"We must balance our demand for energy with our rapidly shrinking resources. By acting now we can control our future instead of letting our future control us."

Jimmy Carter

# Energy

## Sustainability by Design Research Roundtable

by Nicole Miller

### Introduction

Energy measures the ability to do work and provides the conditions and services required for all the activities of daily life. In the built environment, flows of energy from a variety of sources provide the heat for buildings and hot water, power for lighting, appliances, communications and other technologies, industrial applications and the transportation of resources, goods, and people.

The Sustainability by Design Research Roundtable Working Group on Energy will investigate energy demand, supply and distribution in the region. The group will identify trends and drivers and explore key indicators that help to define the relationship between energy, infrastructure and urban form. The group will also propose recommendations on how regional energy systems can contribute to the Provincial target of an 80% reduction in greenhouse gas emissions by 2050.

### History

At the end of the nineteenth century, energy supplies in the Metro Vancouver region included gas for lighting and industrial processes generated from coal, wood waste, and eventually electricity – first supplied in 1887 to a small area of Vancouver from a small downtown steam plant. New transportation technologies such as street cars developed to take advantage of developing energy sources, although by the 1930s streetcars were already being replaced by automobiles and buses. Oil and natural gas were not available in the area until the 1940s and late 1950s respectively (BC Hydro History 2008).

By 1903, the region received hydroelectric power from the 1500 kilowatt Buntzen Lake facility. The Provincial government purchased BC Electric in 1961, making possible large scale hydroelectric development and supply. The British Columbia Hydro and Power Authority (BC Hydro) formed in 1962. Less than 20 years later, BC Hydro began a series of energy conservation programs including education and outreach, incentives for home energy upgrades, and eventually BC Powersmart. BC Gas, now Terasen Gas, Inc formed in 1988, privatizing natural gas service (BC Hydro History 2008).

Recent volatile energy costs, increasing demands, supply shortages, and present and future climate change impacts have led to increases in programs and legislation seeking to reduce regional and provincial energy consumption, while seeking new local, renewable and low-carbon energy supplies.

## Current Context

Energy consumption across British Columbia is increasing. Since 1990, total annual energy consumption has increased 19%, with increases in every major sector. These increases are directly related to population and economic growth in the province, which increased at rates of 25% and 61% respectively over the same time period (Nyboer 2004). Although approximately one-quarter of this energy is from renewable sources, burning of fossil fuels supplies the remainder.

### Demand

While per capita energy consumption in the region has declined slightly in recent years (Figure 1), total energy consumption across the Province has continued to increase through economic and population growth. From 1990 to 2002, transportation, commercial and agricultural energy consumption have each grown 30%. Over the same time period, residential energy consumption increased by over 19% and industrial energy consumption increased 13% (Nyboer 2004). These increases have begun to strain current energy infrastructure, including BC Hydro's hydro-electric generation capacity (Wiggin 2002). The consumption of fossil fuel based energy sources have increased accordingly – the use of petroleum products, such as gasoline and diesel, has increased 21%, natural gas use has increased 50%, and coal consumption has increased 198% within the past quarter-century (Nyboer 2004).

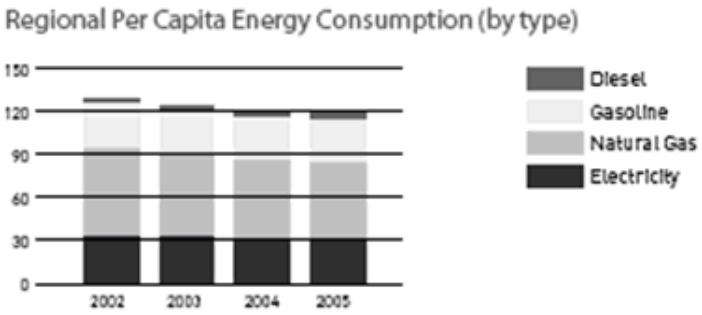


Figure 1: graph illustrating total per capita energy use in Metro Vancouver
Source: GVRD Sustainability Report 2003-2005.

