiency of new and redeveloped buildings by at least 25% (RMOW, 2003a).

**Strategy 4: Use natural gas as primary energy supply**

The capacity of the current piped propane system that fuels Whistler’s services will soon be exceeded (Centra Gas, 2003). The construction of a natural gas system is being considered as an alternative to the current approach (Centra Gas, 2003). Although energy demand will not be affected, a natural gas system
is expected to significantly reduce GHGs and other air contaminants because the emission intensities for natural gas are lower than propane.

**Strategy 5: Develop small-scale and localised renewable energy sources**

A number of local micro-hydro and geo-thermal energy generation projects have been proposed for Whistler (RMOW, 2003a). Although these projects will not impact energy demand, they are expected to reduce GHGs by displacing electricity from the province’s electricity grid with local renewable energy.

Elements of each of these strategies were used to inform the development and application of a model for forecasting energy consumption and GHGs associated with Whistler.

**Energy use model development and application**

To assist destination planners in assessing the relative effects of various strategic planning scenarios on energy consumption and associated GHG emissions, an energy use model was developed. It used a ‘bottom-up’ approach that explicitly accounted for energy use associated with different categories of building, infrastructure, and transportation modes currently and potentially available to residents, visitors and businesses in the destination. Originally developed in the late 1970s in the form of energy end-use models designed for load forecasting (Robinson, 1982), bottom-up models are based on the concept that the fundamental purpose of energy use is to satisfy demand for end-use services, such as transportation or lighting (Gardner & Robinson, 1993). Total energy demand is derived from the demand for end-use services and the efficiency with which they are provided. Bottom-up models are effective tools for assessing policy decisions regarding efficiency improvements and fuel switching through the introduction of new technology (Gardner & Robinson, 1993). In tourism and recreation, only a few applications of bottom-up models have been developed to analyse energy consumption (Becken et al., 2001; Deng & Burnett, 2000).

The energy use model developed in this research explicitly accounted for energy consumption and GHGs for all buildings, infrastructure and transportation internal to Whistler, as well as for employee commuting and visitor travel to and from the resort. Specific components and operational characteristics of this model are outlined in the following sections.

**Internal energy consumption and GHG emissions**

The model estimates energy consumption and GHGs for buildings, infrastructure, intra-community transportation, corporate and institutional vehicle fleets, and landfill operations. The methods employed to calculate these estimates follow.

**Buildings**

Several categories of buildings can be incorporated into the model. In the case of Whistler, these included: restricted employee housing, single family, duplex, multi-family dwellings, hotel, other paid accommodation, retail, office, service, food/restaurant, bar, convention/conference, tourist/recreation, wholesale/storage, light/heavy manufacturing, and institutional. New development of each building type was assumed to increase by a fixed annual rate until available
capacity was reached. In Whistler, most types of development were expected to reach capacity by 2006. In addition, it was assumed that a fixed percentage (3%) of existing buildings would be redeveloped each year. This rate was determined through consultation with municipal planning staff.

Forecasts of energy consumption for each building type were calculated as follows:

\[
\text{Energy Consumption}_{kt} = \text{Existing Floor Area}_{kt} \times \text{Existing EUI}_{kt} + \text{New Floor Area}_{kt} \times \text{New EUI}_{kt} \tag{3}
\]

where \(\text{Energy Consumption}_{kt}\) is the energy consumption for buildings of type \(k\) in year \(t\); \(\text{Existing Floor Area}_{kt}\) is the floor area of existing buildings of type \(k\) in year \(t\); \(\text{Existing EUI}_{kt}\) is the energy use intensity (energy consumption per unit of floor area) for existing buildings of type \(k\) in year \(t\); \(\text{New Floor Area}_{kt}\) is the floor area of new buildings of type \(k\) in year \(t\); and \(\text{New EUI}_{kt}\) is the energy use intensity for new buildings of type \(k\) in year \(t\).

