Chapter Six: Provide a Diversity of Housing Types

[Figure 6.1 in margin]

Where you live is the other side of the work/live relationship discussed in the previous chapter. In this chapter we look more carefully at how the types of houses we live in and their arrangement on the parcel, the block and in the district influence the sustainability of the region and per capita production of GHG in particular.

In both the US and Canada, buildings generate a larger share of GHG consequences than any other sector—larger than the transportation sector; larger than the industrial sector.[1] However, the relative contribution of buildings to the total regional GHG produced varies from one part of North America to another. This is due to a few basic factors: the more or less stringent building energy performance standards in force, the source of energy used for building heating and cooling, and the severity of the climate. In states and provinces where the climate is quite extreme and coal is used to produce electrical energy, and where the fuel for non-electric furnaces is typically oil, GHG production per square foot of built space will be relatively high. The US New England states and Atlantic Canada fit that bill. Oil heat and coal fired electrical generation provide the bulk of the energy used by buildings there.

In milder climates where electrical energy comes from hydro electric or nuclear power, and where heating is either from electric or from natural gas, GHG production per square foot of built space will be much lower. The Canadian West and the US Pacific Northwest fit that bill. Due to the ready availability of hydroelectric power and natural gas, the GHG production per square foot of built space is relatively low there. Thus, in Seattle, Portland and Vancouver transportation accounts for a higher percentage of total metro area GHG than buildings.[2]

These basic energy differences will influence how various regions approach the GHG reduction challenge. For some buildings might take priority, for others it might be transportation. In either case the arrangement of buildings on the land, and how one moves form one to the other, will be the crucial starting point for analysis.

Residential land uses typically consume between 65 and 85 percent of all developed urban lands. How these lands are utilized and configured is likely the most crucial physical factor for determining the social, economic, and social sustainability of the region. Current policies have worked at cross purposes with basic social, economic, and ecological sustainability goals.

The homogeneity of our residential landscapes, in many cases fostering a residential monoculture that covers whole municipalities, has undercut ecological sustainability in two ways. First, as discussed in the previous chapter, zoning and subdivision regulations make it much more difficult to supply affordable housing near work sites. Second, zoning and subdivision regulations insure that GHG impacts from buildings will be unreasonably high, this by favoring building types that are inherently expensive to heat and cool,[3] and in arrangements that gain none of the potential benefits of adjacency to other dwelling units.

Zoning has been used, consciously or unconsciously, as a tool to undercut social sustainability. It does so by enforcing social inequity. Zoning regulations do one thing well. They insure that large districts are covered by residential lots of one size and that these lots allow only one tenure type. Neighborhoods regulated this way are inherently exclusionary and thus defy the most elemental definition of a sustainable society. Proscriptive zoning policies lead naturally to neighborhoods occupied by a very narrow demographic band, a narrow range of ages, a narrow range of incomes, and a narrow range of family types.

Such monocultural neighborhoods also undercut economic sustainability; they are difficult if not impossible to adapt to changing future circumstances. Most metropolitan areas have dedicated the lion's share of their lands to a housing demographic that is rapidly disappearing: two parent families with more than two children. Three and four bedroom houses, now increasingly occupied by one or two individuals—often aging empty nesters with more than one empty bedroom—dominate many first and second ring suburbs.[4] Meanwhile young singles and couples are likely in search of adequate and affordable places to live in what might be a highly competitive housing market, while all those bedrooms sit empty.[5] Our regulations insure this imbalance and, because zoning is so difficult to change once set in place, make it almost impossible to fix.

Given that current policies are counterproductive, it may be reasonable to start over with an opposite set of policies. Where we previously insisted on uniform parcel sizes perhaps we should insist on a diversity of parcel sizes that would lead inevitably to a diversity of housing types. Where previously we insisted on one tenure type covering vast areas, perhaps we should insist on multiple tenure types on every block. Where once we insisted that commercial and residential uses be separated, perhaps we should bar single-use subdivisions. Where we once banned rental units from the neighborhood, perhaps we should find policy tools that could insure their presence. The strategies for building and arranging sustainable housing listed below provide a starting point for citizens and officials to assemble such a suite of policy tools.

The Influence of Building Type on GHG Production

For the purposes of this chapter, at the risk of oversimplifying, there are three basic types of residential structures: residential towers of between 15 and 35 stories, mid rise structures between 4 and 9 stories, and ground-oriented detached structures, mostly single family homes, of three or fewer stories. Each has its own inherent energy performance characteristics and resultant GHG production profile. While it is possible to reduce GHG production by over 70% in any type of structure (through special glazing, more insulation, heat pumps, etc) for some building types it is more difficult and therefore more expensive than for others. For example, residential towers, through their design, expose themselves to more heat losses and gains from climatic factors than other building types. Vancouver has pioneered the modern North American version of the residential tower, the “point tower,” called this because it is very thin, usually with fewer than 8,000 square feet and as few as four units per floor. The gross density for this type building is generally above 100 dwelling units per acre. Between 1990 and 2000 the residential population of the Vancouver downtown peninsula doubled, surging from 40,000 to 80,000 in just ten years. Virtually all of these new residents were accommodated in point towers. Other cities such as Toronto, Calgary, San Francisco, Portland, and Seattle, inspired by Vancouver, are moving in this direction.

