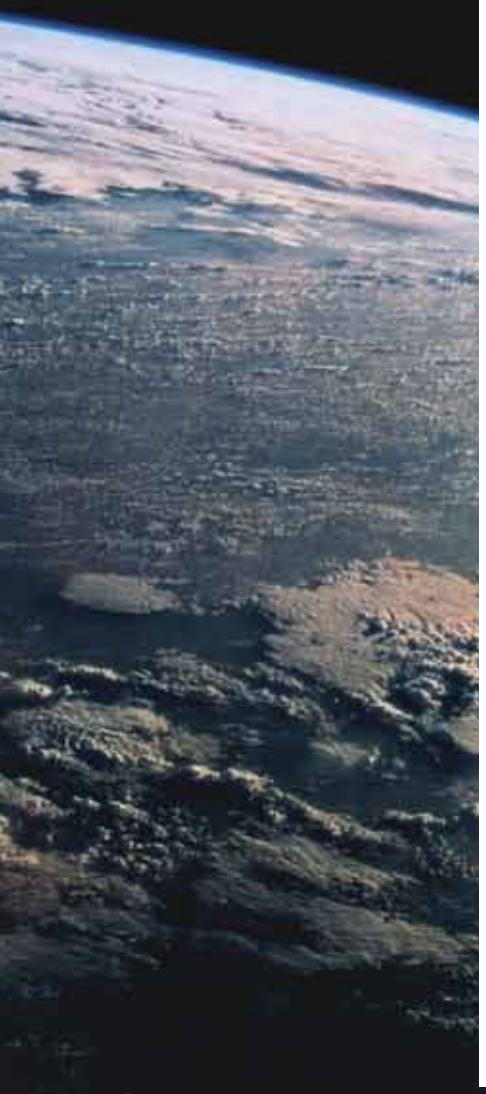
PACIFIC INSTITUTE FOR CLIMATE SOLUTIONS

SUSTAINABLE COMMUNITIES

NOVEMBER 2008

# Infrastructure & Communities: The Path to Sustainable Communities

JOHN ROBINSON, TOM BERKHOUT, SARAH BURCH, EMILY JANE DAVIS, NICHOLE DUSYK, AND ALISON SHAW
WITH STEPHEN SHEPPARD AND JAMES TANSEY
UNIVERSITY OF BRITISH COLUMBIA



University of Victoria

SFU SIMON FRASER UNIVERSITY THINKING OF THE WORLD

THE UNIVERSITY OF BRITISH COLUMBIA

UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

The Pacific Institute for Climate Solutions gratefully acknowledges the financial support of the Province of British Columbia through the BC Ministry of the Environment.

**Pacific Institute for Climate Solutions**

University of Victoria
PO Box 1700 STN CSC
Victoria, BC V8W 2Y2

Phone (250) 853-3595
Fax (250) 853-3597
E-mail pics@uvic.ca
www.pics.uvic.ca

## EXECUTIVE SUMMARY

The focus of this White Paper is on infrastructure and communities. More specifically, we look at the critical role that 'sustainable communities' can play in achieving long-term climate change mitigation and adaptation goals, and the short- to medium-term actions needed to ensure that this potential is realized. By addressing climate change adaptation and mitigation through the pursuit of a fundamentally sustainable development pathway, we encourage an integrated approach that considers not only emissions reductions and climate change adaptation, but also the underlying drivers of unsustainable patterns of development.

Communities lie at the very heart of our everyday lives. Their networks of built structures, institutions and behaviours have a powerful influence on how we collectively use energy and, in turn, how we both influence and respond to climate change. Changes in land-use, density, urban form and transportation, energy and water infrastructure, therefore, are essential mitigation strategies that can contribute to significant, long-term greenhouse gas reductions. Just as important as these structural changes are changes in how people think about and use energy, both with respect to individual energy use and also with regard to the level of acceptance by individuals of the policies and measures required to achieve collective energy savings.

To better understand how sustainable communities are intricately linked to climate change mitigation and adaptation choices, we describe the characteristics of sustainable communities of all sizes in British Columbia in the decades ahead. These include densification, mixed land use, a net-zero energy system, and a diverse local economy. In addition, the sustainable community is the site of integrated local-level adaptation and mitigation actions that are critical to the arenas of governance, decision-making, and behavioural change. In short, the scenario described here demonstrates how climate change adaptation and mitigation are the favourable outcomes of deeply sustainable communities.

The accumulated changes needed to transform today's carbon intensive communities into the low-carbon sustainable communities of the coming decades are undoubtedly enormous. The major effect of these actions, and their parallel positive outcomes on climate change, will occur in the post-2020 period. Yet, it is essential that they be started now, since fundamental change in both underlying infrastructure and in human attitudes and behaviours must overcome considerable inertia and time lags. We need to begin now to make the changes that will give rise to more sustainable and low-carbon development pathways in the future. In order to get started, we recommend a strategy to steer and coordinate the decisions of governments, markets, local groups and individuals toward favouring low-carbon infrastructures, institutions, and behaviours so that, over time, the cumulative result of these decisions will be recognizable as sustainable communities.

## 1. CLIMATE CHANGE AND SUSTAINABLE COMMUNITIES

Greenhouse gas (GHG) emissions are very significantly affected by decisions we make about how we design our communities and organize human activities. Changes in land-use, transportation, energy and water infrastructure, density and urban form that help reduce emissions are essential to mitigation strategies that aim for significant, long-term GHG reductions because they change the underlying drivers of emissions. Denser urban developments,

for example, require less energy to heat and cool, and less transportation energy to move people around (Newman & Jennings 2008; Newman & Kenworthy 1989; Roseland 1998). They are also associated with lower per capita water consumption and lower waste production (Newman & Jennings 2008; Roseland 1998). When combined with the mitigation and adaptation measures that will help achieve the province's shorter-term emission goals, changes in land-use, density, and urban form offer the potential of achieving much lower emission futures (BCCAT 2008).

While the most visible sites for climate action in communities are structural, relating to land-use and built form, communities are also critical in shaping values and behaviour. Changes in how people think about and use energy are likely to be a necessary part of achieving our long-term climate goals, both with respect to changes in individual energy use and also with regard to the acceptance of the measures required to achieve collective energy savings relating to transportation, energy and water infrastructure and policy, such as the development of locally-based renewable energy sources (BCCAT 2008). In turn, the design of our communities can reinforce the necessary shifts in collective and individual behaviour.