Since local energy audit information was not available, the EUIs in this study were referenced from the Buildings Table of Canada’s National Climate Change Process (1999) and the Greater Vancouver and Fraser Valley Air Quality Management Plan (GVRD, 2000). Some level of uncertainty is clearly associated with these EUIs because of regional differences in climatic conditions, average building age, occupant characteristics, and other factors. To correct for these differences, the forecasts of energy consumption were calibrated to ensure that the base year estimates for 2000 were consistent with the actual amount of energy consumed in that year.

The mix of fuel types in each year was determined by multiplying total energy consumption by estimated fuel shares. Energy consumption from the use of wood for space heating was estimated separately using existing data sources (RMOW, 2003a). GHGs were then forecasted by multiplying energy consumption by established emission factors (BC Hydro, 2003; Environment Canada, 2002).

**Municipal building and infrastructure**

Energy consumption for municipal buildings and infrastructure was forecasted using data provided directly by the Resort Municipality of Whistler.

**Intra-community transportation**

Forecasts of PKT for personal and public transportation internal to Whistler were calculated for each mode as follows:

\[
\text{PKT}_{it} = \text{Equivalent Population}_{t} \times \text{Per Capita PKT}_{t} \times \text{Modal Split}_{it} \tag{4}
\]

where \(\text{Equivalent Population}_{t}\) is the tourism destination’s equivalent population in year \(t\); \(\text{Per Capita PKT}_{t}\) is the per capita PKT by all modes (personal vehicles and public transportation) in year \(t\); and \(\text{Modal Split}_{it}\) is the proportion of total PKT by mode \(i\) in year \(t\). Forecasts of per capita PKT were calculated by multiply-
ing the per capita PKT in the base year by a fixed annual growth rate. Note that equivalent population is the total number of people at the tourism destination per day. This includes residents, commuting employees, as well as overnight and day only visits.

Forecasts of vehicle kilometres travelled (VKT) for each mode were calculated by dividing PKT by the average occupancy rate of the mode. Energy consumption for intra-community transportation was then estimated by multiplying VKT by the fuel efficiency of the mode. The fuel efficiencies were assumed to be the same as in the base year. This assumption was made to allow the destination planning strategies to be compared independent of external technological advancements. GHGs were then calculated by multiplying energy consumption by established emission factors (BC Hydro, 2003; Environment Canada, 2002).

**Corporate vehicle fleet**

Forecasts of VKT for the Whistler Blackcomb commercial fleet were calculated by multiplying the base year VKT by a fixed annual growth rate of 1.5%. This rate was determined through consultation with Whistler Blackcomb staff.

**Municipal vehicle fleet**

It was assumed that VKT for the municipal vehicle fleet would continue to increase until most development was complete in 2005, after which time VKT would not change.

**GHGs from landfill**

Direct GHGs from the Whistler landfill were forecast by multiplying the amount of solid waste disposal by an established emission factor.

**Employee commuting**

Forecasts of PKT for three main modes of commuting (automobile, car pool and bus) were derived using equation 1. In developing forecasts of PKT, it was assumed that the size of Whistler’s workforce would continue to increase until most development was complete in 2005, after which time the workforce would stabilise. VKT for each mode of travel were forecast by dividing PKT by the average occupancy rate of the mode. Energy consumption was then calculated by multiplying VKT by the fuel efficiency of the mode. GHGs were calculated by multiplying energy consumption by established emission factors (BC Hydro, 2003; Environment Canada, 2002).

**Visitor travel to and from resort**

Forecasts of PKT for three modes of visitor travel (automobile, bus and airplane) were derived using equation 2. In generating the forecasts of PKT, it was assumed that the number of visitors would increase at current rates until remaining tourist development was complete in 2005, after which time the growth rates would significantly decline. Further, it was assumed that the post-development growth rates would significantly differ for each visitor type (e.g. the growth rate for visitors staying in paid accommodation would be much lower than for day only visitors). VKT for each mode was estimated by dividing PKT by the average occupancy rate of the mode. Energy consumption was then calculated by multiplying VKT by the fuel efficiency of the mode. GHGs were
calculated by multiplying energy consumption by established emission factors (BC Hydro, 2003; Environment Canada, 2002).