Towers are more exposed to the unwanted heat loads and drains caused by wind and sun than lower buildings.[6] Wind speeds, even in low wind areas like Seattle and

Vancouver, increase with height. Loss of building heat to wind increases parabolically as wind speeds increase linearly.

The radiant heat provided by the sun is also a problem. Solar heat gain on tower walls during summer can be immense, especially on the east and west walls (exposed to the sun for many hours in early morning and late afternoon). No buildings or trees can shade towers, so there is no shield against the sun. Modern towers usually have glass skins for reasons of buyer preference and ease of construction. Glass sheathing is usually partially reflective as a way to mitigate the heat gain inside the shell; but heat still penetrates.[7] Even in perpetually cool climates like Seattle and Vancouver, towers require air conditioning. B.C. Hydro statistics indicate that, on average, towers consume 50% more energy per habitable square foot of floor space than do mid rise structures, even though energy codes have been tightened for this building type.[8]

At the other end of the density spectrum is the detached single-family house on its own lot. The density range for this type of structure is very wide, but generally cannot be higher than eight dwelling units per gross acre (absent duplexes or secondary suites that is), and is more typically between one and four dwelling units per gross acre.

In the fifty years since the death of the streetcar, the interior area of the average US single family homes has doubled.[9] This ballooning of the structure, at the same time that average family size has plunged, has overwhelmed the relatively small efficiency gains for this house type. Thus, occupants of this type of house have steadily increased their per capita GHG production consequent to their home size.

This is not the only aspect of the single family home GHG production problem however. People could go back to their average pre 1940s per capita square foot interior space and still produce more than their fair share of GHG. Why is this? Single-family homes have the same physical handicaps as towers, they are just smaller. From an energy perspective, a single family home is the least efficient way to house a family. It has more exterior skin exposed to the elements per family than any other type. Even duplex structures have at least one shared wall, a wall that is consequently not subject to convection losses or radiant heat gains. Townhouses have at least two shared walls. Apartments have at least four shared walls and as many as five. Thus the intrinsic exposure of apartments to the elements can be up to 80 percent lower than that of a single-family home.[10]

At the middle of the density spectrum lays the most GHG-efficient housing type: low-rise medium to high-density structures. **[Figure 6.3a, 6.3b and 6.3c in margin]** This type generally inhabits the density range between 20 and 65 dwelling units per acre. (parking requirements have a large influence on density for this type). It is efficient because it has the most number of shared walls possible, can be shaded by trees and other buildings from both sun and wind, and requires less elaborate and expensive to run elevators and heating and cooling systems than point towers.

In the Vancouver region homes at densities of over 25 units per acre make up more than half of all new homes built. Seattle and Portland are following similar trends, albeit not so dramatically. The reasons are numerous but demographic shifts are a major driver. In Metro Vancouver the percentage of families with children is shrinking in proportion to other age and family type cohorts. These other fast growing cohorts, notably those over 50 and younger singles or couples without children, tend to favor higher density options close to urban services over single family homes on their own lots.[11]

It is fortunate that the market is no longer averse to this housing and density type since it is inherently more GHG efficient than the single family home. But unfortunately the arrangement and configuration of these new buildings often defy simple and time tested rules for good urban districts. Typically these buildings are arranged around parking lots, preventing them from shading each other, and in arrangements that thwart walking and biking.**[Figure 6.5a and 6.5b in margin]** Configurations like this insure the same auto dependency experienced by those who live at the end of suburban cul-de-sacs.

The GHG performance of medium density residential buildings can be enhanced if they are located within an efficient block and street pattern. Tight urban blocks that are not dominated by parking areas reduce convection losses and heat gains, as buildings protect each other from wind and sun. Boulevard trees on streets have always functioned to shade structures, particularly against the low morning and afternoon summer sun. Trees provide this protection more elegantly and cheaply than elaborate wall details and “green gizmos”[12] ever can. This is partly because trees absorb rather than reflect heat energy, using sun energy for the production of sugars, and leaving the air that surrounds the tree five to eight degrees cooler than ambient air.[13] Street trees in healthy situation attain 40 foot heights within 20 years in most North American areas (generally, and understandably, the warmer the temperature and the more the available moisture, the faster trees will grow). If these site planning and urban design strategies are employed, it is likely that the energy saving will be over 30% and even 50% without any changes to the building skin or heating/cooling systems.

