SOLAR ACCESS PLANNING: THE CASE OF BOROONDARA

AN EXPLORATORY CASE STUDY OF AN AUSTRALIAN CITY'S POLICIES FOR PASSIVE SOLAR DESIGN AND SOLAR ACCESS RIGHTS

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By

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ABSTRACT

This case study explores the solar access policies for residential dwellings stipulated by the City of Boroondara, in Victoria, Australia. Boroondara is a renowned garden suburb located near Melbourne in Australia. The case study research examines the unprecedented policies pertaining to solar access, overshadowing and daylight for residential neighborhood of Boroondara, as given in the local government's planning scheme and the legislative documents of state government of Victoria. The primary research objective of this thesis research is to identify and analyze the agendas of various stakeholder groups towards solar access in residences. The main question is – "*Why* is the City of Boroondara implementing policy for solar access in dwellings of its neighborhoods?" Stakeholders groups include local politicians and policy makers at the city council of Boroondara, residents, planning industry professionals, and environmentalists associated with this city. Natural resources have been ubiquitously surrounded by many social, political-economic, racial tensions. Hence a "Why" research question is used to explore the contextual conflicts linked with the governance of solar access policies for residential design in this city. This qualitative exploratory case study uses a variety of methods: semi structured interviews with stakeholders, photo documentation, document analysis and media analysis. Field study was conducted at the City of Boroondara. The results of qualitative data analysis show the following themes – amenity, respect for neighborhood character, sense of place, solar access, desire for control, dislike for real estate development and conservative and vocal community. Solar access policies are executed mainly through controlling height, setback, and number of dwellings on a plot. Regulating these features regulates the real estate and high-rise development. It helps the city to maintain its neighborhood character through prevention of excessive development, intensification and construction of high-rise buildings.

BIOGRAPHICAL SKETCH

Neha Yadav got a Bachelor in Design in Product Design from National Institute of Fashion Technology at New Delhi, India in 2012. She began her graduate program in Sustainable Design Studies at the department of Design and Environmental Analysis at Cornell in August 2013.

DEDICATION

To my mother, who opened my eyes to marvels of nature.

And that protecting nature is a godly act.

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Literature Review

Prologue to the literature review

Design of built environment results from exerting human labor, thinking, customs and economic resources on natural resources. Built environment comprises of buildings for settlement, education, health and recreation, civic and cultural purposes, and transportation systems like roads, trains, etc. Built environment is a combination of human effort on naturally occurring resources like land, forests and water for supporting human activities and lifestyle. Societies are constructed around built environment, each with distinct religious, political, economic and aesthetic views.

Construction of built environment by human beings produces many desirable and undesirable effects on the ecosystem. Many actors and members share the effort and outcomes from the built environment. Amongst the various actors there is a constant need for managing and controlling the functioning of the built environment – investors, beneficiaries and rule making bodies. Many goals are advanced through management of built environment and use of natural resources. Livelihood, socioeconomic status, housing, recreation and well-being, travel, and religious and communal goals are all fulfilled through features of the built environment design. Presence of diverse interests with diverse stakeholder groups makes environmental management process a multilayered activity. Hence, dissociation of these layers of interests becomes important for analysis of sustainable and unsustainable impacts generated from the built environment.

Governance plays a game-changing role in the management of built environment, its design and in regulation of associated natural resources. Governance pertains to decision-making process

amongst stakeholders groups for use and management of resources. The distribution and control over resources impacts the quality of built environment design and the long term affects on the ecosystem. Along with the ecosystem, governance of natural resources significantly manipulates the economic returns from the use of a natural resource, political power through authority over a resource as well as gain in social status. The decision of regulating a chosen resource emerges from the necessity and demand for that resource – with more important resources facing more stringent regulation.

The contexts in which environmental management plans, policies, laws are situated remain critical areas of study. The adjacent and overarching context hides within itself the real motives behind goals for protecting the ecology and implores the investigator in understanding the various types of conflicts that interact with the making and implementation of environmental policies. The context is built over ages and through diffusion of cultures and information over geographic boundaries. The depth and width of the context in which environmental policies are enclosed remains a challenging yet intriguing devise for making future policy making and analysis more rigorous and effective.

Regulation of built environment design for effective use of passive solar energy presents a significant area of opportunity to explore how governance of solar access in residential design in an Australian local jurisdiction is influenced by the surrounding factors of political economy, culture and the social structure of the city of Boroondara. Ralph Knowles' concept of Solar Envelope is analyzed as practiced by this city through solar access policies and related rights for the property owners. For this purpose, the following text presents to the reader a top-down survey of literature, containing the following parts:

Part 1 provides an awareness of how resources and governance shape each other, the role of resources in an institution (politico economic, social, and ecological) and the existing theoretical schools of thought in this area. In the later half of this part, land is explored as a resource, with critical analysis of land use and city planning.

Part 2 takes the reader towards review of solar energy as a resource for planning cities and the design of the built environment. The invention and technical features behind solar envelope as a tool for governance of built environment design are presented. Other studies that have studied the benefits of solar envelope and related engineering are described in the later half of this part.

Part 3 describes various solar access based policies, programs and strategies existing in various geographies around the world. Solar rights, laws and policies for exposure to sunlight in buildings from United States, Japan, Germany, France and Australia are covered.

Part 4 narrates the origin, history, present day built environment design policies about the City of Boroondara. Many demographical facts are represented through graphs.

Part 1: Sociology of Resource Systems

Section 1.1: Theoretical foundations[1]

In the 1930's economist Erich W. Zimmerman said, "Resources are not, they become" (Edwards, 1980, p. 122). Resources can be understood as instruments, created with the help of human knowledge and capabilities. Human beings have been successful in bringing about new resources on this planet for their "gainful occupations" and gaining control over this planet. Time and again human beings have attached new values to existing and everyday resources. Knowledge, technology and needs of the hour propelled this process of finding new adaptations of existing resources. American economist Wesley C. Mitchell rightly advocated human knowledge as the "greatest resource" of human kind and that all resources are born out of human knowledge ("Resources and man; a study and recommendations," 1969, pp. 45-47).

Resources exist in the biophysical world, such as naturally occurring water bodies, forests, even endangered species of flora and fauna. On the other hand, resources could also mean manual, intellectual or technical skill sets of a person that assist in the creation of man-made systems and commodities like buildings, cities and transportation systems. Such resources are also known as human-capital (Turner, 2003, p. 103). In the anthropocentric world all resources have owners and generate "yields" or some form of output. Owners typically exist as individuals, communities, private corporations, and public organizations, or joint ventures. Yield of a resource can be defined as the amount produced or the capability of the owner to earn from the yield of the resource. For instance, if land is the resource, then the yield would be the financial gain of the land owner upon selling the land in the market, from a building constructed on the land and fetching appropriate real estate values from it. Moreover, earnings from yield could be

[1] The text for part 1 and 2 has been borrowed from the final paper written for NTRES 6300, Fall 14. It has been edited

in terms of non-monetary gains as well – increase in social status, a tool for exercising authority in a community, greater political power or as means of establishing a cultural symbol of the region or community. Thus, yield can be understood as one of the criterion for human beings and societies to adopt a biotic or abiotic entity as a resource. True to Mitchell's argument, it is through human knowledge that a society and its members foresee and calculate the yield of a resource in the making – essentially tying back to Zimmermann's concept of creating resources by adding value to things. The higher the yield from the resource, the higher is its value for human beings and societies

Historically, resources were adopted by human societies for fulfilling basic needs of human beings such as acquisition of land for creation of settlements, as well as development of cultural symbols of the society. These resources also proved to be the deciding factor for the norms, conventions and values of the associated society (Gregori, 1987, p. 102). The interaction of resources over the course of time plays a critical role in the social order of the community and leads into political and economic consequences. The work of Sociologist Walter Firey, *Man, Mind and Land,* published in 1960's addresses resource systems and why certain resource systems gain special attention from human beings and societies as potential "commodities" irrespective of fulfillment of anthropocentric goals. Firey explains in his book that certain resource systems are "naturally selected" as important parts of the human society These systems align with the needs & values of the society in three formats – ecologically, ethnographically, and economically. The development and existence of society is impeded in absence of these resource systems. He also argued that a proposed change in the use and management of resources that requires change in lifestyle or shift from typical thinking paradigm of the inhabitants of society is unwelcomed. Acceptance of change relies on fitness of the proposition with the ethnic,

ecological and economic goals of the society. Sociological goals contain within them interests and voices of the inhabitants. Firey argues that the fitness of the proposition plays a deciding role for long-term agreement with changes in the society brought by a shift in the management of resource use and also mitigates associated psychologically or societally perceived risks of the proposed environmental change (Vatn, 2005, pp. 54, 167).