Findings

Base Year Energy and GHG Inventory

This section summarises the energy and GHG emission inventory for Whistler generated by the model for the study’s 2000 base year.

Internal energy consumption and GHG emissions

Based on this research, residents, businesses and visitors in Whistler consumed approximately 2.9 million GJ of energy in the year 2000 (Table 2). The largest component of this consumption was linked to the community’s commercial sector, which was responsible for about 39% of total internal energy use. The vast majority of this energy consumption was attributable to commercial functions such as hotels, other accommodation, retail stores, restaurants, bars, ski hill operations, and other tourism service functions, including the ski area’s commercial vehicle fleet.

Other major consumers of energy within Whistler included internal passenger vehicles and residential housing which generated about 31% and 27% of the community’s total energy consumption. Municipal buildings and related vehicle fleet, along with other related public infrastructure (e.g. recreation centres,

Table 2 Energy consumption and GHG emissions

<table>
<thead>
<tr>
<th>Sector</th>
<th>Fuel</th>
<th>Energy consumption (GJ)</th>
<th>%</th>
<th>GHG emissions (tCO₂)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Electricity</td>
<td>614,223</td>
<td>21.3%</td>
<td>4,266</td>
<td>3.2%</td>
</tr>
<tr>
<td></td>
<td>Propane</td>
<td>142,112</td>
<td>4.9%</td>
<td>8,516</td>
<td>6.5%</td>
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<tr>
<td></td>
<td>Wood</td>
<td>36,000</td>
<td>1.2%</td>
<td>4,475</td>
<td>3.4%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>792,335</td>
<td>27.4%</td>
<td>17,256</td>
<td>13.1%</td>
</tr>
<tr>
<td>Passenger Transportation</td>
<td>Gasoline</td>
<td>892,707</td>
<td>30.9%</td>
<td>62,596</td>
<td>47.6%</td>
</tr>
<tr>
<td>Commercial, Industrial and Institutional</td>
<td>Electricity</td>
<td>532,080</td>
<td>18.4%</td>
<td>3,695</td>
<td>2.8%</td>
</tr>
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<td></td>
<td>Propane</td>
<td>531,036</td>
<td>18.4%</td>
<td>31,820</td>
<td>24.2%</td>
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<tr>
<td></td>
<td>Gasoline</td>
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<td>0.7%</td>
<td>1,478</td>
<td>1.1%</td>
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<td></td>
<td>Diesel</td>
<td>45,301</td>
<td>1.6%</td>
<td>3,235</td>
<td>2.5%</td>
</tr>
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<td></td>
<td>Total</td>
<td>1,129,499</td>
<td>39.1%</td>
<td>40,229</td>
<td>30.6%</td>
</tr>
<tr>
<td>Municipal Buildings and</td>
<td>Electricity</td>
<td>31,235</td>
<td>1.1%</td>
<td>217</td>
<td>0.2%</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Propane</td>
<td>7,398</td>
<td>0.3%</td>
<td>443</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>Gasoline</td>
<td>5,678</td>
<td>0.2%</td>
<td>398</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>6,155</td>
<td>0.2%</td>
<td>439</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50,465</td>
<td>1.7%</td>
<td>1,498</td>
<td>1.1%</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>Diesel</td>
<td>25,239</td>
<td>0.9%</td>
<td>1,802</td>
<td>1.4%</td>
</tr>
<tr>
<td>Solid Waste Disposal</td>
<td></td>
<td></td>
<td></td>
<td>8,243</td>
<td>6.3%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>2,890,245</td>
<td>100.0%</td>
<td>131,625</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
community cultural centres, public transportation) consumed far less (3%) of the overall internal energy budget.