The Sustainable Single Family Home

Even though mid rise structures may be inherently more GHG efficient than single family residential structures, this does not alter the fact that most houses are now single family homes and that in most metropolitan areas this type still dominates.

Purchasers of new and used single family homes enjoy the separation afforded by owning all four walls and the exterior spaces that separate one building from the next, and believe deeply that single family homes hold their value better than other types.[14] Whatever the case, single family homes can be designed and arranged in a way that is more socially, economically, and ecologically sustainable than is now typical.

The typical suburban subdivision yields about four dwelling units per acre, even on lots so small that they provide very little space for backyards.[15]

We have somehow created a system for producing detached single family homes that gives us none of the benefits, large yards, green spaces, of low density and none of the benefits of streetcar city density (walkability, stores, transit). Detached houses in most U.S. and Canadian streetcar suburbs retain the advantages of the single-family home, without losing the ten dwelling units per acre minimum density necessary for sustainable, walkable, transit friendly and low carbon neighborhoods. Most streetcar suburbs are inherently low carbon due to block size and density,[16] for the reasons discussed in chapter four.

Perhaps even more important, streetcar city single-family homes often illustrate that the advantages of single family living can be shared equally by apartment livers and duplex owners. Architectural solutions abound that allow for multi-family housing on one parcel in structures that retain the single family “feel”. Various styles of duplex and even triplex living are suitable for these small and deep lots. Lane houses are the most obvious way to add an additional unit, but forming one building with two entrances in a way that respects the desires of owners and the language of the street is another way. In both of these cases the green space on the parcel in the front and back yards can be divided in such a way that each family has a private garden for planting or for play.

Build and Adapt Neighborhoods for all Ages and Incomes

In U.S. and Canadian cities, zoning has been used as a tool of separation rather than integration. From the social perspective zoning by density categories is especially heinous, as this separates families by income and thus by class. Census data confirms an almost one to one relationship between a zoning designation for a particular district and a narrow band of family incomes enjoyed by the families living therein. Discriminatory impulses play themselves out in the process of determining new zoning status for adjacent areas, with many homeowners extremely reluctant to see a designation applied nearby that would allow families of lesser means to find a home.

Prior to 1940s districts typically had more than one house and tenure type and sometimes a wild profusion of variety. Maple Avenue in Cambridge Massachusetts (shown in figure 6.7) exhibits a level of income, tenure, and house type variety that was banished from virtually all neighborhoods built after WWII **[Figure 6.7 in margin]**. On Maple Ave you can still find a one-, two-, or three-bedroom apartment. You can also find a 16-room house on four floors. The income demographic on the street is tremendously wide and provides residents of all ages and incomes a place to live, residents who can fill the jobs in the district and age in one place should they wish. But the success of Maple Ave must not be oversimplified. It is not only that the street contains a variety of tenure types, it is also that the buildings make, for all their differences, a unified but diverse visual ensemble. Porches and protruding eves abound, horizontal clapboards predominate, floor heights are common from one lot to the next, and each house takes pains to acknowledge the importance of the street architecturally. Successful places must be successful in both the quantitative realm (tenure types, numbers, rents, sizes) and the qualitative (architectural details, massing, materials, sensitivity to historical context)

Policy changes whereby all newly developed or renewed and retrofitted areas would be required to include a wide variety of house types, not on a town by town basis as in Massachusetts' 40B law that requires workforce affordable housing (discussed in chapter five) but on a geographically smaller scale.[17]

Vancouver provides a good model for adding housing diversity to existing residential districts, and in two different ways: through building new higher density buildings low rise buildings that are compatible with lower density neighbors, and by learning how to convert existing single family homes into multiple dwelling structures. In the ten years between 1990 and 2000, 40,000 new residents found homes in the cities older single family and low rise residential neighborhoods, a number equal to the number accommodated in downtown point towers (as discussed above). During this period, Vancouver architects and city planners learned that residents don't so much object to added density as they do to the *feel* and *appearance* of density. Not wanting to engender unnecessary resistance, architects learned how to design buildings that looked and felt like the low-density buildings next door. **[Figure 6.8 in margin]** Large facades were broken into pieces scaled to the massing increments of nearby residences. Roof pitches of new buildings were steeply sloped and highly articulated to mitigate four story heights. Building fronts were provided with as many individual entrances as possible for the same reason. The example proves that NIMBY responses are not knee jerk reactions to density per se, but understandable reactions to disrupting the unified and comforting qualities of many fine single family home areas.

The second effective strategy for gradually adding density to existing single family home areas has been through converting single family homes to multiple dwelling unit structures. As mentioned above, because of the way North American cities grew, and the influence of the baby boom demographic in particular, most US and Canadian metropolitan areas are oversupplied with single family homes built for large families but now occupied by only one or two people. **[Figure 6.9 in margin]** Vancouver was no exception, but has found a way to occupy those empty bedrooms.