### Supply and Distribution

The current energy supply for Metro Vancouver consists of approximately 25% non-carbon based, renewable energy supply – predominantly hydro-electricity – and 75% carbon based, including natural gas, gasoline and diesel fuels (Metro Vancouver 2005). The region imports a majority of this energy from elsewhere in the province, the country or the world.

The region imports electricity, provided by the provincial crown corporation BC Hydro, predominantly from large hydro-electric dams near the Peace and Columbia Rivers and supplemented by electricity from Alberta. Natural gas, supplied by privately owned Terasen Gas, Inc. originates from northern British Columbia and Alberta. Existing natural gas pipelines run at capacity most of the year with little capacity for increased demand and no existing storage capacity. The region sources unprocessed oil internationally, used mainly for transportation, and imports it by pipeline to regionally-based refineries (Wiggin 2002).

Within the region, renewable energy is predominantly hydro-power, which provides approximately 90% of the electricity generated by BC Hydro. Wind, biomass, biogas, solar, etc also provide small amounts of renewable energy (Nyboer 2004).

Within Metro Vancouver, Burnaby's waste-to-energy facility processes over 280,000 tonnes of garbage (approximately 20% of the region's total) into 900,000 tonnes of steam. A nearby paper recycling facility uses this steam both to offset natural gas consumption and to produce electricity (Metro Vancouver 2007). Additionally, the region hosts two hydro-electric dams (Buntzen Lake, 73MW; and Alouette, 9MW) as well a micro-hydro facility in West Vancouver. Numerous district energy systems in the region, including downtown Vancouver, the City of North Vancouver and several university and hospital systems, also supply energy within local contexts.

## Urban Form

In Metro Vancouver, over 50% of GHG emissions come from light-duty vehicular travel (28% of total) and building space heating (26% of total) (Wiggin 2002). Urban form decisions greatly influence both of these sectors. In addition to direct reductions in energy consumption and emissions stemming from changes in urban design, good development decisions will also enhance the potential for local energy technologies and energy conserving behaviors (see Steemers 2003; Ewing and Rong 2008; US EPA 2001; Ewing, et al 2008 and Boarnet 2001 for reviews of relevant literature).

Additionally, considering urban form at the neighbourhood scale provides greater opportunities for the utilization of more integrated energy systems. At scales larger than individual parcels and buildings, a greater intensity and diversity of energy demands and potential sources can lead to more efficient and synergistic energy flow strategies (Energy foundation bulletin). Higher densities and a greater diversity of land uses enhance the feasibility of district energy, waste heat and combined heat and power technologies.

| Land Use Variables | Energy Factor Influenced | Magnitude of Potential Impact |
|---|---|---|
| Combination of land use factors (shape, size, interspersion, etc.) | Travel requirements (esp. trip length and frequency | Variation of up to 150 percent |
| Interspersion of activities | Travel requirements (esp. trip length) | Variation of up to 130 percent |
| Shape of urban area | Travel requirements | Variation of up to 20 percent |
| Density/clustering of trip ends | Facilitates economic public transport | Energy savings of up to 20% |
| Density/mixing of land uses/built form | Facilitates CHP | Savings of up to 15%. Efficiency of primary energy use improved up to 30% with district energy. |
| Layout/orientation/design | Passive solar gain | Energy savings of up to 20% |
| Siting/layout/ Landscaping/materials | Optimize microclimate | Energy savings of at least 5%; more in exposed areas |

*Source: Adapted from Owens 1991, Oregon Dept of Energy 1996, and Blais 1996.*[52]

Figure 2: Table summarizing the influence of urban form on building and transportation energy demand. Source: Torrie, Parfett and Steenhof, 2002.

**Advancing Technologies in Renewable Energy:**

Passive Solar Design
Hot Water Panels
Space Heat Panels
Photovoltaics
Biomass Heat Systems
Geo-exchange
Wind Turbines (various designs)
Micro-hydro Turbines
Sewer Heat Recovery
District Energy

## Future Trends

With increased emphasis on climate change and greenhouse gas mitigation, the sectors making the largest GHG contributions will require targeted efforts, particularly in the face of continued regional population growth. Within all sectors, reducing GHG emissions will involve both significant reductions in energy consumption and the replacement of fossil fuels with renewable energy sources.