Section 1.2: Resources and Society

While explaining the evolution of society with resources, Thomas Gregori adds to Zimmermann's theory that human beings create tools for "growth or advancement" through resources. These resource fall into two categories, renewable and exhaustible. Growth is understood as addition of gains or engaging in activities that lead to profit maximization. Gregori calls humans active agents who create one tool in search for the next. He uses an example of early man who "recognized" pebbles and stones as potent for some use, explored them and in the process created fire. Now, fire was the first tool, and it led on to advent of very many others, such as protection from animals through fire, and cooking food (Firey, 1960, pp. 62-65). One resource carved the path for the other. This example also depicts the two-way relationship that resources have between human beings and their knowledge – while manipulating a resource, for satisfying their goals, human beings evolve themselves. He claims that human beings emerged and created better societies through the tool making skill and resource generation abilities. However, communities and societies are heterogeneous in their skills of creating tools necessary for creating new resources. The more skillful societies create tools more efficiently and effectively, along with being agile in evolving with environmental changes. Resilient and sustainable communities are known to rely on their agility in providing for necessary changes like political conflicts and natural disasters arising from time to time.

As mentioned before, ownership of resources are also a method of executing hierarchy, authority, along with increased socioeconomic power in a given region. For instance, in a monarchy, it is the king who owns most of the resources like land, within a given boundary. The king earns through the crops that are grown on the land, by the peasant that is employed by the king. He supplies goods (crops and grains) to the demand (food for buyers and employment for peasants) – and hence gets to claim economic authority over the demand side (his employees and buyers), along with his existing political power. A more topical example could be the federally controlled land. The ownership of land by the federal government demonstrates its authority as the central figure of the nation. The citizens have to abide by the federal decision-making and it's legislative powers over the lands. It is the federal government and the responsible agencies whom have the power of deciding who gets the rights to use the lands, how and when. They have the authority over nature and manner of federal land usage. Non-compliance with these "hard rules" is counted as violation of authority and results in penalties as mandated by the rulebook of the authority. Other types of penalties would also include costs that the defaulter has to bear in terms of economic, social costs, or even psychological costs.

Section 1.3: Institutions

An institution is a man made body that conducts its everyday functions through its set of conventions, norms and values. Examples of institution include society, religious group and even an economic framework within which a nation functions and grows (Gregori, 1987, pp. 37-38). Arild Vatn, in his famous work, institutions and the environment, argues that institutions change societies and societal developments in turn have a huge impact on the institutions over the course of time. He further makes a claim that Institutions cannot be taken merely as physical artifacts, which are given the role of governing a given jurisdiction – be it at a county, city, and state or

nation level. Vatn[2] argues that the context surrounding an institution, called the "social construct", lends a variety of impacts on the institution. Hence, institutions hold a dynamic relationship with the social construct. The choices and constraints provided by the institution are a result of both the formal and informal elements of the institution. John L. Campbell argues that the single most important contribution of sociologists and political scientists is the choice-within-constraints approach. It considers that " informal norms and formal rules and regulations, limit the range of choices individuals are likely to make as they pursue their interests. Shift in the dynamic relationship between institutions and social construct requires change in the behavior, practices and sanctions of the human users. Reflection of this shift is often seen in the form of resistance, due to inertia of the users. A man made institution like a municipality, city councils and residential groups struggle and compete for acquiescing more and better resources, along with maintaining the status quo of resources. One reason for this is the association of resources with increased survivability amongst human beings – increased resources, increases the chances of society to sustain through crisis and conflicts, like natural disasters. Hence, the high concern and fight for infinite supply and access to resources, is ubiquitous – across communities, cities and nations. Human beings constantly strive for newer resources and unlimited growth (limits to growth) by utilizing human capital in the form of advanced technology and innovation in research for reducing any anticipated resource shortages. These efforts seldom match the needs of the environment, but do match the human centric goals of certain sections of the society. Gain of one region is often means loss in another region. The goal of acquiring more resources from example water from a common reservoir between two regional jurisdictions, also leads to

[2] Due to role of the various fields like sociology, political philosophy, and economics and even psychology in the intellectual enquiry related to institutions, Vatn has most appropriately included a variety of definitions chosen from a variety of fields – such as the definitions of Scott (Sociology; Theory of organizations), Bromley, Veblen (Classical institutional economics; evolutionary theory), Berger and Luckmann (Sociology), and North (New institutional economics). Each definition reflects the assessment of different fields.

conflicts and competition between communities and institutional bodies. Acquisition of a resource also includes exhaustion of common pool and open resources, apart from physical division of resources like land. Common pool and open resources are complex due to lack of boundary, and use of such resources includes measuring the amount other users have exhausted through pollution and other kinds of degradation of resource. Often various users negotiate and balance the use of resources between themselves through a variety of trade mechanisms for instance carbon emission trading. The end goal is maximization of personal profits for the parties – in both direct and indirect ways.

Given that a resource is situated within a community or a collection of people, the use and mandates surrounding the resource are decided by the values and stakes attached to the resource – depending upon how important is the resource for the people associated with it. For instance, in a city with exceptional aesthetic quality of houses and streets, the inhabitant community would most likely make every effort for preserving the neighborhood character, urban environment and sustaining the valuable features. In an attempt to preserve the urban scape, the city would set its norms and rules to protect the unique aesthetic quality of urban scape. Any new comer in such a society would be required to adapt to the norms and sanctions set by the society. Divergence from these sanctions would threaten the membership of the new comer and would be treated as non-conducive to preservation of its urban environment. However, it remains likely, that some individuals (irrespective of having any mutual feelings or association) disregard the collective object of preserving the city's urban scape – a mismatch between individual and societal values and preferences. Irrationality and non-linearity of human behavior might propel some human agents to further their personal goals with no consideration for societal sanctions, values and

objectives. It remains debatable whether it is right and/or executable to forego individual benefits in pursuit of greater good of the greater number (utilitarianism).

The mismatch between individual goals and societal goals can be explained also through the issue of trust – between various individuals who are expected to share a common object for the preservation and/or development of a resource. Different governance regimes are used for increasing compliance towards resources within the boundaries of an institution. John Dryzek while explaining his work on discourses has provided a timeline with evolving governance regimes from participatory to democratic to deliberative alliances between actors in a regime. He also describes the changing objectives towards environmental protection in the United States of America in detail. Compliance is also triggered with the help of incentives, like tax rewards, subsidies, and other monetary and material ways. Incentivizing a required behavior in human agents is seen as a successful way of ensuring efforts for resource conservation. Schemes of incentivizing compliance typically require multi authority regime, i.e with collaborative actions of state, markets and community efforts.

Section 1.4: Resource politics on national and international frontiers

As seen in the case of petroleum or “black gold” as a fuel to run transportation, government budgets across the world continue to put extra efforts in ensuring uninterrupted supply of this resource. More so, the demand and supply of petroleum impacts international relations amongst countries, along with the historical conflicts amongst owners of source or “wells” of petroleum. It would be noteworthy to call into the picture, the land politics amongst neighboring nation states that was brought in due to the fight over petroleum and the gains it generated. The world wide acute shortage of petroleum saw the world dooming in a near catastrophic stage. This was

1970's. It was around this time that the ideas of the "limits to growth" and "era of limit" were seen as popular phrases by experts and academia. Hence, the resource shortage or abrupt alteration in its availability directly affects laws, human lifestyles and the relationship between nations. Such disruptions are seen as threat by and for human beings. To maintain the expected order, with the required resources in place and necessary functions taking place to support human life and surrounding society, various actors and institutions play a role, namely – states (governments, public agencies and public enterprises), markets (multinational corporations, private firms), communities (community based groups, collective action groups) and other hybrid groups (for instance, public private partnerships).

Institutions also function with the help of diffusion of information between various actors – when state based bodies adopt commercial innovations for better management of resources and organizational efficiency, and when market learns from community based collective actions and activism – with diffusion being the operative word (Vatn, 2005, p. 321). For adequate functioning of resource systems, the political, economic and social system adopt certain norms, conventions and rules to ensure compliance by members of the society and hence attempt to preserve the resource and the systemic attributes associated with it. In the process of preserving the status quo, institutions also undergo some changes. Institutionalists advocate three primary patterns of changes – evolutionary, revolutionary and punctuated equilibrium (Campbell, 2004, pp. 78-79). The need to preserve and protect some "special" or even purely fundamental resources is addressed through the political-economic structure of a system. In this way, resources can be seen to shape institutions, and institutions shaping the resources in return.

Once resources become the integral part of institutional dynamics, they begin to set as the "preconditions" along with the embedded values of a society. As Karl Polanyi stated in the

1940's that any activity that takes place within a collection of people is based on the embedded social, political, cultural and often even religious values. These values can act as constraints as well as enabling factors for an exchange to take place. As per Polanyi's double movement theory, a society engaging in a exchange of resource or commodities, cannot function adequately unless the process of exchange takes place in collaboration with markets and states – absence of either, or excess participation from either creates tensions and disruptions in the exchange process. His emphasis on the participation of both markets and states is also relevant for concerns about consumption and over consumption of resources. Having more than one decision-making figure in a resource exchange process ensures a figure to "watch the watchers".

Governance of natural resources like land, water, air and sunlight exposes the heterogeneity of political and economic interests within an institution. It is not unusual to find inconsistency in the sentiments towards preservation of natural resources and bleak interest in issues such as sustainability, amongst the governing bodies and other stakeholder groups. While many governance schemes are put in place for protection of resources, the critical question of "why are resources protected?" remains. Preserving natural resources brings some larger outcomes that remain hidden as the agendas of the stakeholders. Morality, "deep ecology" and concern for ecology is not always the reason behind existence of governance schemes that protect the natural resources. The agendas behind conservation of environmental resources and ecosystem are critical for reflecting upon the relationship between human made institutions and resources. Analysis of political economic, and social factors behind maintenance and regulation of ecological resources requires an understanding of multidimensional nature of an institution, its instruments, stakeholder groups and the patterns of historical events that have impacted it.