These two areas of climate action—structural change and behaviour change—come together in complex ways in communities. The energy-related patterns of everyday life take shape in the midst of networks that have both social and material characteristics (Shove 2003). For instance, transportation energy requirements, and thus emissions, are increased in sprawling communities and reduced in denser, more compact communities (Frank & Pivo 1995). This is a result of the increased viability of public transit systems and of increased use of non-motorized transportation, such as walking and cycling, in compact communities. Research has shown that the choice of zero-emission transportation options, such as walking and cycling, is strongly related to supportive physical features of communities (Frumkin et al 2004; Moudon et al 1997). Thus transportation emissions are linked to both individual choices and to the structural features of communities. This relationship also has important implications for the overall health and quality of life within a community (Frumkin et al 2004). In addition, social norms, habits, cultural concepts of space and time, and expectations take form within these socio-material networks (Davison 2001; Shove 2003; Winner 1986). Like the structural features of a community, these non-tangibles have important implications for energy use and the potential for reducing emissions. For instance, the size of homes, which is directly related to heating and cooling requirements, is significantly influenced by social norms, building conventions, and expectations of personal space (Wilhite et al 2000).

The concept of a development path helps us make sense of the network of social and material infrastructures that are at play in communities and that ultimately shape energy use and emissions profiles. The term development path is used to describe the basic socio-economic and technological trajectories of a jurisdiction. It consists of "a complex array of technological, economic, social, institutional, cultural, and biophysical characteristics that determines the interactions between human and natural systems" (Sathaye et al 2007) and forms the context for energy-related activities. Evidence for the importance of development paths in achieving mitigation goals comes from research into long-term climate mitigation scenarios. That research indicates that the difference in GHG emissions between alternative development path scenarios can be as great as that between scenarios with or without climate change mitigation (Fisher et al 2007; Moomaw et al 2001). This suggests that structural and behavioural changes that support a low emission development path can be as important in reducing emissions as mitigation policy (Swart et al 2004). The combination of transformative change to

the development path with supporting mitigation measures, such as a carbon tax, is therefore desirable in attaining a zero emissions future.

There is a strong, iterative relationship between climate change and development. "Specifically, climate change vulnerability and impacts influence prospects for development, and in turn, the development path not only determines greenhouse gas (GHG) emissions affecting future climate change, but also influences capacities to adapt to and to mitigate climate change" (Bizikova et al 2007). In effect, the success of climate change mitigation and adaptation strategies relates in important ways to the characteristics of the underlying development path.

At the local level, this means that climate change mitigation and adaptation can also be used to help achieve social and economic goals and improve the overall sustainability of communities. For instance, clean energy systems, such as biomass and micro-hydro, can help create and keep jobs in rural communities. It also implies that climate change goals may be more effectively achieved by framing the issues in terms of broader sustainable development goals rather than just in terms of carbon emissions reductions. This makes practical sense since the issues that a sustainability framework introduces—such as quality of life, resilience, economic development, and social justice—already align with the concerns and agendas of many communities. However, we may need to expand, sharpen and re-prioritize the commonly used criteria for sustainable development if we are to achieve challenging, quantified targets on climate change (eg. BC's legislated emission reductions by 2020 and 2050); simply getting "greener" is not enough to get us to those targets and help attain stabilisation of GHG concentrations (Sheppard and Pond, 2008).

The degree to which communities adopt a sustainability framework will vary from place to place, as will the priorities and approaches used. There is no standard or model of sustainability that can be applied across the board. Nevertheless, to gain insight into sustainable communities, we can focus on how common systems—such as water, energy, transportation, and waste—are configured at the local level. We can also look at specific characteristics, such as density and land-use patterns, which enable or constrain sustainability. Finally, we can look at the institutions, planning practices, and collective decision-making processes that help communities move toward more sustainable futures.

Regardless of the specific approach in any jurisdiction, creating sustainable communities is a long-range goal. The major effect of these actions, and their parallel positive outcomes on climate change, will occur in the post-2020 period. Yet, it is essential that they be started now, since fundamental change in both underlying infrastructure and in human attitudes and behaviours must overcome considerable inertia and time lags. We need to begin now to make the changes that will give rise to more sustainable and low-carbon development pathways in the future (BCCAT 2008).

## 2. WHAT WOULD SUSTAINABLE COMMUNITIES IN BC LOOK LIKE?

Sustainable community development is the focus of recent research (Roseland 2000; Roseland 2005) and practice (Curran & Leung 2000) that explores an array of community goals including: quality of life, promotion of continuity and integrity in economic systems, and simultaneous reduction of community ecological footprints. Sustainable communities will

be guided by initiatives that combine strategies for sustainable development and responses to climate change. Regardless of its size, the sustainable community is generally characterized by densification, mixed land use, sustainable water and transportation systems, a net-zero energy system, and a diverse local economy. Furthermore, the sustainable community is the site of integration of local-level adaptation and mitigation actions with development choices in the arenas of policy formation, decision-making, governance and behaviour change (Wilbanks and Sathaye 2007) (see Figure 1). To better understand how sustainable communities are intricately linked to climate change mitigation and adaptation choices, the remainder of this section adopts a backcasting approach (Robinson, 2003) and describes how a successful sustainable and resilient community might look in British Columbia in the decades ahead. The intent here is not to predict the most likely future for BC, but to sketch the outlines of what changes might occur that would improve community sustainability and in so doing respond effectively to the climate change challenge, including expected climate change impacts. Such future visions can then serve as the basis for analysis of what policy choices and measures would be required to move us in the direction of such outcomes.

**Figure 1.** The shift to sustainable communities requires consideration of 1) mitigation strategies, such as increased alternative transportation corridors (rail, bikes, etc.), zero energy buildings, and district energy systems fuelled by renewable sources, and 2) adaptation strategie, such as increased permeable surfaces to adapt to increased rainfall and increased street trees for shading under increased temperatures. (Credit: David Flanders, CALP/DCS, UBC)

## 2.1 THE LOW-EMISSION COMMUNITY DEVELOPMENT PATH

### *Densification and integrated communities*

*Imagine mixed-use land-use planning that increases density, services, and transportation options and protects valued industrial lands and ecosystems.*

In the high density, mixed-use neighbourhoods of BC's larger cities and towns, residential and commercial mixed-use zoning increases community economic development and diversification (DCS 2006; Curran & Leung 2000). This allows people to live and work centrally, with

access to services, such as shopping and entertainment. Compact design and development encourage household energy and water conservation (Ewing and Rong 2008) (see Figure 2). For instance, LEED standards make mandatory household energy and water metering, low flush toilets, and recycled grey water (Southeast False Creek in Vancouver). Densification has taken various different forms that reflect local conditions and community character, and larger suburban areas have been retrofitted for energy efficiency and local services (Pond, 2008).