These energy-consuming sources along with the disposal of solid waste were responsible for producing Whistler’s internal GHG emissions. In 2000, the community’s total GHGs were estimated to be approximately 131,000 tCO$_2$e (Table 2). Passenger vehicle transportation accounted for almost half (48%) of the internal GHG emissions. This did not include emissions generated via inter-community transportation. Overall, the commercial sector was responsible for generating about 31% of the internal GHG emissions, while the residential sector produced another 13% of the total. Municipal buildings, related infrastructure and public transportation contributed only 2% of total GHG emissions. In addition, direct emissions of methane from the Whistler landfill accounted for approximately 6% of total internal GHGs.

The amount of GHGs produced per GJ of energy varies significantly depending on the fuel used. For instance, electricity is primarily generated from renewable large-scale hydro sources in British Columbia. As a result, the amount of GHGs produced per GJ of energy is much lower for electricity than for energy generated via the burning of fuels such as propane, gasoline, diesel, and especially wood. As an illustration, the use of wood in Whistler’s residential sector accounted for slightly more GHGs than electricity, even though this sector utilised approximately 17 times more electricity than wood sources for its various energy requirements (Table 2). As in many other winter destinations, the use of wood for space heating is a significant problem that needs to be addressed.

Approximately 65% of Whistler’s internal energy consumption and GHG emissions were attributable to tourism. The industry’s impact was greatest in the commercial sector where about 93% of the energy and GHGs were allocated to tourism. While tourism accounted for just over half of the energy and GHGs associated with passenger transportation, it contributed only 15% of the energy related to public transportation. In addition, tourism accounted for about 37% of the energy usage and GHGs in the residential sector. The industry’s overall impact would be even greater if induced effects, such as the domestic energy consumption of resort employees and their families, were considered part of tourism’s contribution.

**Employee commuting**

Approximately 1850 permanent employees and 930 seasonal employees commuted to Whistler from outside the community’s boundaries in the year 2000. Approximately two-thirds of these employees commuted from Squamish (60 km south of Whistler), while the remainder came from Pemberton (30 km north of Whistler). Employees also commuted from more distant communities; however, the share of commutes from these areas was assumed to be negligible for the purpose of this study.

In total, commuters travelled about 18.9 million PKT by private (single-occupancy) automobile, 30.4 million PKT by car pool, and 2.6 million PKT by bus (Table 3). Expressed in terms of VKT, commuting employees travelled approximately 18.9 million VKT by private automobile, 12.2 million VKT by car pool, and 58,000 VKT by bus. Because of lower occupancy rates, single-occupancy
vehicles travelled more kilometres than vehicles with more than one commuter, despite the fact that car pools accounted for a larger share of PKT.

Overall, this research estimated that commuting private automobiles consumed about 2.3 million litres of gasoline fuel, car-pooling vehicles used 1.5 million litres of gasoline, and buses consumed 19,000 litres of diesel fuel. This translated into the consumption of an estimated 134,000 GJ of energy and the production of 9400 tCO$_2$e of GHGs in the year 2000 (Table 6). If employee commuting were included in Whistler’s inventory of energy and GHG emissions, then it would account for approximately 4.4% of Whistler’s total energy consumption and about 6.6% of GHG emissions.

Visitor travel to/from Whistler

Approximately 2.1 million visitors travelled to Whistler in the year 2000. Of these, an estimated 61% were overnight commercial accommodation users, 29% were day visitors, 7% stayed with friends and relatives, and 3% stayed in second homes. About 62% of all Whistler’s visitors originated in British Columbia, with smaller proportions coming from other parts of Canada, Washington State, other regions of the United States, and various international locations (Table 4).

In getting to and from the resort, visitors travelled about 499 million PKT by automobile, 185 million PKT by bus, and 4.5 billion PKT by airplane (Table 5). Expressed in terms of VKT, visitors travelled approximately 235 million VKT by automobile, 7.5 million VKT by bus, and 16 million VKT by airplane. This resulted in 29 million litres of gasoline fuel consumed by automobiles, 2.5 million litres of diesel fuel used by buses, and 319 million litres of aviation gasoline used by airplanes.