Section 1.5: Land as a resource

One resource that has been given attention since early civilizations is land. These civilizations and the community members have relied immemorially on land and the activities associated with it to support their lives and livelihood (Turner, 2003, pp. 129-131). Arable lands were used for agricultural purposes since early on, for both subsistence or mainstream profit generation. Land ownership has also defined the political norms of a society – with the occupants high above in hierarchy owning maximum amount of land (Richard & Chris, 2012, pp. 4-5). This was also to assert their stature and authority on rest of the community. Beginning from a basic need for livelihood, emerged with complex governing schemes for the land and the activities that take place on it. The capacity to purchase land and converting it into a house for investment is seen as an important socioeconomic milestone for people in many cultures. Karl Polanyi also sees land as one of the three fictitious commodities, which regulate the functioning of an ideal market. As discussed earlier, ownership of land acts as a resource for the owner, and helps him/her to "build" more resources through it (Foley, DeFries, Asner, Barford, & et al., 2005, pp. 570-574). In earlier days, land owners would establish agricultural farms on the lands they owned, whereas in present day modern societies, a piece of land becomes a sedge way for an owner to earn property rights, and autonomy to build it further for commercial purposes like real estate. Land ownership is an equally important concept and is a widely accepted norm in some cultures. It is seen as a gateway to home ownership.

Section 1.6: The concept of land – use

Land is also a geological and biophysical entity that inhabits a unique role in contributing to the ecosystem of the region it is situated in. Within the ecosystem, a piece of land undergoes several changes based on the requirements of the human beings inhabiting it. It is the values, preferences and cognition of human beings that indirectly affect the way the land is used. This concept is also

known as “Land Use”. Formally, land use can be defined as, “the purpose to which land is put by humans (e.g. Protected areas, forests for timber, human settlements)”.

Land use activities create the built environment. The conversion of natural landscapes into anthropocentric infrastructures and changing governance practices on the existing landscapes produces many desirable and undesirable impacts for the ecosystem. Factors such as population density, infrastructures established by humans, and lifestyles of occupants on a piece of land are not always in alignment with the “carrying capacity” of land (Polanyi, 2001, pp. 63-65). What gets build on a hectare of land goes a long way deciding the longevity, quality and sustainability of the ecosystem. The built environment contains man made structures like residential apartments, schools, roads, and other amenities for public use that often impair the natural resources such as land, water and soil, and are critical areas of concern. Public, private and community organizations have stakes attached to land and act as per their interests and accordingly decide what and how to build on land, and who gets to use the land.

An inherent dilemma in matters of land use is that of differentiating between absolute necessities of human life that can only be fulfilled through land use – like shelter and settlements, agriculture, and roadways, and more affluent, sophisticated and technological advancements in built environment, that are also considered critical for growth of human society (in terms of economy, local and global politics & status (Lambin & Meyfroidt, 2010). More affluent land use activities have been found to enable human beings to “appropriate an increasing share of the planet’s resources” and causing irreversible damage to the environment.

Section 1.7: Land governance

The concern towards ubiquitous problem of environmental damages, natural resource depletion and the direct association of land use with the built environment, has led to the genesis of several governance regimes and tools for land use activities, motivated to bring forward novel ways of preserving the environmental resources and restoring the ecosystem dynamics of an area. Some regimes are singular – comprising only of state based decision makers and interests, or solely market based decision makers, whereas others involve more hybridity in their nature of interests and decision-making procedures. The impetus for change in land-use comes from the perceived ability of the land to generate rent and other formats of economic gains for the landowners. As per the 19th century land rent theory of Von Thunen (and that of Ricardo), a piece of land is used by the owner to maximize the rent generating abilities of the land (van den Bergh & Grazi, 2014, pp. 10-19). As per this neo – classical tradition of economics, the transitions made between different kinds of land uses – for instance, conversion of natural ecosystem into a commercial parcel of land, are based on the earnings generated for the landowner. Such rent-based transitions are often found in the urban areas across multiple nations. The sprawling metropolitan cities find themselves, converting natural landscapes and ecosystems in pursuit of economic development through land rent. The "relative rent" between potential uses of natural parcel of land versus the proposed plan of the land, decide the trajectory of land conversion and consideration given to ecosystem restoration. The values attached to any land parcel depend on "market access, policy interventions, land tenure and economic opportunities" – including both endogenous (socio-ecological factors) and exogenous socio-economic factors (Edwards, 1980, pp. 272-276). The neo classical scheme of land rent theory, attempted to run the society and fulfill the needs of the inhabiting human beings through economics and least intervention of the state. On a divergent note, several countries have also attempted to control land and associated ecosystem damage, by

introducing new forms of governance regimes – by including local communities such as through common – property resource management, private enterprise based resource management and other important formats. Other examples of new land governance techniques included formalizing land ownership through state ownership of land, and reducing open access land use

Section 1.8: Cities and Human settlements

Cities are one of the many examples of jurisdictional regions that utilize principles of land use to regulate their resources and assets to resolve issues pertaining to ecological disturbances, economic development and social equity and inclusion. City councils and municipalities function in order to promote socio-ecological and socio-economic growth. They alter their institutional frameworks such as planning scheme guidelines and local policies, from time to time to adapt to intrinsic factors and external pressures. Factors such as top down state legislation, country wide economic or ecological epidemic, and other kinds of natural and man made disasters can lead to changes in the institutional structure of cities. These changes could be evolutionary or revolutionary.

Cities are human institutions (Lambin & Meyfroidt, 2010, pp. 11-15). Cities reflect centuries of human labor and thinking. They are a physical platform for populations to settle. Around 15,000 – 20,000 years ago, humans began establishing permanent settlements around readily available resources such as in proximity to water bodies for food and river basins for practicing agriculture. Population grows around such resources, with more and more permanent settlements. A more recent example would be the population rush of the early 19th century due to gold mining in nations like Australia. A profitable resource invites populations and subsequently permanent settlement expansion around such resources. Managing large population density as

well as resource consumption requires such regions to devise rules and sanctions (Turner, 2003, p. 12). The population further develops itself by creating infrastructure for their use and survival – such as transportation, commercial activities and infrastructures for trade and economic returns, cultural and community centers for recreation of the population. Formation of social capital and community values, norms and sanctions follows, assists in governance of regions (Turner, 2003, pp. 43-46).

Modern day cities represent multiple layers of interests, activities and stakeholders. Cities and their municipalities thrive upon a unique combination of social capital and community relations, environmental resources and economic frameworks. They are known to be the focal points of resource consumption. Due to fossil fuel dependent urban development – excessive building construction, transportation, commercial activities and industries – major cities of the world exert heavy pressures on the urban ecosystem. Buildings and transportation systems account for nearly two-thirds of the carbon in cities ("Urban sustainability : reconnecting space and place," 2012, pp. 56-59). While cities remain the focal point of development and economic growth, they also present huge challenge for curtailing the resource consumption and prevention of environmental degradation through loss of vegetation and carbon emissions.

Several experts in the field of environmental policy and ecological footprint have also analyzed Land use as an "environmental indicator" (Knox, 2015). These experts advocate inclusion of "spatial configurations of economic activities" by addressing land use, infrastructure, trade and transport. Land use and related decisions are known to create ripple effects. These decisions and the regulations formed due to them impact quantity and type of buildings (public, private or joint use buildings), urban layout (street layout, transit and public services), population density, zoning and housing affordability (van den Bergh & Grazi, 2014, pp. 72-73). In turn these

elements also, affect the ecosystem metabolism and biophysical environment in and around the city – in the form of deterioration of physical (air and water contamination through pollution), physiological (deterioration of public health standards), aesthetic (damage to neighborhood and historical character of localities and cities), social (community conflicts over resources, social fabric of community, and social sustainability) and economic (impact on trade and other commercial activities).

Section 1.9: Governance in Cities and Urban Landscapes

The role of governance schemes and actors (public, private and community based) is to reduce negative impacts on listed factors through land use decision-making, create equity in distribution and allocation of resources, and promoting welfare of the society. Land use decision-making guides building construction and development of built environment. Given the impact that buildings feedback into the ecosystem of cities and the significant changes brought to surrounding biotic and abiotic environment, local governments of the cities utilize land use based governance instruments such as zoning, planning and building codes and regulations long term sustainability and welfare of the city residents. Most cities across the world lay down the regulations and policies pertaining to city planning and building construction through a planning scheme document. Metaphorically, the policies of the planning scheme document, "advise" how property right owners should "cap" their interests with due regard to the legislative authority present in the city. It would be important to note that while the city functions independently and autonomously within the over-arching mandates of the state and federation, its decisions are fed through constant information collection and analysis of existing regulations, procedures and their output in the society. Several cities also seek dual assistance from incentives and penalties, when

building owners excel and reject the mandates – a form of “carrots and sticks” approach ("Urban sustainability : reconnecting space and place," 2012, pp. 87-88).