The main per capita source of GHG emissions at the turn of the 21st century - single-occupant vehicles - decline as residents begin to live and work within complete communities. Service jobs are generated from diverse commercial and industrial sectors within each community, where the majority of residents can obtain secure employment (DCS 2006). When working outside the community is necessary, employers subsidize transit passes. New communication technologies change the notion of the "workplace". Employees are more able to integrate work/life responsibilities, enabling a greater sense of well-being. A virtual commute to the office for many workers reduces high-flow commuter traffic on both public transit and roads. The number of single-occupant vehicles and overall per capita vehicle kilometers are significantly reduced, limiting highway expansion and overall encroachment onto agricultural and natural lands (Newman 1999).

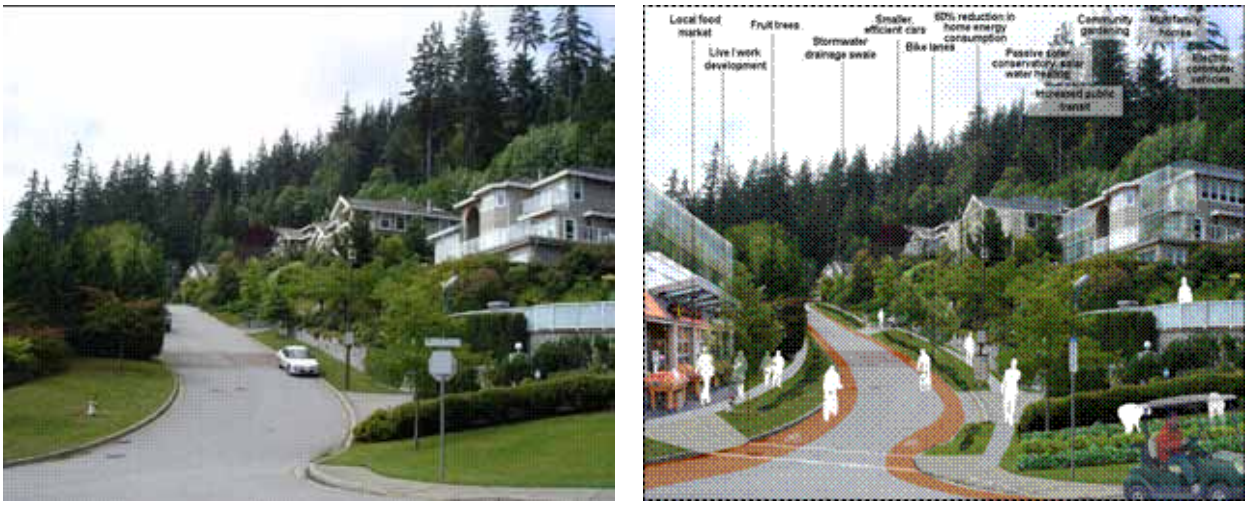



**Figure 2.** Complete communities in either urban, suburban (above), or rural communities emphasize density, alternative transportation options, increased local services, and public and private energy generation/ conservation. (Credit: Jon Laurenz/David Flanders, CALP/DCS, UBC).

Density and changing social values promote investment in transportation infrastructure (DCS 2006). Integrated light rail systems combined with broad-reaching hydrogen bus systems weave a web across urban and suburban communities, making it much easier to get across town to shop or visit friends and family. People enjoy walking and bicycling in the summer months, which encourages an active and healthy population (CHER 2008). In smaller rural and remote communities, community-wide ride-sharing programs are the primary mode of transport to work and school. Many citizens make use of the high-speed rail and hydrogen bus lines connecting communities throughout BC (and eventually North America) (CBC 2007).

### Net-zero energy systems

*Imagine local design and planning that closes the waste loop, protects productive lands and ecosystems and where communities run like ecosystems, producing their own energy and reusing byproducts and waste.*

High-density buildings with shared walls and demountable recycled materials are designed for energy and water conservation (Ewing et al 2007). Each building is required to maximize its energy-producing potential based on principles of orientation, elevation, and capacity for solar, wind, and geothermal energy (DCS 2006). Most buildings link into an integrated community energy system where surplus is sold and deficit is bought (CIRS 2008); surplus electricity is also used to power electric vehicles (Miller 2006). Residential, commercial, and industrial energy is recycled in rotations of high and low use. Acting as alternative energy clusters, neighbourhoods link into an integrated, modular system, which promotes energy self-reliance (BCCEA 2008). Furthermore, buildings are designed to explicitly consider local future climate impacts over their lifespan (Murdock, 2008).

This integrated framework supplies energy as a coordinated system, capturing and reusing transformed energy such as steam and biomass to supply other end-uses (Sheltair 2003). In a number of communities, industrial plants located near high-density neighbourhoods capture excess heat and power for use in people's homes (Ethos 2006).

Collaborative inter-jurisdictional energy planning that includes provincial and local governments, utilities and community energy planning teams fulfills energy requirements throughout the century despite economic changes and an expanding population. Hydroelectricity developments are made at smaller scales and with early and full consultation of aboriginal residents and other local interests, to provide local benefits and protect riverine ecosystems as well as areas of cultural significance for future generations. Forest, biomass, and energy industries function through comprehensive long-term land use plans to avoid impacts on watersheds and other ecosystem services that are valuable to the health of communities. Regional connections between timber and pulp milling sectors are maintained through chip supply agreements and other measures to optimize harvested forest biomass. The need to manage for multiple land-use values such as energy production, local economic development, recreation, spiritual connections, and restoration is also met through these processes.

### Diversified local economies

*Imagine transformation that supports economic development and diversification in your community, while increasing local self-reliance and responsibility for local resources.*

New forms of carbon emissions certification and production valuation internalize the costs of production and transport of goods, increasing the price of imported goods, and supporting local economic development (Sheltair 2003). Local economic networks and local innovation are enhanced through the efficient production and use of goods and services. Farmers' markets and small businesses provide a range of goods for residents. Agricultural lands and opportunities for urban farming are utilized for local food and biomass production (Ethos 2006), and surplus is sold. Rural economies are increasingly based on numerous "value-added" activities rather than single-industry dependence (Markey et al 2005), and are not solely reliant on urban demand and supply linkages in the secondary sector. The integrity and sustainability of such local rural economies is ensured through appropriate intergovernmental cooperation

and regulation to properly mediate the effects of urban dependency on rural ecological services as well. Impetus for innovative markets is created through corporate social responsibility and performance requirements, such as certification programs for sustainably-harvested forest products. These requirements allow for increased consumer awareness of commodity chains, and enforce smaller-scale production economies designed around minimal transport costs and energy usage.