Ever since the 1970s, housing in Vancouver has become increasingly unaffordable. With rents rising certain homeowner decided to convert part of their homes for rental to capitalize on this demand. Typically these “illegal suites” as they were known, were located in the basements of Vancouver’s most common house type, the bungalow. Bungalows of Vancouver have a peculiar characteristic. Due to soil conditions, the slab elevation of the home is very shallow, leaving the basement floor only two to three feet below grade. Thus tens of thousands of basements in Vancouver have full size windows, and a basement floor that can be reached from the outside at grade or with just a few steps down. These units were built without the benefit of code inspection, so they varied wildly in their execution.

Area residents, and thus their elected officials and code enforcement officers, knew of this trend. But rather than closing down these units as might be expected in US cities, the city of Vancouver took a somewhat blind eye to this emerging trend. The subject came up for debate in council on many occasions, but for every homeowner who complained there was a renter or a rental-housing advocate who argued that these units were necessary to avert a housing crisis.

The supply of these units gradually grew until there were many thousands. During this same period the cost of single-family homes more than tripled in real terms. This influenced the behavior of individuals and families seeking not a place to rent, but a place to buy. Since average family income had more or less stagnated during these decades, single-family homes, once affordable to the middle class, were now out of reach—unless!—unless an income stream were available to help support the mortgage costs. The income stream available was the secondary suite. Fully one third of the monthly cost of the mortgage could be met by the rent from the suite, making it at least possible for the school teacher, or the merchant, or the bus driver to own a detached home. Suddenly the entire market shifted. Real estate agents would show a home paying specific attention to an existing suite or a space suitable for a suite, providing probable rents and helping potential buyers calculate what effect this money would have on their monthly payments. In time the vast majority of home buyers were looking for homes where they could also be landlords. By this time we are well into the 1990s. During 80s and 90s, proposals to legalize these suites were occasionally floated. Long time residents of areas who owned their homes and who therefore felt none of the financial pressures that weighed on younger homebuyers usually opposed these proposals. Thus proposals for legalizing secondary suites died during these decades. It was not until the first decade of the new millennium that a citywide blanket allowance for the creation of new secondary suites in single-family homes passed city council. By this time well over half of single family homes in the city had already been converted. Thus voting homeowners were no longer opposed to this new policy, since they already depended on it.

Vancouver has been changed, for the better, by secondary suites. Tens of thousands of affordable new rental units have been created, and a synergy between middle and upper middle class families and lower middle class and blue collar and service sector employed families has emerged; an economic ecology of the parcel, where neither the landlord nor the tenant could afford to live there without the other.

In time the creation of suites was legalized, as was the separation of existing single family homes into two, creating a duplex where each side was available for purchase. In some areas the regulations allow the conversion of single family bungalow structures into three unit condominium structures, providing that the original structure is preserved and the architectural quality of additions conforms architecturally to the host structure.

Consequent to Vancouver's slow and organic integration of these new residential units, and the general satisfaction with the results, other BC communities have been able to adopt similar polices, with muted political opposition. Now virtually all of the major municipalities in the metro area, including those that are profoundly suburban in form, allow for the legal creation of secondary suites.

The same logic applies for new housing developments. Including secondary suites in a new residence can bring the cost of buying a new home, even when land costs are over $300,000 per acre, into the affordability range of over 50% of wage earners.[18] The income from rental suites can be affordable and still support mortgage payments, such that all but the lowest 12% of families in the Portland Region can rent market rate rental units without the need for subsidies. **[Figure 6.10 in margin]** Those requiring subsidies could of course rent there too providing they have vouchers or cash subsidy, thus fully integrating neighbors to include all income classes.

Although certain cities, such as Vancouver, have managed to attain a relatively high degree of diversity, such conditions often arise more from organic and fortuitous circumstances than from a systematic approach to the issue. When planning for diversity in new communities, a robust methodology is required.

One such technique that can be implemented at the project scale is to directly use the income and family type demographics of a specific area to generate the appropriate palette of building and tenure types for a given neighborhood. The quantitative portion of this undertaking (income and demographics) can be readily attained through census data. Once obtained, this information can be the major driver in selecting the building and tenure types for a particular neighborhood development. In doing so, the project could and would be a physical manifestation of the larger demographic pattern particular to a specific area.

The Pringle Creek Community in Salem, Oregon will serve as a case in point. This project, developed by Sustainable Development Inc., is grounded in a rigorous set of guiding principles that integrate green building, energy efficiency and environmental responsibility.