These governance instruments include macro level guidelines such as those on urban design and city plans and micro level guidelines that focus on individual buildings with the help of building codes and architectural requirements. These guidelines serve as the floor and ceiling for the decision-making and environmental management process adopted by urban planners & designers, associated city officials, real estate developers, architects and other professionals of the building construction process, respectively. A variety of motivations can bring these policies into place – ecological proactivity, economic aspirations, cultural and cognitive values of the region in the picture. Motivations could also arise from temporal and spatial events, such as resource shortage and related conflicts between the demand and supply side. Planning and zoning regulations of cities ideally plan for such contingencies, to perform uninterruptedly in case of internal and external breakdown of the institutions.

Part 2: The revolution and shift towards solar energy

Section 2.1 Revolution in resources

The 70's were a decade known for a resource disruption [3]– the famous oil embargo or Oil Crisis of 1973. It is known in the history of international politics, as an attempt of oil producing Arab nations (OPEC members) to control the political conflict of the Yom Kippur War[4] and on the other hand gaining unprecedented profits (economic, political and social) by quadrupling the price of oil for importing to national markets. Several other religious and political tensions formed the backdrop of this monopolized decision of oil producing nations. Most societies across the world were fully dependent on oil – a resource that was instrumental for their everyday lifestyle activities, ran the economies they acquired livelihood from, and as a commodity their markets and states had established themselves with. Importantly, the resource wasn't absent from the international market; rather it was made available at four times the price, as opposed to the typically available low price version.

This put an end to "cheap energy" era. The field of political economy understands this mega event as an "oil shock" – that disrupted many institutions across the globe. While developing nations were left with no better option except for seeking foreign aids and international debts for fulfillment of basic necessities that were dependent on oil, industrialized nations were forced to reform their conventional ways of operation and existing institutional paradigms, as in the era prior to 1970's. Countries across the world began finding alternatives for oil and other new methodologies of curtailing the resource consumption and energy demands of their internal constituents.

[3] https://history.state.gov/milestones/1969-1976/oil-embargo
[4] http://bancroft.berkeley.edu/ROHO/projects/debt/oilcrisis.html

A shift was caused due to the shortage of resources and led to the evolution of research and interest in renewable energy. Across scales, renewable energy was seen as the answer to crippling effect of dependency on fossil fuels such as oil. Even after the end of oil embargo, oil-importing nations saw oil as a weapon against them, held by the exporters. They sought shelter in alternative fuels, and particularly those that could assist them in running their everyday functions such as transportation, energy for households, commercial activities, with least support from fossil fuels like coal, petroleum and others. This shift was reflected in several areas – transportation, businesses, and other activities that provide for the societal, economic and national benefits. The growing reliance on renewable sources of energy was the fruit of economic aspirations, such that user nations do not have to rely on overseas sellers. Whether inspiration from environmentally beneficial "clean" sources of energy, was also a part of the growing renewable energy market, remains arguable (Dale et al., 2000, pp. 640-643).

Along with the international scale disruption caused by the "oil embargo", it also left decision-making authorities with a critical lesson for the future sustainability of their regions and jurisdictions. The looming dangers of "oil weapon" and similar threats due to resource politics propelled the growing reliance on alternative renewable energy. City planning and urban areas underwent major overhauling post oil embargo in the 1970's. Energy dependency of cities was curtailed through renovations in better land use planning, building energy efficiency and more efficient transportation planning. The goal was to ensure protection from future planning for resource shortages and similar emergencies.

Section 2.2: Solar energy

Harnessing solar energy became one of the most potential devices for reducing dependency on fossil fuels – a scientific innovation for managing resources on local community, city, and national level. Solar energy from sunlight was an open, abundant and free renewable resource. Advent of solar power in the form of photovoltaic (PV) cells was a major breakthrough for buildings and its occupants, as well (Butti, 1980, pp. 39-40). Solar cells, also known as PV's, enabled buildings to harness solar power and run free from fossil fuels like coal and oil. This was an active form of solar energy – storing solar power in silicon cells for conversion to other kinds of energies such as electricity and heat, as opposed to using natural light and energy directly from sun's rays. Significance of constructing solar powered buildings lays in the aggregate impact that buildings lay on the resource consumption pattern of the cities. Major architectural and urban design advancements took place as a result of impending shortage of fossil fuels like coal, petroleum, and others – to make operations and maintenance of buildings more efficient and sustainable, and also to reduce their demand on the total resources available to the parent city and the ease the job of associated authority responsible for resource allocation (Ross, 1981, pp. 238-239).

Section 2.3: Utilizing solar energy in built environment - the solar envelope

Ralph L Knowles, professor of architecture from University of Southern California, presented one such innovative measure in 1981. He proposed using solar rays to guide the form and orientation of the buildings in a city. The concept he proposed is known as – 'Solar Envelope'. It is a technique of creating passive solar buildings that receive adequate and unhindered amounts

of sunlight for certain crucial periods in a day (Byrd et al., 2013, pp. 948-949; Dong & Wiser, 2013, p. 534).

As defined by Knowles,

" The solar envelope as it is conceived in this work is a container to regulate development within its limits derived from the sun's relative motion. Development within this container will not shadow its surroundings during critical periods of the day. The envelope is therefore defined by the passage of time as well as by the constraints of the property. "

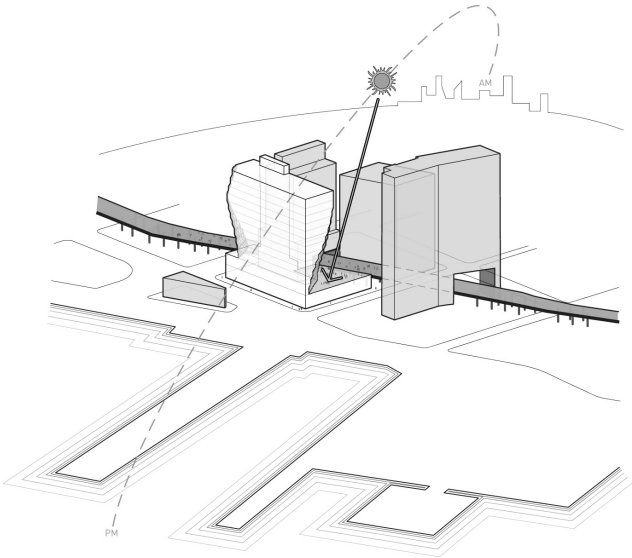


Figure 1 above: Diagram showing the concept of solar envelope as invented by Knowles. Source: http://www.archdaily.com/289562/solar-carve-tower-studio-gang-architects/54eb85d0b24b454a5600084d

This concept was extremely helpful for neighborhood development, in which two adjacent or closely spaced buildings do not over shadow and over expose a neighboring building. The principle argument was that the quality of life of human beings depends upon the sun and that

sunlight is the source of "energy, warmth, vision and rhythm" for human life. He also argued that the "modern built environment did not follow nature" and hence, cities were non-directional. They remain "static and unresponsive" to the rhythms of their surroundings.

Ralph Knowles did not intend the concept of simply as a replacement for fossil fuels to operate buildings; rather he was motivated by the sustained quality of life and durability of 'solar envelope based building design'. This concept intended to push further the concept of solar access – for present and future support for quality of life. There were four components of the idea of quality of life that Knowles, was deeply interested in: *physical comfort, choice, sense of well-being, and joy*. Conclusively, Ralph Knowles advocated solar access as an essential component for human beings and the over all society (Knowles, 2003, pp. 17-19).

Section 2.3: Solar policies

The sun and the solar energy gained a increased prominence as a topic of discussion and policy making in the 1970's for a variety of political and economic reasons. The sun was realized as a potential source of energy by states and other resource managing authorities across regions. It is this conversion of sun and its energy into a potential resource that fueled the public policies for solar access – where the aim is to regulate and watch "how and when neighbors may shadow one another." Extending the assistance in regulation and governance provided by the executing solar envelope, Knowles compared systems such as covenants, permits and easements for guaranteed solar access, and that of solar envelope. He found solar envelope to be an alternative for permit system. The permit system is executed by cities, counties and states with zoning regulations and intends to maintain future rights of access to sun.

Solar envelope based urban developments on the other hand were a more "neighborly approach" to the issue of solar access. The idea of solar envelope rested upon restricting the development on a particular piece of property to protect the surrounding areas, instead of restricting the development around a given property. It would be important to note that this critical and nuanced difference between the two approaches can have significant ethical and legal implications. The time of exposure would be guided by following the sun's path around a given building, located in a given area. This time would define the solar access, a period of direct, line-of-sight approach to gather solar heat and light. Further, the duration and required amount of solar access will decide the land parcel[5] configuration, surrounding environment, the size and shape of the envelope.