Overall, visitor travel accounted for approximately 11.8 million GJ of energy and 859,000 tCO$_2$e in GHGs during 2000 (Table 6). If external travel energy consumption and GHGs (including employee commuting) were included in Whistler’s total energy inventory, it would account for approximately 80% of the destination’s overall energy consumption and about 86% of GHG emissions. The contribution from airplane travel alone would account for about 72% of total energy consumption and 78% of GHG emissions. In total, tourism would account for over 90% of Whistler’s energy consumption and GHG emissions if external travel was included in the overall inventory.

Table 3 Employee commuting

<table>
<thead>
<tr>
<th>Mode</th>
<th>Person kilometres travelled</th>
<th>Vehicle kilometres travelled</th>
<th>Fuel consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Km</td>
<td>%</td>
<td>Km</td>
</tr>
<tr>
<td>Private Automobile</td>
<td>18,874,657</td>
<td>36.4%</td>
<td>18,874,657</td>
</tr>
<tr>
<td>Car Pool</td>
<td>30,386,124</td>
<td>58.6%</td>
<td>12,154,450</td>
</tr>
<tr>
<td>Bus</td>
<td>2,592,673</td>
<td>5.0%</td>
<td>57,615</td>
</tr>
<tr>
<td>TOTAL</td>
<td>51,853,455</td>
<td>100.0%</td>
<td>31,086,722</td>
</tr>
</tbody>
</table>
Table 4 Visitation to Whistler

<table>
<thead>
<tr>
<th>Region</th>
<th>Place of origin</th>
<th>Number of visitors</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>British Columbia</td>
<td>1,275,086</td>
<td>61.6%</td>
</tr>
<tr>
<td></td>
<td>Alberta</td>
<td>32,669</td>
<td>1.6%</td>
</tr>
<tr>
<td></td>
<td>Ontario</td>
<td>89,251</td>
<td>4.3%</td>
</tr>
<tr>
<td></td>
<td>Quebec</td>
<td>22,089</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td>Other Canada</td>
<td>26,256</td>
<td>1.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,445,351</strong></td>
<td><strong>69.9%</strong></td>
</tr>
<tr>
<td>USA</td>
<td>Washington</td>
<td>215,284</td>
<td>10.4%</td>
</tr>
<tr>
<td></td>
<td>Oregon</td>
<td>23,126</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td>California</td>
<td>74,230</td>
<td>3.6%</td>
</tr>
<tr>
<td></td>
<td>Mountain</td>
<td>44,437</td>
<td>2.1%</td>
</tr>
<tr>
<td></td>
<td>Midwest</td>
<td>33,389</td>
<td>1.6%</td>
</tr>
<tr>
<td></td>
<td>Southern</td>
<td>27,659</td>
<td>1.3%</td>
</tr>
<tr>
<td></td>
<td>Eastern Seaboard</td>
<td>59,217</td>
<td>2.9%</td>
</tr>
<tr>
<td></td>
<td>Alaska/Hawaii</td>
<td>10,875</td>
<td>0.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>488,217</strong></td>
<td><strong>23.5%</strong></td>
</tr>
<tr>
<td>Europe</td>
<td>United Kingdom</td>
<td>40,312</td>
<td>1.9%</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>9,573</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Other Europe</td>
<td>16,977</td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>66,862</strong></td>
<td><strong>3.2%</strong></td>
</tr>
<tr>
<td>Asia</td>
<td>Japan</td>
<td>28,152</td>
<td>1.4%</td>
</tr>
<tr>
<td></td>
<td>Other Asia</td>
<td>6,425</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>34,577</strong></td>
<td><strong>1.7%</strong></td>
</tr>
<tr>
<td>Australia/New Zealand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Latin America</td>
<td>9,412</td>
<td>0.5%</td>
</tr>
<tr>
<td></td>
<td>Other Overseas</td>
<td>5,236</td>
<td>0.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>14,648</strong></td>
<td><strong>0.8%</strong></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>2,069,730</strong></td>
<td><strong>100.0%</strong></td>
</tr>
</tbody>
</table>