One of the major goals was to make Pringle Creek “look like Salem”, meaning include all the types of families that are found in that city. Towards this end, the design teams conducted an in-depth analysis of the demographic patterns of the Salem region. This required an understanding of the types of household in the region—single parent families, extended families, two children families, etc.—and their respective average incomes and space needs. Given the direct relationship between spatial requirements and the costs of construction, this information was supplemented by the hard data concerning housing and building. This hard data included the average price of homes throughout Salem and the square foot costs associated with the construction of certain building types. This helped the design team understand the economic, social, and construction context within which the project was to be built - methodically bringing together all the elements required to make development decisions in keeping with their housing diversity goal.

With this information in hand, the design team organized the community as a microcosm of the larger Salem context. The number and type of dwellings chosen were directly correlated to the demographic patterns analyzed - each home calibrated in size and costs to the incomes of each type of household to be accommodated. The result is a mosaic of people and places in homes that they can afford and that suit their family needs.

Buildings with a Friendly Face to the Street

The idea of articulating the layers of space between fully private space (the deep interior of the home) and fully public space (the street) was best articulated by Jane Jacobs in her penetrating work *The Death and Life of Great American Cities*.[19] In this 1961 work she stood alone against what were then the dominant urban design cannons, those of Le Corbusier manifested in his Radiant City schemes. His vision was of towers and massive apartment lines lifted off the streets on piloti, eliminating any formal connection to the ground and obliterating any clear distinction between buildings and streets, public spaces and private spaces. Thus the entire landscape was completely public right up the apartment door, and the only means for controlling that membrane was the peek hole device in the door. By the time of Jane Jacobs, a few of the more sensitive observers of the city became alarmed about the social inadequacies of this form. **[Figure 6.11 in margin near here]** An increase in lawlessness was observable when neighborhoods were "renewed" to this form, the opposite of the claims made by their enthusiasts.[20] It was left to Jacobs to explain what had occurred. By removing all the New York brownstone apartment types that predominated in much of New York City, renewal officials had erased a subtle but crucial language of behavioral civility – a language that was embedded in these seemingly pedestrian structures. These previous types were built in such a way that the short distance between the sidewalk (fully public) and the front door, included three or four distinct layers of space that visitors needed to penetrate before entering. At each of these layers residents of the buildings had the opportunity to (one might even say they were compelled to) engage unknown visitors with the classic question put in such circumstance "can I help you?" Visitors who belonged or were invited were not intimidated of course, but others were. The key here is that the architecture of the space created zones that residents could easily control. In Radiant City planning all that had been destroyed. The public spaces below the buildings, far from being available to all residents like the proponents supposed, were impossible to effectively control, and were thus abandoned to various denizens of the night. Crime became rampant and only the criminals who claimed these abandoned pieces of turf felt comfortable within them.

What was forgotten in all this was that the most important part of any building is the part that meets the street.[21] The *face*, or the façade. If the streets are indistinct and the buildings floating in space you have a problem. No face. Without a face and the associated layering of the space between the face and the street you lose control, and thus civility. The primary function of the front of a building is to make a contribution to the community, while other faces on the street make a contribution back. Any face presented socially can either be welcoming or off-putting. The best buildings express themselves as welcoming, while still suggesting social boundaries. These boundaries are much like human boundaries, where a smile of welcome can quickly disappear if the other person is dense enough to move too close too quickly, invading the personal space in front of us – a space that, while not obvious, we all nevertheless fiercely protect.

Cars backing out of front yard driveways and crossing sidewalks can easily injure or even kill small children, making it unlikely that parents will allow children to play out front – in the space where they might serendipitously see the kid next door and start to play safely.[22] The presence of garage doors on the street also violates the "friendly face to the street" rule, as the garage door on the façade consumes so much space as to make the part of the façade dedicated to humans an insignificant remnant. With ideal lot sizes of only 33 feet in width a garage door, even for only one car, would occupy more than half of the front façade. Were it a two car garage there would be no actual house left. This form of housing, called a “snout house” in many jurisdictions, is the ultimate in unfriendly facades and incredibly dangerous for pedestrians, particularly small ones **[Figure 6.12 in margin]**. The best solution to this problem is to take car storage off the front of the house, and put it to the back, accessible by a lane in the mid block. With the car removed from the front, the façade can be a human face to the street. With the car removed to the back the sidewalk can be truly that, a place completely protected from cars.