Several provincial and regional initiatives have recently been produced to address these issues: the **Metro Vancouver 2040: Shaping our Future (draft), 2008** directs urban development into patterns that reduce building and transportation energy demands. T**he BC Energy Plan, 2007** sets targets to achieve zero net greenhouse gas emissions from electricity generation and seeks electricity self-sufficiency by 2016. **The BC Bioenergy Strategy, 2008** promotes biomass projects, biofuels and bioenergy technologies, and requires methane capture from largest landfills. **The Energy Efficient Buildings Strategy, 2008** seeks to: reduce average energy demand per home by 20% and work by 9% per square meter by 2020; complete energy conservation plans for all BC communities; and, make public sector buildings GHG neutral by 2010. **The BC Green Building Code, 2008** requires new insulation and overall performance standards for wood frame construction and energy efficiency standards for high-rise multi-family and large industrial, commercial and institutional buildings. Finally, the **Provincial Transit Plan, 2008** targets doubled transit ridership by 2020 through investing in: 4 new Metro Vancouver rapid transit lines; high-capacity, energy-efficient rapid-bus routes; and, 15,000 new clean energy buses and infrastructure.

## Synergies with other themes

### Food

The production, processing and transportation of food for the regional population consumes immense amounts of energy. Food systems in the U.S account for approximately 16% of total national energy use (Hendrickson 1996, referenced in Brodt 2007). Inefficiencies in food production and transportation intensify related energy consumption. In British Columbia agriculture consumes more energy than the resulting food provides (Alexander and MacRae 2002).

### Mobility

Mobility systems intrinsically link to the issue of energy. People, resources and products, as well as information require energy to move. Currently, a majority of mobility modes are mechanized and depend on fossil fuels as the energy source. Many modes use highly inefficient internal combustion engines and mechanical transmission systems, producing large amounts of waste heat, air pollution and greenhouse gas emissions. Reducing energy consumption and greenhouse gas emissions related to mobility will require changes to mobility provision and energy sources.

### Water

British Columbia depends on water for a large portion of its electricity supply. Changes in the regional climate and increased water consumption may decrease the future reliability of this energy supply, resulting in

increased greenhouse gas emissions from electricity produced by fossil fuels. Water consumers are often unaware that inefficient water use also results in increased energy consumption, both through water heating and water treatment. Treating water to potable standards requires large amounts of energy although less than 16% of household water requires that level of quality (Hallsworth 2002).

### Natural Habitat

Energy generation and distribution often have impacts on natural habitat locally, regionally and globally. Fossil fuel-based forms of energy generate greenhouse gas emissions and other pollutants that affect the ecosystem, including climate. The renewable, large-scale hydropower found in British Columbia also impacts hydrologic cycles, plant and animal habitat and other ecological systems. Increasing needs for energy will create more pressure on natural habitat in the future.

### Economy

Energy is a foundation of a healthy economy – to enable growth, to build communities, to produce goods and provide services. Generally, a growing economy means more energy use. Fossil fuels presently supply a majority of energy for transportation, industry, homes and businesses. Economic shifts are creating new demands for alternative energy technology to enable the switch from fossil fuels to renewable resources. In the Canadian environmental industry, renewable and alternative energy are two of the fastest growing economic sectors (Speck, 2002).

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## Questions

What is the current baseline performance for energy production, transportation, storage, and consumption in Metro Vancouver?

How vulnerable is the region to changes in the supply of fossil fuels, and what would a more resilient region look like?

Are there optimal urban forms or patterns for energy efficiency or local/ renewable/ low-carbon energy generation?

How do energy efficient forms of development conflict with or support other sustainability goals?

What renewable energy technologies are most feasible for the region and what urban forms or patterns support or limit these technologies?

At what scale(s) should energy be generated and distributed?

Are there synergies between building and transportation energy demand and supply that should be developed?

What regulatory/political/social/economic/technological barriers exist to creating optimal regional conditions for reducing energy demand and increasing renewable energy generation?

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