Table 5 Visitor travel to and from Whistler

<table>
<thead>
<tr>
<th>Mode</th>
<th>Person kilometres travelled</th>
<th>Vehicle kilometres travelled</th>
<th>Fuel consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Km</td>
<td>%</td>
<td>Km</td>
</tr>
<tr>
<td>Automobile</td>
<td>499,199,043</td>
<td>9.6%</td>
<td>235,471,247</td>
</tr>
<tr>
<td>Bus</td>
<td>184,635,263</td>
<td>3.5%</td>
<td>7,520,785</td>
</tr>
<tr>
<td>Airplane</td>
<td>4,522,371,687</td>
<td>86.9%</td>
<td>16,151,327</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>5,206,205,993</td>
<td>100.0%</td>
<td>259,143,359</td>
</tr>
</tbody>
</table>
Evaluation of planning strategies

The preceding findings estimated existing levels of energy consumption and GHGs at Whistler in 2000. However, the model’s utility as a planning tool becomes more apparent when used to assess the relative effect of Whistler’s proposed energy conservation strategies. This section illustrates the model’s ability to estimate the future effects of Whistler’s five primary energy and emission strategies. In this context, the estimated effects of implementing all five of Whistler’s ‘Energy Efficient’ strategies by 2020 are compared with the impacts of continuing with its current ‘Business-as-Usual’ path.

Internal energy consumption and GHG emissions

Under the current Business-as-Usual scenario, the model estimates that approximately 3.8 million GJ of energy will be consumed in Whistler in the year 2020. This represents a 31% increase over year 2000 estimates (Table 7). Under the same assumptions, Whistler’s GHGs will increase by about 35% to 178,000 tCO₂e in 2020. The sectoral breakdown of energy use and GHGs in 2020 will be about the same as in 2000. As in the base year, the direct impacts of tourism account for just under 60% of Whistler’s internal energy consumption and GHG emissions.

In the Energy Efficient scenario, approximately 3.3 million GJ of energy will be consumed in Whistler in 2020. This scenario represents a reduction of 12% or 0.5 million GJ over the Business-as-Usual scenario. In the Energy Efficient scenario, Whistler’s GHGs will be approximately 145,000 tCO₂e in 2020. This represents a reduction of 18% or 32,000 tCO₂e over the Business-as-Usual scenario.

Employee commuting

Approximately 2900 permanent employees and 1300 seasonal employees are expected to commute to Whistler from outside the community’s boundaries in the year 2020. The model estimates that private (single-occupancy) automobiles will consume about 2.0 million litres of gasoline fuel, car-pooling vehicles will use 0.8 million litres of gasoline, and buses will consume 0.4 million litres of

Table 6 Energy consumption and GHG emissions (including inter-community transportation)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Fuel</th>
<th>Energy consumption</th>
<th>GHG emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GJ</td>
<td>%</td>
<td>tCO₂e</td>
</tr>
<tr>
<td>All Internal Uses</td>
<td>2,890,245</td>
<td>19.4%</td>
<td>131,625</td>
</tr>
<tr>
<td>Employee Commuting</td>
<td>Gasoline</td>
<td>132,819</td>
<td>9,313</td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>732</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>133,551</td>
<td>9,366</td>
</tr>
<tr>
<td>Visitor Travel to/ from</td>
<td>Gasoline</td>
<td>1,007,929</td>
<td>70,676</td>
</tr>
<tr>
<td>Whistler</td>
<td>Diesel</td>
<td>95,554</td>
<td>6,823</td>
</tr>
<tr>
<td></td>
<td>Aviation Gasoline</td>
<td>10,735,261</td>
<td>781,448</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11,838,744</td>
<td>858,947</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14,862,541</td>
<td>100.0%</td>
<td>999,938</td>
</tr>
</tbody>
</table>
diesel fuel. As a result, employee commuting will account for approximately 111,000 GJ of energy and 7800 tCO₂e of GHGs in the year 2020 (Table 8). There are two main reasons that these energy flows and emissions are projected to be lower than in 2000. First, a substantial modal shift towards bus commuting is assumed to take place once dedicated commuter bus services to Pemberton...
and Squamish become available. Second, the Resort Municipality of Whistler is planning to significantly increase the available capacity of restricted employee housing in Whistler. Although this initiative will lead to higher energy consumption within the community, the model predicts that the amount of energy consumption and GHGs associated with employee commuting will be reduced. More employees will reside within Whistler’s municipal boundaries thereby substantially reducing negative commuter effects.