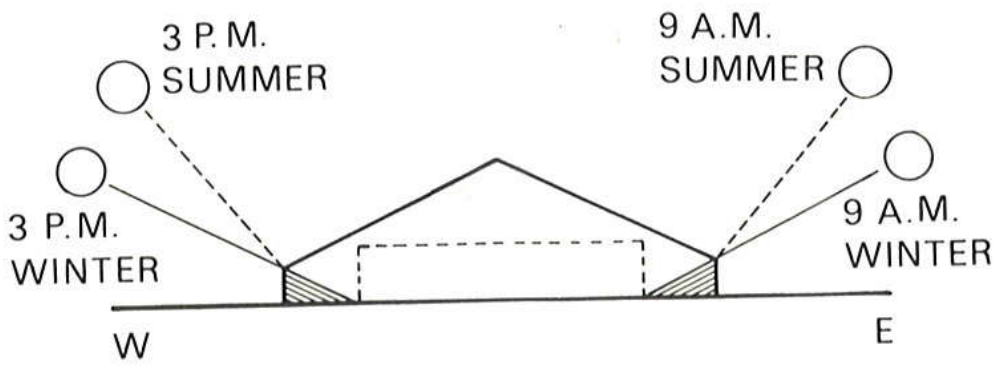


Figure 2 above: Calculating the sun's path for making the envelope for a building construction (Knowles, 1981, p. 36)

Rhythm, as seen in natural processes and other ecosystem cycles, could be linked to architectural and urban design creations. Knowles advocated that transformation and incorporation of natural

[5] A land parcel is an individual piece of land that can be taxed and sold separately. Definition accessed from http://www.dtpli.vic.gov.au/property-and-land-titles/property-information/reports,-plans-and-surveys/find-a-parcel-of-land

rhythms inspired by natural processes, helps people (occupants of buildings and cities on the whole) to connect with the environment around them. He found direct connection between rhythm (the spatial and temporal movement of sun) and forms of the building – this connection was analogous and extremely useful for understanding the relation between energy and form.

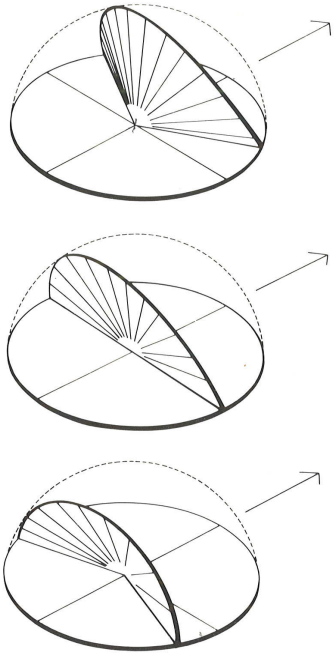


Figure 3: three different building envelopes based on sun's path at different times of the day (Knowles, 1981, p. 53)

Ralph Knowles discussed the pueblos of America's southwest region as an example of how early settlements of 1100 A.D. adapted their locations and form for human form. The location and form of buildings at Long-house pueblo, Mesa Verde, Colorado, provided these ancient settlements with year round comfort. This society was able to ameliorate extreme environmental temperature variations by adapting their living locations in the built structures within the caves. The adaptation strategy of the pueblos was dynamic and reflected in the form of locational

changes – they would shift their built structures within the cave as the shadows and insolation from summer and winter sun. Largely, Knowles states that the "tempo of life" of pueblo settlers may have been affected by the solar conditions. Pueblos shaped their society on the basis of solar dynamics and environment – through festivals and rituals. These rituals, as per Knowles, serve to increase the awareness of the occupants for their environment. The example of pueblos can be understood, as previously mentioned, the relationship between resources (solar insolation) and institutions (rituals and festivities). While solar insolation was not a commodity for pueblos, but being unresponsive to solar rhythm could potentially bore social or monetary losses on the pueblo society.

Solar envelope based urban development aspired to make the built environment energy efficient and self sufficient by regulating building forms as per the natural rhythm of sun's movement. Functioning under the guidance of natural rhythms would ensure that built environment does not use more energy than they exchange with their immediate ecosystem. In this way the built environment would fit the local conditions and not be dependent on centralized pools of energy supplies (Knowles, 1981, pp. 9-13).

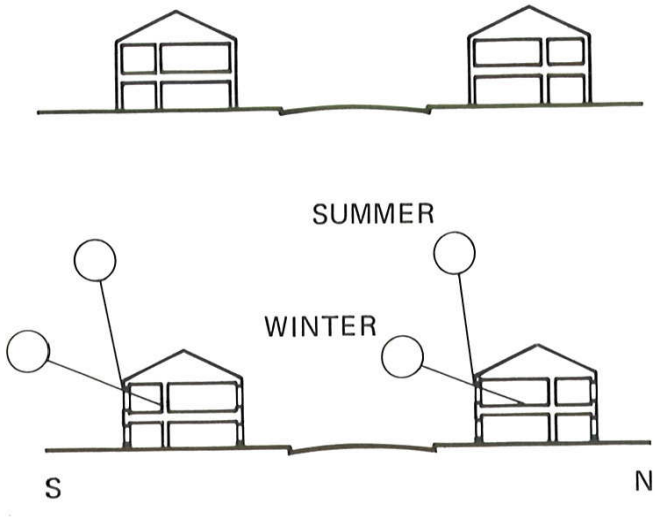


Figure 4: Summer and winter sun over a building and the potential variation in solar envelope (Knowles, 1981, p. 36)

Section 2.4: Sunlight and the ecosystem of cities

Knowles described cities as unresponsive to recurring natural forces like the temporal and spatial movement of the sun in the sky. He argued with the help of an empirical example that the way the sun's rays act on a hill, the same way they act on the buildings in a city. Climatic differences between two ends of a city or two facades of a building can be huge. The diversion and attention to resources required for warfare during World War II left cities in United States with huge population to accommodate and hardly any building stock. By 1945, a hefty backlog of building need was created. Increasing population, shifted from farms to cities, causing major urban expansion. Availability of transportation machinery and cheap fuel, assisted in outward expansion and sprawl of the population. Thus, due to the sudden need to house population, buildings were built in an assembly line fashion and were not (entirely) planned. It was the result

of industrialization also, that was applied to buildings and created buildings that looked alike, and with least concern to local environment and culture. The implications of a misfit building in a local ecosystem, results in over expenditure of resources like electricity and other forms of energy to run and operate the building and provide for the comfort of the occupants. The period of exuberant and rapid growth dialed down by 1975 – and left cities with "overburdened with population, fewer employment opportunities and taxpayer revolts."

Ralph Knowles argued that the resolution of challenges posed by the building stock on the environment lay in end of "growth as-usual". He saw "expansionary" processes of land use as threats for the future, while "transformational" processes based on selective land use as a healthy way forward. Urban rebuilding and transformation can take place such that solar energy becomes the primary fuel for cities and improve the quality of life for inhabitants. Solar envelope was thus created as a framework for urban growth so that less energy is expended in maintaining the built structures.

The patterns of urban settlement also play a decisive role in defining the size, shape and orientation of the solar envelope. Typically, as also in the United States, cities seek assistance from grid orientations – based on climate, geology and topography of a region. Street grids influence the solar envelope. A variety of grid formations of streets exist – Jeffersonian and Spanish to name a few (Knowles, 1974, pp. 18-19). These types have inherent differences amongst themselves – especially for the amount and direction of the shadows casted by them. For instance, streets running east west in an urban area get shadowed all through a winter day. In the Spanish grid system, every street receives direct sunlight and heat at some period of a winter day and at the same time has the benefit of receiving shadow during some time period of a summer day. Conclusively, solar envelope is impacted by street orientation in two ways:

consequences for development, secondly, on issues on urban design. The proposition of solar envelope was not to curtail the freedom of building designers, but to enable them to include "aesthetical, ethical and energic implications" of the concept of solar envelope.

Section 2.5: The need for solar policy and importance of solar energy

Ralph Knowles championed the need for a solar policy, in relation to the concept of solar envelope. He argued that using the sun requires access to it, which in turn is dependent upon the level of importance that is given to the exposure of sun. The importance of solar access in a region is dependent upon the institution (societal and governmental) that governs the use of sunlight in that region.

Knowles recommended development of public policy for "urban solar access", as that would provide for a medium of public expression in matters of solar access as a far more efficient and durable option, than enforcing solar access in an urban area with the help of design and development initiatives. Prevention of misunderstandings and conflicts amongst neighboring building owners, the access policies are required to be "unambiguous, fair, and must be executed equitable" manner. Success of solar access also lies in the balance between "right to develop property and the right of access to the sun." Another reason for the need of public recognition of solar access and its importance is that buildings are not isolated features of a region; they are relative to the neighbors. Hence, it becomes crucial for an entire neighborhood to value solar access equally, for their private purposes, as well as of others.

Several authors have investigated the benefits of solar envelope and related impacts of access to sunlight in the buildings. Solar gains have been found to have an impact on energy efficiency, carbon emission, and urban microclimate, housing density, health and well being of the building

occupants. Solar gain can be attained in two ways in built environment: Active ways through usage of photovoltaic cells (solar cells) and through passive architecture in buildings. The policy research area has addressed the concerns around usage and issues associated with use of solar cells more adequately, in comparison to investigation about the implementation of passive solar gains in buildings. Several municipalities, state and federal governments have invested enormous research and technical and financial assistance to make policies for advancing the use of solar energy in built environment.