Conclusion

Housing in North America has reached a crisis point, where homogenous communities discriminate against buyers, not by race, but by income (which in some areas amounts to the same thing). From a social equity perspective it is not an overstatement to suggest that this apparently intentional breach of the principle of fair play and opportunity is a disgrace of major magnitude, and must not stand. As a practical matter it is equally odious. The radical segregation of our cities and towns by class, often assigning entire towns for the exclusive occupation by one income group, and another town far distant for everyone of a lower income group, guarantees that our transportation woes will continue indefinitely. Legislation like Massachusetts 40B, is a big step in the right direction. Upheld many times in the face of constitutional challenges and political assaults, it clears a path for redress. But much remains to be done. Massachusetts 40B, and similarly narrowly executed policies, have not yet integrated communities in an organic and holistic way. It is of very little benefit in rationalizing our urban landscapes for walking and transit if worker housing continues to be placed in locations that are only serviceable by car. Fortunately emerging models for suburban and urban retrofit, tools for planning and designing more equitable communities are emerging.[23] The US is expected to add 130 million new residents in the next 30 years. Canada is expected to grow at a similar rate. Where and how are these people to be housed? With proper local and regional strategies in place, these new families can be the instrument for a vastly more equitable, efficient, and low carbon urban landscape. This is enough building mass to create thousands of new walkable centers, or be the vehicle for retrofitting presently car oriented strip commercial corridors.[24] No new opportunity should be wasted in deploying this growth strategically in an integrated way. There is not a moment to lose.

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[1] Between 1990 and 2005, residential, commercial and institutional buildings in Canada accounted for 41% of all greenhouse gas emissions while transportation accounted for 33% and industry accounted for 18% (CEUD 2005, NRCan 2008 and Market Resource Consultants for the CHBA in Canadian Home Builders' Association, 2008). According to the American Institute of Architects (2007), building sector emissions account for 48% of total greenhouse gas emissions in the United States. This includes the annual energy required to operate residential, commercial and industrial buildings along with the embodied energy of industry-produced building materials like carpet, tile, glass and concrete. **[Insert Figure 6.2]** In 2006, carbon dioxide emissions from residential buildings alone accounted for 20 percent of total US emissions (DOE 2008).

[2] Building sector GHG emissions in Oregon and Washington state are relatively low compared to Atlantic Canada and the upper midwest United States because much of their energy generation comes from hydro, nuclear or biomass facilities rather than coal

burning power plants (Kerstetter, 1999; Sadler, 2007). Lower emissions in the building sector raise the relative importance of transportation emissions in these regions. In Oregon, 34% of the state's GHG emissions are attributable to the transportation sector while in the Upper Midwest (Iowa, Minnesota, North Dakota, South Dakota and Wisconsin) transportation accounts for only 28% (EPA 2000, PCO2R Partnership June 2005 Report). In Nova Scotia, where a dependence on coal and oil for electricity generation is a significant factor behind the relatively high emissions, electricity generation accounts for 42% of all GHG emissions while transportation accounts for only 26% (Nova Scotia Department of Energy, 2007).

[3] According to data provided by BC Hydro, electrically heated, single family detached homes use approximately 21,000 kWh/unit/year (Marbek 2007).

[4] See Ramlo, Andrew. 1999. British Columbia's Empty Bedrooms. Vancouver: Urban Futures Institute, for more information about this phenomenon in British Columbia.

[5] In 1900, nearly half of the US population lived in households of six or more people (Hobbs and Stoops, 2002). By 2007, the average household size had fallen to 2.6 and more than 27 percent of households had only one person living in them (US Census 2005-2007). Due in part to the trend towards smaller household size, the number of housing units has increased at a far faster rate than population growth. Between 1978 and 2007 the number of housing units increased by over 50 percent while population increased by 30 percent. Surprisingly, as household size has been decreasing, the size of homes has been increasing. According to census figures, the average size of a new home has increased almost 50 percent from 1970 to 2000. This trend has only very recently

begun to correct itself. In 2007 15.5 percent of residential architects surveyed in the United States reported that home sizes were decreasing; in 2008 this number had more than doubled to 33.5 percent (Baker, 2008)

[6] Conduction is the transfer of heat directly in and through a material. Conduction heat loss or gain results from the transfer of heat directly through the materials of the building envelope. If the outside temperature is greater than the inside temperature heat is gained from outside the building. Convection is the transfer of heat from particle to particle through the movement of fluids such as air or water. This is the process through which hot air rises and cool air sinks. Radiation in contrast is energy transmitted directly through space and does not require matter in transmission although it does require a line of sight connection between the objects. All objects radiate energy or heat, which heats all cooler objects around it. Solar radiation passes through space to heat (and light) objects that it strikes.

[7] The G Solar Factor is the fraction of incident solar energy which is transmitted to the interior of the buildings. Single clear glass has a G solar factor of 89%. Clear double glazed units have a G solar factor of 75%, highly insulated triple glazed units 35% and solar control double glazed units with “soft coating” represent the upper performance range with a g solar factor of 31% (Allesandro 2005) Generally, gains in G solar factors reduce solar gains but also reduce the visual transmittance or availability of daylight. Evaluating the energy performance of glazing depends on finding a balance between keeping solar energy out (low G solar factors) and letting solar light in (high visual transmittance) (Allesandro 2005).