### *Adaptation and mitigation strategies*

*Imagine changes to land use and urban form that support the adaptation and mitigation strategies needed to reduce climate change.*

Projected climate change impacts at the regional and community level along with appropriate short- and long-term adaptation and mitigation strategies are integrated into all official community plans. Comprehensive, long-term and complementary adaptation strategies build climate change vulnerabilities and projected impacts (such as increased flooding or sea level rise) into urban design and land-use planning by either integrating resilience into residential and commercial design (e.g. houses on stilts or floating foundations) or preventing/removing development in vulnerable areas. Furthermore, dense, complete communities prevent encroachment onto agricultural and natural lands, simultaneously building energy and food security, and overall community resilience to unpredictable futures. For instance, as temperature, soil, and water conditions change, crop-shifting, integration of efficient energy and water technologies, and adaptive infrastructural changes (such as raising dikes) become community decisions. In all decisions, though, careful attention is paid to the trade-offs that may arise between mitigation efforts and adaptive responses.

## 3. MAKING SUSTAINABLE COMMUNITIES A REALITY IN BC

### *3.1 Strategies for Steering the Transition Toward Sustainable Communities*

Achieving the vision of sustainable communities described above requires a fundamental transformation of the development paths that are currently being followed by many communities in British Columbia (Dusyk et al, forthcoming). Many development paths in western industrialized cities are characterized by heavy dependency on fossil fuels, rapidly diminishing biodiversity, degraded human health, and social inequity (IPCC 2007; United Nations 2008). Urban communities face specific challenges related to low densities, affordability of property, and transportation, while rural and remote communities face issues linked to their capacity to offer adequate employment, public transit, and social services to residents. Single-industry development paths in many rural and remote communities have led to vulnerability in the face of climate-related changes and economic challenges (Davidson et al 2003), illustrating the degree to which industry, community, and ecological sustainability are linked (Ostry 1999). In contrast, a sustainable development path is one in which climate change goals and broader development priorities are explicitly targeted and attained simultaneously (Robinson & Herbert 2001; Swart et al 2003).

A development path approach to sustainable communities helps to illustrate the synergies between climate change goals and development priorities. For example, the key elements of

density, transportation infrastructure, water and energy systems, land use, and urban form are planned with changing global and local conditions in mind (Bizikova et al; Sheppard & Shaw 2007; Sheppard and Pond 2008). Taken together, comprehensive planning for reduction of greenhouse gas emissions, and adaptations to changing local and global conditions, in the context of explicit consideration of the development of community social, economic, and environmental systems, ensures that all development decisions are non-contradictory and, where possible, mutually reinforcing, increasing the resilience of a community over time.

In British Columbia, comprehensive planning at the municipal level is particularly critical, because just less than half of the province's total emissions are under the control of municipal governments (Miller et al 2008). The challenge is that the transformative actions to prevent and reduce greenhouse gas emissions in these communities must address elements such as urban form, energy systems, and local economic development, which are not subject to change by individuals, but instead are the result of collective decision-making. Traditionally, efforts to alter political or behavioural outcomes focused on two core approaches: influencing policy through the provision of analysis and advice, and influencing the behaviour of individuals through public education campaigns (Robinson, forthcoming). It is unlikely, however, that these approaches on their own will stimulate the pervasive and integrated responses that are required for communities to transform unsustainable patterns of development to sustainable ones. The intervention tool-kit, therefore, needs to extend beyond incremental policy recommendations and the individual actions of well-intentioned citizens. To achieve our vision of sustainable communities, we must re-structure the ways in which we conduct business, govern our cities and regions, and reinforce individual and collective behaviour change.

### *3.2 Barriers to Change*

In order to pursue an integrated sustainability mandate, barriers to action at the local level must be identified and addressed. These barriers fall into three broad categories: institutional issues that are internal to municipal governance organizations; institutions that are external to municipal governance such as other levels of government and markets; and individual values, perceptions and behaviour.

***Municipal institutions:*** Barriers to action on sustainability are present in many governance institutions at the local level. For instance, sustainability is a far-reaching and deeply integrative goal, which requires the insights of practitioners and experts from a wide variety of disciplines. However, organizational cultures built around disciplinary thinking often discourage collaboration between individuals from various municipal departments, thereby undermining successful action on sustainability (Kok et al 2000). Related to the issue of organizational culture is the question of where responsibility for sustainability efforts resides within the organizational hierarchy of a municipal government. Although no single approach will be suitable for all communities, it is often the case that climate change and sustainability are more effectively tackled when the weight of a high level office (such as that of the city manager) is behind action on these issues (Betsill 2001). Unfortunately, however, sustainability is all too often relegated to a branch of municipal organizations that has little authority, and is not yet strongly connected to routine planning mechanisms. Strong political leadership that provides a clear policy directive is yet another internal institutional issue that will enable action at the local level. The challenge, however, is for politicians to overcome the short-term planning horizons of local policymaking that may be perceived to conflict directly with the long-term implications of climate change (Wilson 2006). Finally, recent research has

shown that efforts to design integrated climate change adaptation and mitigation measures are strongly constrained by knowledge limitations (Wilbanks et al 2003). Especially in rural, remote and indigenous communities, it can be difficult to attract and retain the technical skills, capital, and staffing levels required for innovation, even though these communities typically have higher vulnerability to the impacts of climate-related change (Adger 2003; Schneider et al 2007).

***Inter-jurisdictional and private sector issues:*** Policies adopted at the regional, provincial, and federal level are often deeply inconsistent with sustainability and climate change priorities at the local level. In addition to the potential for contradictory inter-jurisdictional decision-making, many crucial legislative or regulatory powers do not fall within the domain of municipalities. A critical ingredient of local sustainability, therefore, is the competency and power of local authorities to both plan effectively within their own boundaries and reach beyond these boundaries to develop consistent and integrated responses. At the same time, municipalities need also to eliminate inconsistencies in their own policies, eg. reducing GHG emissions and permitting high-energy consumption building styles.