Section 2.6: Solar access – for sustainable design of built environment

Le Corbusier famously said: "The sky is dominant, foremost among all things, this same sky which is the source of climate. The angle at which the sun meets the meridian imposes basic limitations on man's behavior. I believe that man's yearning for light is natural. In a temperate climate I would not balk at having that light, even the sun itself, flooding the home." (Morello & Ratti, 2009, p. 1)

Architecture since early civilizations of the Greeks and the Romans has paid critical attention to sunlight and daylight. It has been the key generator of urban forms in the cities. Vernacular architecture was an evidence for this practice, as well as a source of inspiration for many architects. In modern urban planning, the implementation of solar access in building relies on stringent urban regulations. Different cities use different bylaws for ensuring sunlight in their buildings – from simple to complex laws. Ratti and Morello, use New York's City's and Milan's 60 degrees bylaws for guaranteeing solar access in buildings through obstruction angles, as example of bylaws for implementation of solar access in buildings of dense cities. An obstruction angle is defined as the smallest angle with the horizontal under which the sky can be

seen from the lower edge of a vantage point, usually an opening in a building. They argue that traditional solar laws are based on the simple angular criteria, such as obstruction angle rules. More sophisticated laws, such as those based on Ralph Knowles solar envelope study would require technically advanced urban digital elevation models (DEM's).

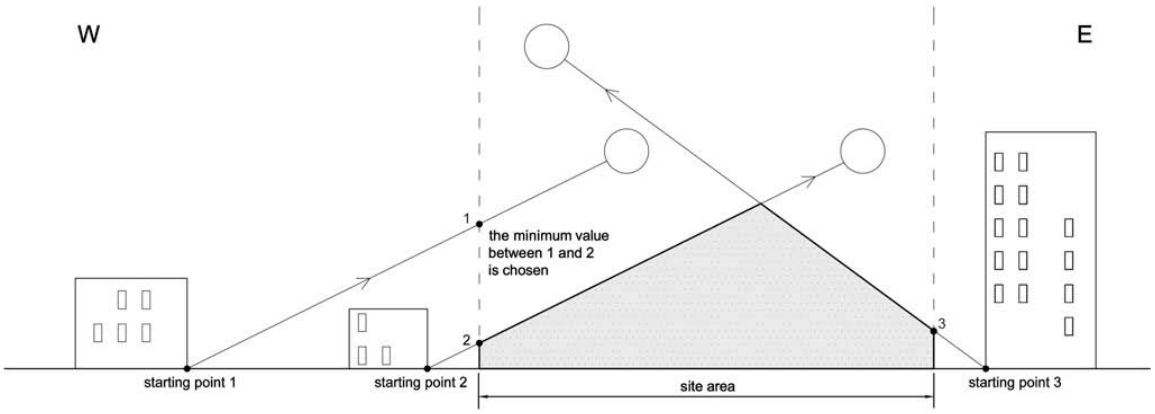


Figure 5 (above): The conceptual construction of the script for calculating solar envelope through the image processing of DEMs. The shadowing function is applied shifting the DEM starting at the base of existing buildings towards significant cut off sun angles. (Amado & Poggi, 2014b, p. 1545)

They further reflect on the gap between theoretical attractiveness and complexity (monetary cost and technicalities) of calculating solar envelope on urban scale. Secondly, they point out that solar envelopes do not take into account energy considerations, instead are only defined in terms of number of hours of sun and shadow. The authors also argued that better calculations would enable more effective and extensive implementation of solar envelope in cities. They proposed the concept of an iso-solar surface, which accounts for the amount of solar energy received at different times of the day, in a building. The solar gain through iso-solar surfaces could become a

more reliable way to promote performance standards such as energy efficient architecture to support sustainable urban planning, replacing the old and traditional use of obstruction angle (Morello & Ratti, 2009, pp. 92-93).

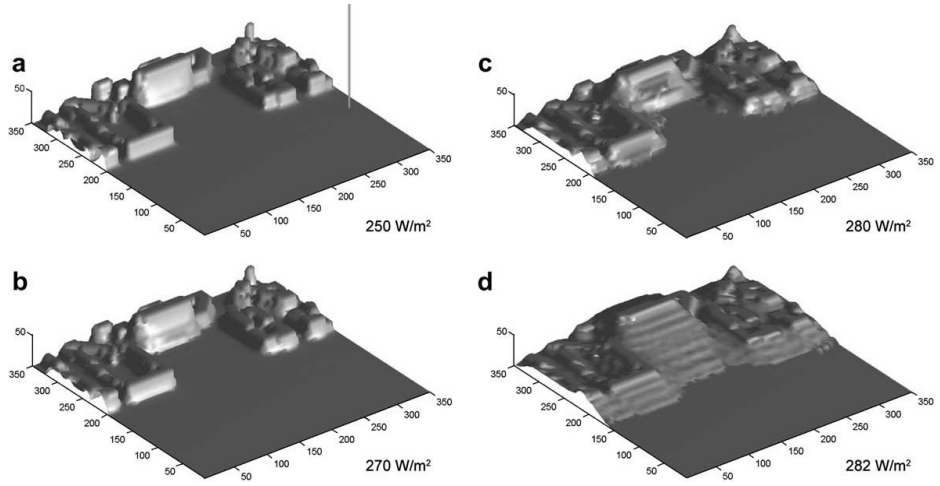


Figure 6: Raster models of urban textures and the changing energy consumption. (Morello & Ratti, 2009, p. 91)

A study done by (Morello & Ratti, 2009) further examined the effects of urban texture on building energy consumption. It was based on the analysis of DEM's – raster models of cities. With due acknowledgement of "finiteness of global resources" and the need of energy conservation strategies for success of environmental agendas, this study was focused on identifying parameters through which building – domestic or non-domestic – energy consumption could be curtailed. They argued that building "designers" overlook the impacts of the building energy usage on an urban scale. Four factors were shown to be impacting the building energy performance: Urban geometry, Building design, Systems efficiency, and Occupant behavior Ratti et al. (2005, pp. 769-770).

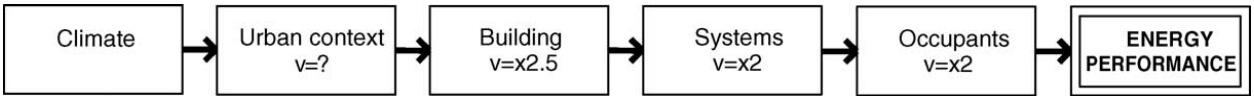


Figure 7 above: Baker and Steemer model, showing the sequential relationship leading to energy efficiency. (Ratti et al., 2005, p. 763)

The authors found urban geometry and building design to be impacted by availability of sunlight and daylight, overshadowing in buildings. There exist key relationships between urban texture, energy consumption and efficient solar gain in buildings, along with addressing the key challenges associated with using this relationship in improving energy consumption in cities and buildings (Baker, 2000, pp. 101-102).

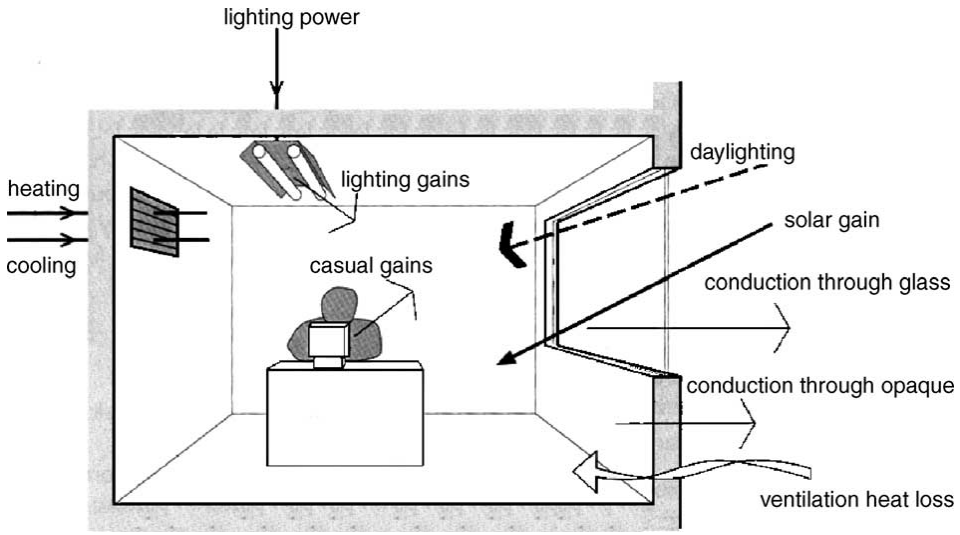


Figure 8 above: Energy flows considered by LT Model, extending the model of (Ratti, Baker, & Steemers, 2005, p. 770)