[8] In the Vancouver region high-rise, electrically heated apartment buildings consume 9,363 kWh/unit/yr; almost 40% more than low-rise, electrically heated apartment units which consume only 6,823 kWh/yr (Malbek 2007). In non-electrically heated buildings this discrepancy is even larger with high-rise units using 56% more energy than units in low-rise buildings (Malbek 2007). It is important to note that a building's energy efficiency is not only a result of the height of the building. Factors such as building materials, unit size and the number and size of windows (the outside of many towers is almost entirely glass) also play a large role in the overall energy efficiency of the structure.

[9] According to the National Association of Home Builders (2007), in the 1950s the average size of a new US single-family house was 983 square feet. By 2005 this number had risen to 2,424 square feet, representing an increase of 148% (National Association of Home Builders, 2007). In many parts of the country this trend was even more extreme. For example, the standard house built in Austin, Texas in the late 1940s was about 1,200 square feet. By 2006 the average house size had increased by well over three times this number to 4,000 square feet (Robinson, 2006).

[10] Post 1976 single family homes heated with electricity consume three times more energy at 20,466 kWh/yr than low-rise apartment units at 6,823 kWh/yr (Marbek, 2007).

[11] According to projections from the Greater Vancouver Regional District (2002), the number of people living in the GVRD who are over 65 years of age will increase by 265% between 2001 and 2056. This is in contrast to an increase of between only 44 and

55% for all age classes below 20 years of age. This will create a "top heavy" demographics distribution where over 22% of the population is over 65 years old and less than 5% of the population falls within each of the 0-4, 5-9, 10-14 and 15-19 age classes (GVRD, 2002). As shown in the graph below, this increase in the absolute number and relative proportion of elderly in the population will lead to a sharp increase in the dependency ratio for this region **[Insert Figure 6.4]**

[12] Green Gizmo refers to high tech building energy use solutions such as automatic window shading machinery. Very often Green Gizmo solutions are applied before simpler and more effective strategies are considered, such as block configuration, building type, and street trees are acknowledged.

[13] The energy savings provided by trees has been referenced in a number of studies. McPherson et al. (2005) found that street trees in Minneapolis showed annual savings of $6.8 million in energy costs and $9.1 million in stormwater treatement and were responsible for a $7.1 million increase in property values (McIntyre, 2008). In 2006, McPherson et al. concluded that the six million trees in the southwestern US stored approximately 304,000 tons of atmospheric carbon dioxide, 12,000 tons of ozone, and 9,000 tons of particulate matter (McIntyre, 2008).

[14] This convention has recently been called into question with the recent foreclosure crisis. Market value data obtained from Zillow.com shows the staggering drop in property values brought about by the recent US mortgage meltdown and shows that second and third ring suburbs are often those hardest hit by the market crash. As shown in the graphs

below, home values in Culver City (a first ring suburb of Los Angeles) peaked in 2006 at approximately $730,000 before falling to $600,000 in 2009, constituting a 17.8% decrease in value. The relative decline in property values was far more extreme in Rancho Cucamonga (a third ring suburb of Los Angeles) where home values fell from $502,000 in 2006 to $324,000 in 2009, constituting a drop of 35.5%. This trend could also be seen in the Boston area where property values in Cambridge (a first ring city/suburb) fell 5.6% between 2006 and 2009 while property values in Stoughton (a third ring suburb of Boston) fell 13.8%. In his article 'The Next Slum?' (*The Atlantic*, March 2008), Christopher Leinberger explores the steep decline of suburban developments in the United States in contrast to the evident revival of urban living. Per square foot, urban residential neighborhood space goes for 40 percent to 200 percent more than traditional suburban space in areas as diverse as New York City; Portland, Oregon; Seattle; and Washington, D.C.

[15] Go to the Alternative Development Standards Project website for more information on conventional suburban development specs: http://www.jtc.sala.ubc.ca/projects/ADS/HTML_Files/ChapterTwo/figure7_us.html

[16] **[Figure 6.6a and b]** The Traditional Neighborhood Pattern (Figure 6.6a) has a density of approximately 10-15 dwelling units per acre (Condon and Teed, 1998). Given 2.5 people per dwelling unit this development pattern accommodates 9500 – 14,250 people within a service circle that fits 380 acres within a 5 minute walk. In contrast, the Status Quo Neighborhood Pattern (Figure 6.6b), with four dwelling units per acre, accommodates less than 4,000 people within a five minute service circle (Condon and

Teed, 1998). This means that any services placed within the lower density neighbourhood have a much smaller population to support their business.