While governments are responsible for ensuring that the strategies, priorities and rules for achieving sustainable communities are consistent with one another, it is ultimately the private sector that will deliver many of the products and services needed to make sustainable communities a reality (Robinson, forthcoming). However, a major obstacle for both existing and yet-to-be invented sustainable solutions lies in the lack of a dynamic market for these types of technologies and practices. A dynamic market is one that is not only 'pulled' by positive changes in institutions, values and behaviours, but also 'pushed' by private sector interests who see opportunities for competitive returns-on-investment through the innovation and diffusion of novel products and services. A 'push' market without an equally strong 'pull' one means that, even if we develop the demand needed for implementing sustainable solutions for communities, the solutions themselves may still take years before they are made viable.

***Individual values and behaviour:*** In addition to the institutional barriers discussed thus far, achieving sustainable communities will also be strongly influenced by the values, perceptions and behaviours of individuals. Transformative change requires a significant shift in social values and may require short-term trade-offs. While trade-offs such as reduced residential space due to increased density, or the lack of convenience and autonomy with regard to vehicle travel, are often presented as negative, there are examples of how these aspects have contributed to a new generation of healthy, vibrant, complete and resilient communities (such as the BedZed residential development in the United Kingdom, and the town of Malmö, Sweden). Altering the development path will require adjustment but, over time, may lead to more desirable behaviour change (Moser & Dilling 2007).

Although many efforts to change individual behaviour focus almost exclusively on first changing values, recent research has demonstrated that behaviour is the outcome of a combination of attitudinal factors (such as values, social norms, and beliefs) and contextual forces, personal capabilities, and routines (Stern 2000). Behaviour is also structured by the material and technological characteristics of communities. This means that in to order achieve a more sustainable development path, policy-makers need to do more than simply provide individuals with information that tries to influence their attitudes. They need to work with citizens in order to create urban infrastructure, institutions, and participatory design and decision-making processes that support more sustainable practices on an individual and collective level, while acknowledging deeply-held local concerns and the uniqueness of each commu-

nity. There is evidence that novel visioning and design charrette processes, for example, can help to overcome awareness and acceptability barriers (Sheppard et al, 2008).

In addition to the institutional and behavioural barriers discussed so far, it is also important to recognize that there is significant inertia in the materiality of communities. "[D]espite the fact that cities are considered to be dynamic and flexible spaces, numerous examples illustrate that it is very difficult to radically alter a city's design: once in place, urban structures become fixed, obdurate" (Hommels 2005). Buildings, roads, sewer systems, energy and communication networks may endure for decades or, in some cases, centuries. This is not to say that change is impossible or even improbable. Despite their longevity and inertia, there is flexibility in how networks are arranged and managed (van Vliet et al 2005). However, in order to create more sustainable communities, long-range planning must account for the interconnectedness of urban infrastructure. It is rare for infrastructure to be constructed from the ground up. Rather, components are replaced and upgraded piece by piece, usually as they reach the end of their lifespan. Because of the slow and incremental turnover, it is necessary to begin transitioning to more sustainable infrastructure now. At the same time, long-range planning is essential to ensure that upgrades increase the flexibility of the system and the interchangeability of its components so as not to impede change down the road. For instance, buildings can be designed to accommodate green-roofs and grey-water systems even if they are not planned for the immediate future, providing resilience with regard to projected changes to extreme precipitation and increased summer temperatures.

## 4. ACTION ITEMS FOR INITIATING SUSTAINABLE COMMUNITIES

Steering the transition toward sustainable communities in British Columbia will undoubtedly be a highly complex and at times uncertain journey. Despite these challenges, action in a number of areas can be carried out in the short- to medium-term to help overcome the numerous barriers this transition faces and to begin building the infrastructure needed to support sustainable communities as rapidly as possible:

First, nurturing collaboration, innovation, and inclusion among municipal departments will contribute to an enabling organizational culture in municipalities. To counteract the establishment of organizational silos, it is imperative that hiring practices and job descriptions reflect the importance of inter-disciplinary modes of thinking. Equally important, however, is designating a central and high-profile organizational home for climate change and sustainability issues that institutionalizes strong inter-divisional collaboration and allows for sustainability and the use of climate information to be embedded in the day-to-day actions of the municipality as a whole.

Second, a reorganized regulatory regime needs to deliver clear rules and incentives for sustainable development, particularly on issues of urban sprawl and carbon-dependent building forms. It also must be coordinated between levels of governance, and must offer greater affordability, participation, and higher quality of life in order to be successful (Alexander & Tomalty 2002). Finally, priorities (e.g. community transit in rural areas) and consensus on actions across organizations need to be aided by tools such as criteria setting and indicators (Patrick & Roseland, 2005).

Third, federal and provincial funding exists to support infrastructure improvement and development for local governments. This funding can be used to structure communities around principles of sustainable land use, density, and built form that allow for planned growth and energy efficiency. However, inter-governmental funding must be directly linked to measurable performance targets in each community (BCCAT 2008) and stakeholders must be included in integrated assessments at the community scale (Ruth & Coelho 2007).

Fourth, an intentional shift towards a more sustainable development path in communities requires integrated and ambitious targets, facilitated by frequent opportunities for course-correction and social learning. While sustainability will look different in every community, and is dependent on whether it is urban, suburban, or rural, there are some defining and transferable characteristics that determine whether a community is meeting its present needs without impinging on the needs of future generations. Our understanding of what is considered sustainable changes over time as socio-economic systems, human values and climate conditions themselves change. It is therefore important for pathways to sustainability (in the form of policies, initiatives, or comprehensive planning) to be re-evaluated on a regular basis in order to better understand long-term strategies to adapt and to identify potential trade-offs and contradictory incentive structures. Sustainability scenarios, compelling 3D visualization tools, criteria and indicators, and multi-stakeholder participation can be utilized to: build capacity; design integrated policy solutions; reveal values and attitudes; build awareness; and enhance collaboration among various departments, disciplines, and stakeholders (Sheppard 2005a; b).

Fifth, action is needed to ensure that the commercialization of sustainable technologies and procedures continues to take place at least at the level of specialized technological (e.g., hydrogen buses and LEED building certification) or geographic niches while more wide-scale demand continues to grow (Loorbach 2007). The private sector plays a critical role in stimulating demand for new solutions through marketing budgets and consumer engagement. In addition, regions and nations have distinct factor endowments that give them distinct geographic or historic advantages. Solutions to specific problems in BC will be delivered most effectively through a diffuse network of innovation, recruitment or imitation distributed globally but oriented to local challenges. Rather than reinventing solutions, it may be more effective to leverage global innovation systems to meet local needs. Conversely, innovations that leverage BC's factor endowments will need to focus on solutions for global markets. Local challenges may require engagement with distant centres of innovation, and local innovation capacity may be best served by focusing on more distant markets. For instance, the primary market for large-scale biomass energy systems for heat and power may be in regions with much higher intensities of greenhouse gas emissions than British Columbia.