Visitor travel to and from Whistler

Approximately 3.4 million visitors are expected to travel to Whistler in the year 2020. In getting visitors to and from the resort, the model estimates that automobiles will consume approximately 47 million litres of gasoline fuel, buses will use 4 million litres of diesel fuel, and airplanes will consume 473 million litres of aviation gasoline. As a result, visitor travel will account for approximately 18 million GJ of energy and 1.3 million tCO$_2$e of GHGs in the year 2020 (Table 8).

The model anticipates that visitor travel to and from the resort will continue to account for the vast share of Whistler’s total energy consumption and GHG emissions. As a consequence, the magnitude of energy consumed by visitor travel will dwarf the energy reductions realised in the Energy Efficient scenario. By including visitor travel (and employee commuting) in the overall energy profile of Whistler, the energy and GHG reductions resulting from the Energy Efficient scenario would only amount to about a 2% decrease from the Business-as-Usual scenario.

Accounting for uncertainty

The projections developed in this research represent one possible view of how the future could look like in Whistler. The accuracy of these projections rests on the validity of various assumptions related to both internal policy choices (e.g. future land use and development decisions) as well as external forces (e.g. changing market demands or increasing energy prices). For example, if the number of visitors staying in paid accommodations in 2020 is 10% lower than anticipated, then Whistler’s internal energy consumption will be about 2% lower than projected (or about 7% lower if external visitor travel is included). Alternatively, if the average fuel efficiency of private automobiles in 2020 is 20% lower than expected, then internal energy consumption will be about 3% lower than projected (or about 7% lower if external visitor travel is included). These examples illustrate the model’s sensitivity and highlight the importance of testing different assumptions about future events.

Implications

These research findings offer useful destination resort planning and management implications. These are discussed in the following sections.

Internal energy consumption and GHG emissions

Although destination planners have little influence over energy use and GHG emissions associated with travel to and from host communities, their planning decisions can shape some patterns of energy resource consumption within desti-
nations. This research suggests that those strategies creating the greatest energy conserving behaviour are linked to transportation, building design and construction, and energy supply system initiatives.

Transportation
This study identified the potential influence of innovative transportation strategies on a resort destination’s energy consumption and associated GHG emissions. These initiatives focus on reducing the need to use fossil fuel-powered vehicles for internal transportation purposes. They include implementing:

- compact and mixed development patterns which minimise travel distances and encourage walking and cycling (Gunn, 1994; Inskeep, 1987, 1991; Quilici, 1998);
- networks of pedestrian and bike paths conducive to tourist and resident use (Inskeep, 1987, 1991; Lumsdon, 2000);
- no-vehicle zones, slow speed areas and parking capacity constraints that curb incentives to use motorised vehicles (Holding, 2001);
- high capacity public transit services linking tourist accommodation areas to surrounding destination attractions (Sweeting et al., 1999; Thrasher et al., 2000); and
- public transit and other resort vehicles that are powered from renewable energy sources such as hydrogen fuel cells (Bode et al., 2003).

Such interventions are especially applicable at tourism destinations where reductions in traffic volume and related air contaminants enhance overall attractiveness for visitors and local residents. They also encourage tourists to experience the destination in a more engaging and tactile fashion.

Building design and construction
This research indicated that reductions in energy consumption and GHG emissions would result from incorporating energy saving technologies into the design of new and retrofit building developments. Destination planners can use policy instruments such as building permit approval processes to encourage energy conservation. A wide variety of architectural, engineering, construction and landscaping options are available (Bode et al., 2003; Chan & Lam, 2003; Inskeep, 1987; Sweeting et al., 1999). These include using:

- natural ventilation for cooling;
- building exposure strategies to retain heat and maximise natural light (Inskeep, 1987; Sweeting et al., 1999);
- alternative energy sources such as solar heating or ground source heat pumps (Bode et al., 2003; Chan & Lam, 2003); and
- high efficiency insulation materials, lighting, furnaces, hot water heating and other equipment.