[17] Inclusionary zoning refers to zoning practices that requires a given share of new construction be affordable to people with low to moderate incomes. Montgomery County, Maryland is often viewed as a pioneer in establishing inclusionary zoning policy. Montgomery County's Moderately Priced Dwelling Unit program requires that developers sell or rent between 12.5 and 15 percent of the total units in every new subdivision or high-rise building of 50 or more at specified, affordable prices (SNRPC, 2005). In return, developers are generally granted density bonuses of up to 22 percent (SNRPC 2005).

[18] Including secondary rental suites in new detached and attached homes helps to provide housing for those at the lower end of the income spectrum while also opening up new opportunities for homeownership to moderate income families. The cost to manufacture secondary suites is up to 30 percent cheaper than apartments built in complexes and could be profitably rented for as little as $500 per month. The extra rent generated from these secondary suites allows families that could not otherwise afford to own a home to enter the housing market.

[19] Jacobs, Jane. 1961. The Death and Life of Great American Cities: the failure of town planning. New York: Vintage. And Le Corbusier. 1964. *The Radiant City*. New York: Orion.

[20] Newman (1972) states that when yards or landscapes have no association to particular residences, such as those of a high-rise, residents of the building are unlikely to claim ownership over the spaces because they seem to belong to all. Therefore no one, except for the security guards, takes responsibility for their care and surveillance (Newman, 1972). The best known example of the breakdown of social systems due to the Corbusier style housing is of the Pruitt-Igoe Housing Project. The architects tried to eliminate the 'wasted space' of public hallways and transitional areas between apartments and the outside public. The result was a lack of semi-private space that could be claimed by particular apartment dwellers, and thus any public space such as the stairwells, elevator and public galleries (on the fourth, seventh and tenth floors) became a neglected and uncontrolled 'no man's land' with frequent occurrences of rape and assault (Yancey,*1971*).

[21] Kupfer (1990) theorizes that in the past the front porch dissolved the wall between private place and public space and invited the communal life which is built on easy and spontaneous social interaction. With the loss of the front porch and the new back yard barbecue orientation, we lose the casual sharing of space and with it the "cultivation of that unit of communal autonomy, the neighbourhood." The house presents on its front a sign of rational order that transcends communal differences (Glassie, 2000). The porch becomes a transitional place where people can negotiate their differences politely (Glassie, 2000). Successful transitions are achieved by regulating devices such as the arcade, the storefront, the dooryard, and the ensemble of the porch, fence and front lawn. These transitional devices soften the visual and psychological edges between zones and allow us to move between them with appropriate degrees of ease (Kunstler, 1998). In his

book ‘Bowling Alone’ (2000), Robert Putman shows how Americans are becoming increasingly disconnected from each other and documents the negative impact this disconnection has on physical and civic health in the United States.Zoning and Development By-law No. 3575 in Vancouver, British Columbia was amended to allow secondary suites in RS, RT and RM zoning districts. See: http://vancouver.ca/commsvcs/BYLAWS/zoning/zon&dev.htm#sections for details of the bylaw.

[22] Researchers from Edinburgh University found that in neighbourhoods where high quality pedestrian-oriented communal spaces are available, 85% of children used these communal spaces for play and only 15% played on roads or in parking areas. Parents and teachers appreciated the positive advantages of linked open spaces and the child accident rate was half that of the nearby street-oriented layout of more conventional suburbs (Cooper Marcus and Sarkissian, 1986).

[23] Zoning and Development By-law No. 3575 in Vancouver, British Columbia was amended to allow secondary suites in RS, RT and RM zoning districts. See: http://vancouver.ca/commsvcs/BYLAWS/zoning/zon&dev.htm#sections for details of the bylaw.

[24] Stapleton in Denver, Colorado is an infill development covering 4,700 acres. With a gross density of 9 dwelling units per acre, Stapleton will include 12,000 dwellings, a large commercial area, business parks, schools, a recreation centre, and industrial and institutional uses (Girling and Kellett, 2005). In 2008, 3,000 of the 12,000 homes had been built and between 2007 and 2008, 21,000 trees were planted (Buntin 2008). A mix

of housing types is provided including single family detached homes, apartments, townhouses, live-work options and low income housing. It is designed to ensure that the majority of homes and businesses are within a 10 minute walk of one of the four town centers. Another example is Orenco Station, Hillsboro, Oregon. Situated on Portland's light rail transit line to downtown Portland, Orenco Station will include approximately 1800 dwellings located within walking distance of the LRT, with a gross density of 12 dwelling units per acre (Mehaffy, 2001). The design of East Clayton in Surrey, BC encourages a compact, walkable community design with a preserved system of natural drainage areas. The community is designed to incorporate a range of housing types and business opportunities and provide good pedestrian connectivity to transit, services and green space (James Taylor Chair). At build-out, the average density of East Clayton will be 10 dwelling units per acre (CMHC, 2001). As of 2009 East Clayton was 60% built out.