Sixth, innovation within British Columbia needs to be more strategically leveraged by the province. Ranked according to the production of high quality research outputs, Canada's universities are among the top three in the world (OECD 2005). While leading universities such as UBC have ratios of commercialization comparable to the top US universities, it has been recognized that there is still a knowledge translation gap that limits our potential (Gannon 2002, 2003). The Province of BC must continue to develop a stronger culture of innovation building on the work of the Premier's Technology Council. Leading jurisdictions globally, such as Finland and Sweden invest three times as much as British Columbia in Research and Development (DTI). More importantly, OECD research has demonstrated that, in innovation-rich jurisdictions, more of the investment into R&D comes from the private sector than the public sector (OECD 2005). Finally, successful innovation requires

new intermediaries that filter candidate technologies and provide support in the early stages of commercialization. It may be useful to engage expertise in innovation and entrepreneurship in the Province's business schools to support these efforts.

Seventh, demand markets for the products and services used in sustainable communities need to be created. In order to generate demand for more transformative technologies and practices, the full-costing of carbon emissions needs to be escalated and accelerated in the province. Moving beyond a pricing strategy, more stringent carbon and energy zoning requirements and codes and standards need to be put in place for districts, buildings, vehicles, and equipment (BCCAT 2008).

Eighth, individuals must be provided with information about climate change and sustainability that is locally-relevant, practical, and empowering. Information alone, however, will be insufficient to stimulate significant behaviour change in individuals (Kollmuss and Agyeman 2002). This must be paired with meaningful opportunities to participate in collective decision-making (Jones and Burgess 2005) and to help shape the social and material infrastructure that makes more sustainable practices possible and desirable, coupled with appropriate reinforcement that supports such change (Green and Kreuter, 2005). For example, cycling advisory committees, as well as supportive physical infrastructure, create opportunities for citizens to build a cycling culture. When coupled with the incentives provided by higher energy prices, such opportunities can lead to sustained processes of change. There is also the need to encourage more "bottom-up" community action groups and to engage less easily reached sectors of the community (eg. youth) through innovative media and online engagement mechanisms, through research to evaluate the effectiveness of these methods.

Ninth, expansion of public transit infrastructure, as well as increased incentives for walking and cycling, are crucial to the reduction of per capita vehicle emissions (CHER 2008). The creation and improvement of infrastructure for non-automobile based transport, should be a component of plans that curtail emissions and encourage healthier communities (CHER 2008; ORTEE, 1995).

Tenth, complete communities are places where built form, energy generation and use, and food production are integrated (Condon 2008; Miller et al 2008; Sheppard and Pond 2008). The total integration of buildings and neighbourhoods into self-reliant community energy clusters requires extensive technological and knowledge capacity development. There is a critical need for tools and models to spatialize and aggregate/disaggregate carbon emissions beyond the current level of community-wide inventories in BC, in order to more accurately project future carbon emissions of development pathways in relation to the targets. At the same time, the urgency of capacity-building calls for much greater emphasis on and encouragement of universities and other centres of expertise to carry out extension activities and collaborative applied research, to test and disseminate improved planning and engagement processes.

Eleventh, long-range planning must account for the long lifespan and physical inertia of urban infrastructure. In addition, changing geophysical conditions, due to climate change, means that long-range planning must not only integrate adaptability into its designs, but also take into account early in the planning process a more dynamic natural system than we have traditionally experienced (Rodenhuis et al 2007, 132). Given the anticipated increasing rate of change, an important element of this planning needs to be improved scenario forecast-

ing in order to understand how infrastructure's underlying geophysical conditions will likely change over the course of its lifespan.

The eleven key areas for research and action listed above apply to all communities in British Columbia, but should be implemented through a differentiation of community type and context. In particular, rural, remote, and indigenous communities face unique issues of capacity and exposure to climate-related change due to their development paths (Davidson, Williamson & Parkins 2003; Larsson 2003). Research is only beginning to recognize the inter-relationships between climate change and other types of changes in rural communities, such as restructuring (CCIAP 2007). For example, provision of inter-governmental funding with measurable targets may play a significant role for smaller communities that wish to develop new energy infrastructure. In addition, specific climate change adaptation and mitigation strategies are needed in all communities in order to plan and be resilient over the long term, while at the same time sustainable community objectives must integrate long-term community risk and vulnerability planning.

## 5. KEY DIRECTIONS FOR FUTURE RESEARCH

Future research must investigate the means by which institutional and behavioural path dependency can be overcome in order to establish a new development path that will give rise to the sustainable communities described above. In particular, the following are critical directions for future research:

- Further exploration of how local institutions and governance systems may inhibit or accelerate the transition towards sustainable communities;
- The development of increasingly sophisticated projections of future biophysical conditions, sustainability scenarios, backcasting methods, and visioning techniques;
- Synthesis and dissemination of important lessons learned by communities as they experiment with innovative new strategies for achieving sustainability;
- Enhanced inquiry into the ways in which markets can be harnessed to commercialize and effectively diffuse sustainable technologies and procedures;
- Integrated analyses of how to best increase the flexibility and interchangeability of urban networks, so that we can build enduring infrastructure that does not constrain our ability to adapt and to enhance sustainability in the future.

Research and action into sustainable development patterns and pathways is directly relevant to the needs of communities across the province, and British Columbia is well-placed to become a world leader in issue-driven, integrated sustainability research and action. This approach has the potential to establish British Columbia as a contributor to global mitigation efforts while enhancing the quality of life of residents in the province.