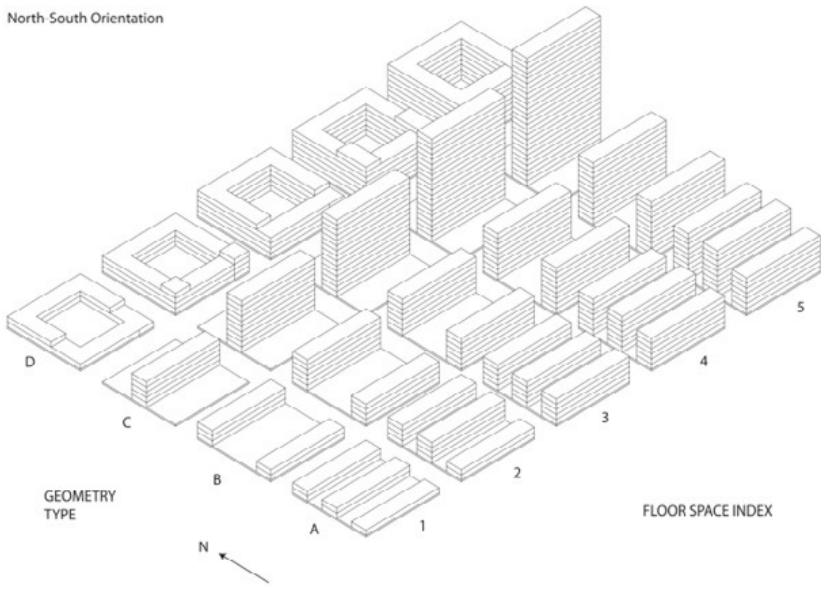
The authors concluded the study by proposing an integrated "Lighting and Thermal (LT) Model". It was developed to assist designers to determine how the energy consumption of a building might relate to the early architectural parameters. This model predicts the annual

heating, lighting, ventilating and cooling energy use/m2 based on the simulation of a 9 m X 6 m X 3 m module with one exposed glazed wall. Along with the relationship between building energy consumption and urban geometry, this study found significant impacts of occupant behavior and systems efficiency on urban geometry. While the authors engage in exploring the interaction between physical attributes of urban layout, building energy consumption and occupant behavior, the study lacked a more expansive understanding of other contextual factors such as the political, economic structures that impact the energy consumption and urban microclimate (Ratti et al., 2005, pp. 774-775).

Similar emphasis on integration of solar energy as a design parameter in urban planning was advocated by (Ratti et al., 2005). With the backdrop of EU's guidelines for constructing nearly zero energy buildings that depend on locally produced energy by 2020 for its member states, also known as "Zero Energy Buildings" (ZEB), the authors highlighted common obstacles faced by urban planners in accounting for solar energy and its impact for the overall energy consumption of cities. Urban energy consumption is seeing an upward growth, with heavy impacts on climate change. The authors also mentioned that while cities face the problem of inaccessibility of renewable energy sources like wind and solar, utilizing solar radiation in urban areas, through careful consideration of site orientation and passive strategies, could lead to energy saving by about 20-50%. This would also require integrated spatial planning in cities. Other authors have also argued for careful site layout, placement and the orientation of buildings in cities in order to maximize solar gains and minimizing energy consumption in buildings in cities (Kanters & Horvat, 2012, pp. 1144-1147).

While energy savings are a great incentive for promotion of passive solar design of buildings in cities, it poses several problems for dense cities. Along with lack of access to renewable energy

sources, urban planners are not technically advanced to quantify the solar potential of the urban region during the building design process. The study of (Littlefair, 1998, pp. 316-320), aimed at integrating the solar potential analysis in the early stages of building design process, when creation of a passive solar design would be an attractive option for the architects. Parametric analysis of four urban blocks, with variations in form, density, orientation and environment were simulated with EcoTect and displayed the difference in energy consumption. Due to lack of transparency in calculation methods of EcoTect and reported possibility of errors, the authors conducted a comparative analysis with DIVA. It is a radiance-based simulation programme, which works with Rhinoceros. The authors strongly encouraged comparative calculations of solar performance and potential. In the end they demonstrated how urban planners could evaluate the impacts of solar gain in buildings of their cities. See images below for more explanation.



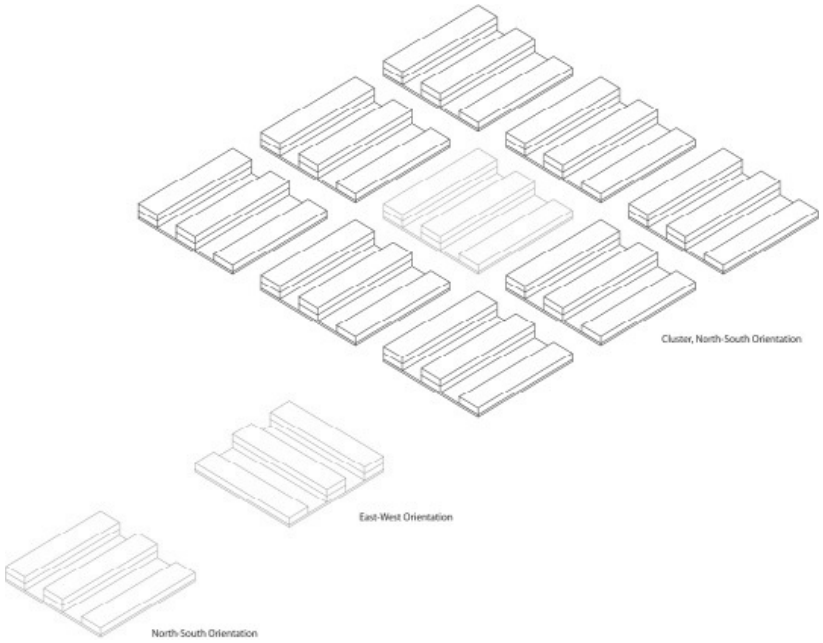


Figure 9 and 10, above two images: overview of geometry in North-south orientation, overview of changes of direction and environment (Ratti et al., 2005)

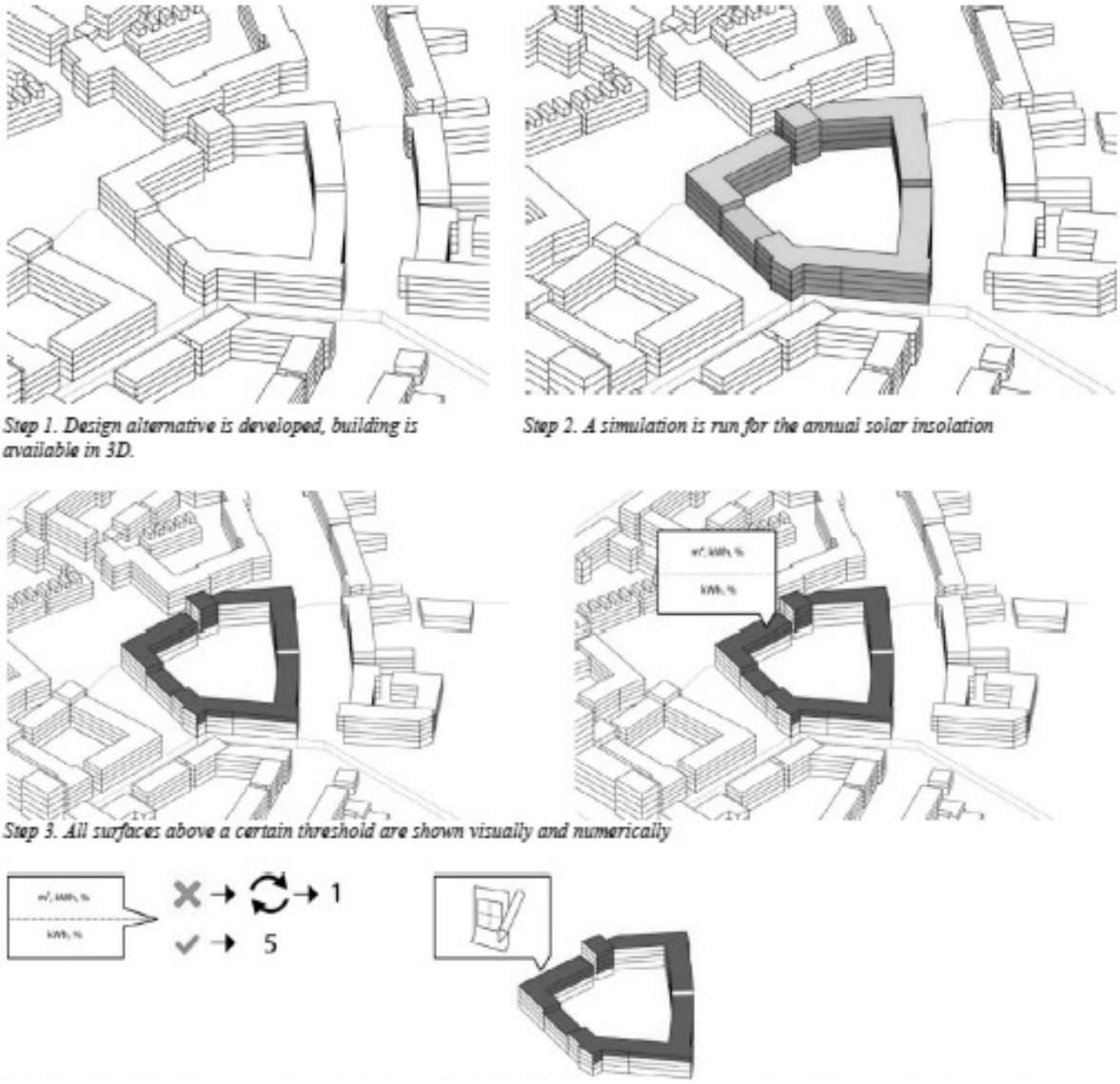


Figure 11,above: Visualization of a possible working method for urban planning; Step 1 to 5, in clockwise direction (Kanters & Horvat, 2012, p. 1150).