Energy supply systems
This study indicated that reductions in GHGs would result from investments in environmentally sensitive energy supply systems. Options for such initiatives include using:
Energy Consumption and GHG Emissions

- local renewable energy power sources, such as wind and micro-hydro plants (Bode et al., 2003);
- photovoltaic equipment to supplement or substitute for other power supply methods; and
- district heating systems to increase overall heating and hot water production efficiencies (Rogner, 1993).

External energy consumption and emissions

The preceding discussion has identified numerous options for reducing energy consumption and GHGs in tourism destinations, but has not confronted those challenges in the context of visitor travel to and from such places. This study’s energy use model indicated that such travel is the overwhelming source of most energy consumption and emissions related to destinations. The technological improvements needed to curb air travel impacts are decades away from happening.

For the most part, managing such energy impacts is beyond the control of destination planners. It is also improbable that destination marketing organisations will shift their marketing focus from ‘higher spending’ distant markets to ‘lower yielding’ regional markets because of potential opportunities to reduce visitor related energy consumption and GHG emissions. A possible ‘transition strategy’ for addressing this challenge involves carbon offsetting (Becken, 2004). In a tourism context, carbon-offsetting involves trading off carbon dioxide emissions from travel for financial contributions to the creation and protection of natural ‘carbon sinks’ (usually forests) that absorb carbon dioxide. While the global effectiveness of forest-based carbon sinks in taking up carbon dioxide is unclear and controversial (Dorsey et al., 2004), several programmes are emerging that encourage consumers to contribute financially to the development of forested areas in exchange for their energy emissions (Carswell et al., 2003; Future Forests, 2000). Beyond their carbon absorbing benefits, these programmes may help protect and enhance regional biodiversity, hydrological, soil, and scenic landscape protection initiatives in tourism destination regions (Becken, 2004). Conversely, they may be detrimental to areas away from tourism destinations established as ‘carbon dumps’ (Dorsey et al., 2004).

Conclusion

Tourism’s role as a contributor to global energy consumption and GHGs has only recently gained academic and institutional attention. The few research studies measuring tourism’s effects have focused on activity specific or broad regional effects. This research provides a conceptual framework and energy use modelling approach that systematically identifies tourism destination contributions to energy consumption and emissions at a strategic planning level. The modelling approach is capable of assessing the impact of varying energy planning scenarios. This makes it a potentially valuable decision support tool for planners assessing future options for energy conservation in tourism destinations.

When tested in a ‘live’ destination planning context, the model offered valuable insights into the projected relative and absolute effects of proposed
planning strategies on Whistler’s future energy use and emissions. Its findings provide a useful foundation on which to make strategic decisions concerning what initiatives will help Whistler reach its intended sustainability goals.

Future research that will help to refine and strengthen the model’s utility include incorporating:

- more precise estimates of energy use intensities (EUIs) for various types of tourism energy consumers (e.g. buildings, infrastructure, tourist activities) based on more refined measurement systems;
- more detailed information concerning tourism’s effects on destination energy consumption and GHG emissions;
- the seasonal effects of visitation on energy usage and GHG emissions;
- the impacts of common air contaminants (CACs) in addition to GHGs;
- the effects of carbon offsetting programmes and other strategies that address the energy impacts associated with visitor travel to and from destinations;
- the effects of escalating costs and technological evolution on the energy consumption strategies of visitors, tourism operators, and local government activities; and,
- a behavioural component which includes actual stakeholder responses (e.g. visitors, residents/employees, tourism operators) to various energy conservation strategy scenarios.

In combination, research of this type will serve to make this energy use model a more robust and useful tool for informing tourism destination planners about the energy effects of their strategic planning decisions.

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References