## BIBLIOGRAPHY


Adger W. 2003. Social capital, collective action, and adaptation to climate change. *Economic Geography* 79:387-404

Alexander, D., and R. Towalty. 2002. Smart Growth and Sustainable Development: Challenges, Solutions, and Policy Directions. *Local Environment* 7(4), 397–409

BCCAT (British Columbia Climate Action Team). 2008. Meeting British Columbia's Targets: A report from the B.C. Climate Action Team. Victoria: Government of British Columbia

BCCEA (B.C. Community Energy Association), 2008. Powering Our Communities – Renewable Energy Guide for Local Governments. Retrieved Oct. 9, 2008 at www.communityenergy.bc.ca/resources-introduction/powering-our-communities-renewable-energy-guide-for-local-governments

Betsill M. 2001. Mitigating climate change in US cities: opportunities and obstacles. *Local Environment* 6:393-406

Bizikova L, Robinson JB, Cohen S. 2007. Linking climate change and sustainable development at the local level. *Climate Policy* 7:271-7

CBC (Canadian Broadcasting Corporation), 2007. Schwarzenegger, B.C.'s Campbell flex green muscles. Retrieved October 10, 2008 from www.cbc.ca/world/story/2007/03/16/bc-california.html

CCIAP (Canadian Climate Impacts and Adaptation Program). 2007. A Comparative Assessment of the Capacity of Canadian Rural Resource-based Communities to Adapt to Uncertain Futures. Natural Resources Canada, CCIAP Project A1234, Ottawa

CHER (Centre for Health and Environment Research). Cycling in cities. Retrieved on October 20, 2008 from www.cher.ubc.ca/cyclingincities/default.htm

CIRS (Centre for Interactive Research on Sustainability). Retrieved October 15, 2008 from www.cirs.ubc.ca.

Condon, P., 2008. Planning for Climate Change: The transportation and land-use nexus. *Land Lines*. Lincoln Institute of Land Policy. Retrieved Oct. 20, 2008 from www.sxd.sala.ubc.ca/lincoln/article_planning_for_climate_change.pdf

Curran, D. and Leung, M. 2000. Smart Growth: A Primer. SmartGrowth B.C. Retrieved October 15, 2008 from www.smartgrowth.bc.ca/Publications/GuidesandToolkits/tabid/159/Default.aspx

DCS (Design Centre for Sustainability), 2006. Sustainability By Design: Guiding Principles, University of British Columbia. Retrieved November 16, 2006 from http://www.sxd.sala.ubc.ca/10_publications/sxd%20brochure.pdf

Davidson D, Williamson T, Parkins J. 2003. Understanding climate change risk and vulnerability in northern forest-based communities. *Canadian Journal of Forest Research* 33:2252-61

Davison A. 2001. *Technology and the contested meanings of sustainability*. Albany: State University of New York Press

DTI Innovation report: http://www.innovation.gov.uk/rd_scoreboard/

Dusyk N, Berkhout T, Burch S, Coleman S, Robinson J. Forthcoming. Transformative energy efficiency and conservation: A sustainable development path approach in British Columbia, Canada. *Energy Efficiency*

Ethos, 2005. Visualising Renewable Energy in the Landscape of 2050. Retrieved October 6, 2008 from ethos-uk.com

Ewing, Reid, and Fang Rong. 2008. The Impact of Urban Form on U.S. Residential Energy Use. *Housing Policy Debate*. Volume 19, Issue 1.

Fisher BS, Nakicenovic N, Alfsen K, Morlot JC, Chesnaye Fdl, et al. 2007. Issues related to mitigation in the long term context. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change*, ed. B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer. Cambridge, UK: Cambridge University Press

Frank L, Pivo G. 1995. Impacts of mixed use and density on utilization of three modes of travel: Single-occupant vehicle, transit, and walking. *Transportation Research Record* 1466:44-55

Frumkin H, Frank L, Jackson R. 2004. *Urban sprawl and public health: Designing, planning, and building for healthy communities*. Washington, DC, USA: Island Press

Gannon, F. 2003, Government rhetoric and their R&D expenditure, *EMBO Reports*, 4(2): 117- 120.

Gannon, F. 2002, Who Pays The Piper, *EMBO Reports*, 3(8): 701

GPI Atlantic. Genuine Progress Indicator for Atlantic Canada. Retrieved on October 8, 2008 from www.gpiatlantic.org/about.htm

Green, L.W. and Kreuter, M.W. 2005. *Health Program Planning: An Educational and Ecological Approach*. 4th edition. NY: McGraw-Hill Higher Education.

Hommels A. 2005. Studying obduracy in the city: Toward a productive fusion between technology studies and urban studies. *Science, Technology & Human Values* 30:323-51

IPCC. 2007. Summary for Policymakers. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* ed. B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer. Cambridge, UK and New York, NY, USA: Cambridge University Press

Jones, P. J. S. & Burgess, J. 2005. Building partnership capacity for the collaborative managment of marine protected areas in the U.K.: A preliminary analysis. *Journal of Environmental Management,* 77**,** 227-243.

Kok M, Vermeulen W, Faaij A, de Jager D, eds. 2000. *Global Warming and Social Innovation: The Challenge of a Climate-Neutral Society*. United Kingdom: Earthscan. 242 pp.

Kollmuss, A. & Agyeman, M. 2002. Mind the gap: Why do people act environmentally, and what are the barriers to pro-environmental behaviour. *Environmental Education Research,* 3**,** 239-260.

Larsson, N. 2003. Adapting to Climate Change in Canada. *Building Research & Information* 31(3), 231 — 239

Loorbach D. 2007. *Transition management: new mode of governance for sustainable development*. Utrecht: International Books

Moomaw WR, Moreira JR, Blok K, Greene DL, Gregory K, et al. 2001. Technological and economic potential of greenhouse gas reduction. In *Climate Change 2001: Mitigation. Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, ed. B Metz, O Davidson, R Swart, J Pan. Cambridge, UK Cambridge University Press.

Miller, N. 2006. Towards Carbon Neutrality: Possibilities for North America's suburban residential developments. Unpublished Master of Science in Architecture thesis, University of British Columbia.

Miller, N., Cavens, D., Condon, P. and Kellett, R., 2008. Policy, Urban Form and Tools for Measuring and Mapping Greenhouse Gas Emissions. Proposal for the Lincoln Institute of Land Policy.

Moser, S.C. and Dilling, L., 2007. *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*. Cambridge: Cambridge University Press.

Moudon A, Hess P, Snyder MC, Stanilov K. 1997. The effects of site design on pedestrian travel in mixed-use, medium-density environments, Washington State Transportation Commission, Seattle, USA

Newman P, Jennings I. 2008. *Cities as sustainable ecosystems: Principles and practices*. Washington, USA: Island Press

Newman, P. 1999. Sustainability and cities: extending the metabolism model. *Landscape and Urban Planning*, Vol. 44(4), 219-226.

Newman, P. and Kenworthy, J., 1999. *Sustainability and cities: Overcoming automobile dependence*. Island Press, Washington D.C., USA.

Newman P, Kenworthy J. 1989. Gasoline consumption and cities. *Journal of the American Planning Association* 55:24-37

Murdock, T. 2008. Historical climate trends and future scenarios for BC. Presentation to BC Climate Action Secretariat, October 17. http://www.pacificclimate.org/docs/presentations/Murdock.CAS.17Oct08.pdf

ORTEE, 1995 (Ontario Round Table on the Environment and the Economy). Sustainable Communities Resource Package, ORTEE, Toronto.

OECD, 2005, Science Technology and Industry Scorecard, OECD: Paris.

Patrick, R., and M. Roseland. 2005. Developing Sustainability Indicators to Improve Community Access to Transit in Rural Residential Areas. Journal of Rural and Community Development 1, 1-17.

Pond, E. 2008. Revealing the landscapes of the future: Retrofitting residential neighbourhoods for climate change mitigation, a Burnaby case study. Unpublished graduation project, UBC: Landscape Architecture.

Robinson J. Forthcoming. Accelerating sustainability in BC: Creating the Centre for Interactive Research on Sustainability (CIRS).

Robinson, J. 2003. "Future Subjunctive: Backcasting as Social Learning", *Futures* 35(8), 839-856.

Robinson J, Herbert D. 2001. Integrating Climate Change and Sustainable Development. *International Journal of Global Environmental Issues* 1:130-48

Rodenhuis, D.R., Bennett, K.E., Werner, A.T., Murdock, T.Q., Bronaugh, D. 2007. Hydro-climatology and future climate impacts in British Columbia. Pacific Climate Impacts Consortium, University of Victoria, Victoria BC.

Roseland, M. 2000. Sustainable Community Development: Integrating Environmental, Economic, and Social Objectives. *Progress in Planning* 54, 73–132.

Roseland M. 1998. *Toward sustainable communities: Resources for citizens and their governments*. Gabriola Island, Canada: New Society Publishers

Roseland, M., with S. Connelly. 2005. *Toward Sustainable Communities: Resources for Citizens and Their Governments.* Gabriola Island, BC : New Society Publishers.

Ruth, M., Coelho, D. 2007. Understanding and Managing the Complexity of Urban Systems Under Climate Change. *Climate Policy* 7(4), 317–336.

Sathaye J, Najam A, Cocklin C, Heller TC, Lecocq F, et al. 2007. Sustainable Development and Mitigation. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer. Cambridge, UK: Cambridge University Press

Sheltair 2003. Forging a Sustainable Energy System in Greater Vancouver. CitiesPLUS. Retrieved October 8, 2008 from www.sheltair.com/library/GVRD%20ENERGY%20DIRECTIONS%20REPORT%20JULY%202003.pdf

Sheppard SRJ. 2005a. Bridging the sustainability gap with landscape visualization in community visioning hubs, Collaborative for Advanced Landscape Planning, Department of Forest Resources Management, University of British Columbia, Vancouver, BC

Sheppard SRJ. 2005b. Landscape visualization and climate change: the potential for influencing perceptions and behaviour. *Environmental Science & Policy* 8:637-54

Sheppard SRJ, Pond E. 2008. Low-carbon attractive, resilient communities: New imperatives for sustainable redevelopment. Conference Proceedings, 2008 Climate Change and Urban Design Council for European Urbanism Conference, Oslo, Norway, September 14-16, 2008.

Sheppard SRJ, Shaw A. 2007. Future visioning of local climate change scenarios: Connecting the dots and

painting pictures to aid Earth System Governance. Conf. Proceedings, 2007 Amsterdam Conference on the Human Dimensions of Global Environmental Change Earth System Governance: Theories and Strategies for Sustainability 24-26th May 2007, Vrije Universiteit, Amsterdam. (12 p).

Sheppard SRJ, Shaw A, Flanders D, Burch S. Can Visualisation Save the World? Lessons for Landscape Architects from Visualizing Local Climate Change. Procs Digital Design in Landscape Architecture 2008, 9th International Conference on IT in Landscape Architecture, May 29-31 2008, Anhalt University of Applied Sciences, Dessau/Bernburg, Germany.

Shove E. 2003. *Comfort, cleanliness and convenience: The social organization of normality*. New York: Berg

Stern PC. 2000. Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues* 56:407-24

Swart R, Raskin P, Robinson J. 2004. The problem of the future: sustainability science and scenario analysis. . *Global Environment Change* 14:137-46

Swart R, Robinson J, Cohen S. 2003. Climate change and sustainable development: expanding the options. *Climate Policy, Special Issue on Climate Change and Sustainable Development* 3:S19-S40

Union of BC Municipalities. (UCBM) 2008. Member Release: Green Communities Update. February 8, 2008.

United Nations. 2008. *Millennium Development Goals Report*, United Nations Department of Economic and Social Affairs

van Vliet B, Chappells H, Shove E. 2005. *Infrastructures of consumption: Environmental innovation in the utility industries*. London, UK: Earthscan

Vogel, C., Moser, S.C., Kasperson, R.E., Dabelko, G.D., 2007. Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change* 17. P. 349-364.

Wilbanks, T.J. and J. Sathaye. 2007. Integrating Mitigation and Adaptation as Responses to Climate Change: A Synthesis. *Mitigation and Adaptation Strategies for Global Change* 12, 957–962.

Wilbanks TJ, Kane SM, Leiby PN, Perlack RD, Settle C, et al. 2003. Integrating mitigation and adaptation-possible responses to global climate change. *Environment* 45:28-38

Wilhite H, Shove E, Lutsenhiser L, Kempton W. 2000. The legacy of twenty years of energy demand management: We know more about individual behaviour but next to nothing about demand. In *Society, Behaviour, and Climate Change Mitigation*, ed. E Jochem, e al., pp. 109-26: Kluwer Academic Publishers

Williams-Derry, C. 2008. Slowing down: Greater Vancouver's smart growth slips. Sightline Institute. Retrieved October 8, 2008 from http://www.sightline.org/publications/reports/slowing-down/slowing-down-may-20.pdf

Wilson E. 2006. Adapting to climate change at the local level: The spatial planning response. *Local Environment* 11:609-25

Winner L. 1986. *The whale and the reactor: A search of limits in an age of high technology*. Chicago: The University of Chicago Press

**Pacific Institute for Climate Solutions**

University of Victoria
PO Box 1700 STN CSC
Victoria, BC V8W 2Y2

Phone (250) 853-3595
Fax (250) 853-3597
E-mail pics@uvic.ca
www.pics.uvic.ca

Printed on 100% postconsumer recycled paper.