Step by step methodology was proposed in Kanters and Horvat (2012, pp. 1149-1151) for solar analysis urban planners. First step was development of a design alternative and creating a 3D model of the building. The second step was running the simulation for the annual solar insolation. Third step showed all surfaces above a certain threshold, both visually and

numerically. The last steps included forwarding information to architects, if the results obtained from simulation analysis fell within the limits decided by the urban planners. While this study, and several others aimed at making the process of solar access and energy analysis more process friendly, and easy to understand, there remains a key gap in analyzing how various stakeholders – building owners, businesses and municipal other important stakeholder groups might interpret the implementation of solar energy based urban planning. The present study only considered two stakeholder groups – architects and urban planners. In order to make cities more environmentally sustainable and less fossil fuel energy dependent, it would be critical to understand the interests and problems that other stakeholder groups face.

Authors Paul Kanters and Horvat (2012, pp. 1145-1152) also presented the key requirements and achievements from detailed consideration of site layout of buildings. They advocated that site layout has a big impact on the passive solar heating of buildings – that are built around tall obstructions and face blockages in incoming light and solar heat. His study examined criteria and techniques that could be used to evaluate solar access in dense urban layouts, as the existing studies did not provide adequate information for dense urban cities. The primary aim of the research project was to improvise the quantification techniques used for estimating the solar gains in building design, and overall impact on the urban context. More precise ways of finding information would help architects and urban planners in making better decisions. The study used an energy impact analysis done by NBA Tectonics in low and medium density housing UK housing estates to demonstrate their hypothesis. While previous studies used rural and suburban sites for such analysis, the author argued that for future success of passive solar design of buildings, studies must incorporate analysis of dense urban contexts. Potential analysis tools ranged from simple angular measurements, angular zones, sunlight availability and solar gain

diagrams, shadowing studies, to the use of computer programmes to evaluate solar heat gain. The study also considers the effect of having solar access based legislations, as existing in United States. Solar access brings with it certain problems. On one hand, existing building owners depend on solar access for effective operation of their buildings. Blocking sunlight would result in monetary losses, and other kinds of losses in reduced capital value. Comfort and amenity would also be lost with blockage in solar access. Adjoining neighbors would also have additional restrictions in developing their sites. The author also questioned whether solar access should only be applied to passive solar buildings, and argues that it is difficult to apply protection of solar access solely to solar buildings. He proposes that a simple solution is to apply it all buildings that make some use of solar gain, with options ranging from - national building regulations, local planning laws, and private legal agreements. In United States, and most other parts of the world the work on protecting solar access appears to aim at protecting active solar collectors. Implementing building height restrictions could be a challenge for planning authorities in terms of verification and oddly shaped sites might be additionally complex. Solar envelope method would be especially stringent for latitudes far from equator and on densely populated urban sites. The study advocates consideration of context, instead of only considering only the sun's position.

Other studies have also used the example of the City of Colorado, Boulder's "Solar Fencing" method Littlefair (1998, pp. 318-322). The fence is an imaginary fence placed around the site of the new building. The new building is not allowed to cast a shadow over the solar fence ta critical times – which are 10:00, 12:00 and 14:00 hours on December 21. A similar solar ordinance from New Mexico, Los Alamos, where the solar fence is as high as 12 feet was studied. The author (Tabb, 1984, pp. 77-79) concluded that such restrictions would be very

problematic due to high restrictions on adjoining development and conclude that – "it is unlikely that this zoning technique would be applicable to districts other than single family detached or low rise attached housing". High latitudes would bring even higher restrictions. The study, Jaffe (1979, pp. 24-25), further analyses the above examples and concludes that both the examples of Colorado and New Mexico lay in south west US and solar access planning is relatively easy to implement there. Littlefair mentioned the following reasons for the ease of solar access planning – relatively low latitude and hence easy to ensure winter solar access; availability of more land and hence spaced out buildings; thirdly, regular rectilinear plot structure.

Passive solar building design is a kind of bio-climatic design. Studies have been done to demonstrate how within the same country presence of a variety of climatic conditions can require diverse building design guidelines Littlefair (1998, pp. 307-308). The author, Edna Shaviv, used example of Israel and the four different types of climatic zones present in Israel, namely – the coastal plain, the lower inland, the mountain, and the Jordan valley zones. Each zone requires differently adjusted solutions for constructing passive solar buildings. The author based the study on relationship between building form, climate and building performance, and that study of this relationship is required in the early stages of building design. Envisioning building performance and the benefits of solar energy for the building requires the designers and architects to have adequate knowledge about the form-performance relation, and the ability to visualize the outcomes of this relation. Computer aided design and simulation tools have been found to be of extreme importance in creation of passive solar buildings that assist in energy savings for the larger urban context, as well as for the occupants and owners of the buildings. While some studies examined calculations for solar gains on individual building level, whereas others took the parametric and integrated approach on an urban level (Shaviv, 1999, pp. 192-195).

In a Hong Kong based research study that examined the preferences of residents, in a high density sub-tropical region, for solar access, based its objectives on the implications that sunlight has on human health, comfort and daily living. The authors defined solar access as the ability of a living unit to continue to receive sunlight without obstruction from any other property or structures. In subtropical high-density areas like Hong Kong, guidelines and policies for ensuring solar access in residences is generally missing. This study found the resident's preferences for sunlight – time, amount, place and purpose – as well as an exploratory factor analysis that explored the impact of environmental factors on the choices indicated by the residents (A.L. Martins et al., 2014; Alzoubi & Alshboul, 2010; Amado & Poggi, 2012, 2014a, 2014b; Arboit, Diblasi, Fernández Llano, & de Rosa, 2008).

Sunlight is an important component of household lighting. From a human dimensions perspectives, studies have shown positive and healing impacts of sunlight on maintenance of health, Vitamin D levels in human bodies, prevention of wide variety of diseases, psychological impacts and other benefits for senior citizens (Lau, Ng, & He, 2011, pp. 1881-1884).

Provision of sunlight, combined with sustainable building design impacts the heating, cooling, illumination and operation of buildings. Moreover, research has also investigated into the variation of attitudes that are brought by sunlight, across different types of climates available in the world (Durvasula et al., 2010, p. 13; Lau et al., 2011, p. 1889; Leung, Cheung, & Chi, 2015, pp. 135-136). Building occupants in hotter countries would want to exclude sunlight and control it in order to prevent overheating. Whereas residents in colder climates would prefer having sunlight in order to replace any need for external heating devices in their spaces. They would

consider sunlight "pleasure rather than a nuisance" (Littlefair, 1998, p. 325)[6]. The need for sunlight also varies with type of activity performed by the building occupants and users. Exposure to sunlight is also of cultural and religious value in some Southeast Asian cultures.

The authors in (Lau et al., 2011, p. 1879) specifically noted the difficulty in providing sunlight in high density living environments of Hong Kong. Availability of sunlight brings with it seasonal variation. The authors argued that understanding the desirable amount of sunlight for residents is remains an important factor and must be considered in policies related to solar access in residential buildings. The objective of the authors was to incorporate the subjective analysis of the resident's attitude towards solar access in their households, along with objective analysis accomplished by several other studies, to quantify adequate amount of solar access in house holds. The authors used public rental housing estates in Hong Kong as case study. For the advantages of sunlight, five advantages were identified by about 80% of the respondents in the study, namely drying clothes, better health, sanitization, and dehumidifying and better illumination. Additionally, exploratory factor analysis was conducted for identifying the influence of environmental parameters on resident's preference for solar access.

Other studies also analyzed the sustainable energy challenge emerging due to fast-paced urbanization in developing countries. Lau et al. (2011, p. 1890) pointed out the crucial role of urban morphology in creation of climate adapted urban environments. The Brazilian city of Maceio is used for case study research. Five urban typical configurations are identified through energy-related morphological parameters. They are evaluated for their envelope solar potential for energy production, daylight availability and potential solar gain. Urban buildings account for a large part of energy demand of urban areas. In Brazil, 47% of urban energy consumption goes

into operation of buildings. The study explained the relationship between urban morphology and energy consumption in tropical climate of Brazil. Urban morphology was defined as the particular shape and dimensions of the built environment and with the aggregations and configurations of building types. This study addresses the effects of urban morphology on solar radiation potential and control – along with exploring a new energy paradigm relying on decentralized renewable energy production in cities. The authors further explore the adaptation of existing building stock of the city into "positive energy" neighborhoods, by altering urban morphology features, such as the building density, geometry and implantation of buildings. The picture below represents Maceio city of Brazil. This city as many others has experienced rapid and intensive urban growth. The growth pattern has remained without "effective control" on environmental and infrastructural concerns. Such urban growth has modified the local urban climate greatly – impacting the thermal comfort conditions as well as building energy demands. Maceio city has tried to direct its urban growth through its urban building regulation established in 1989 and reviewed in 2007. This regulation takes into account a variety of building parameters like building set backs, plot ratio and floor area ratio, and other land use matters. The figure below represents the five different types of urban morphologies studied by the authors.

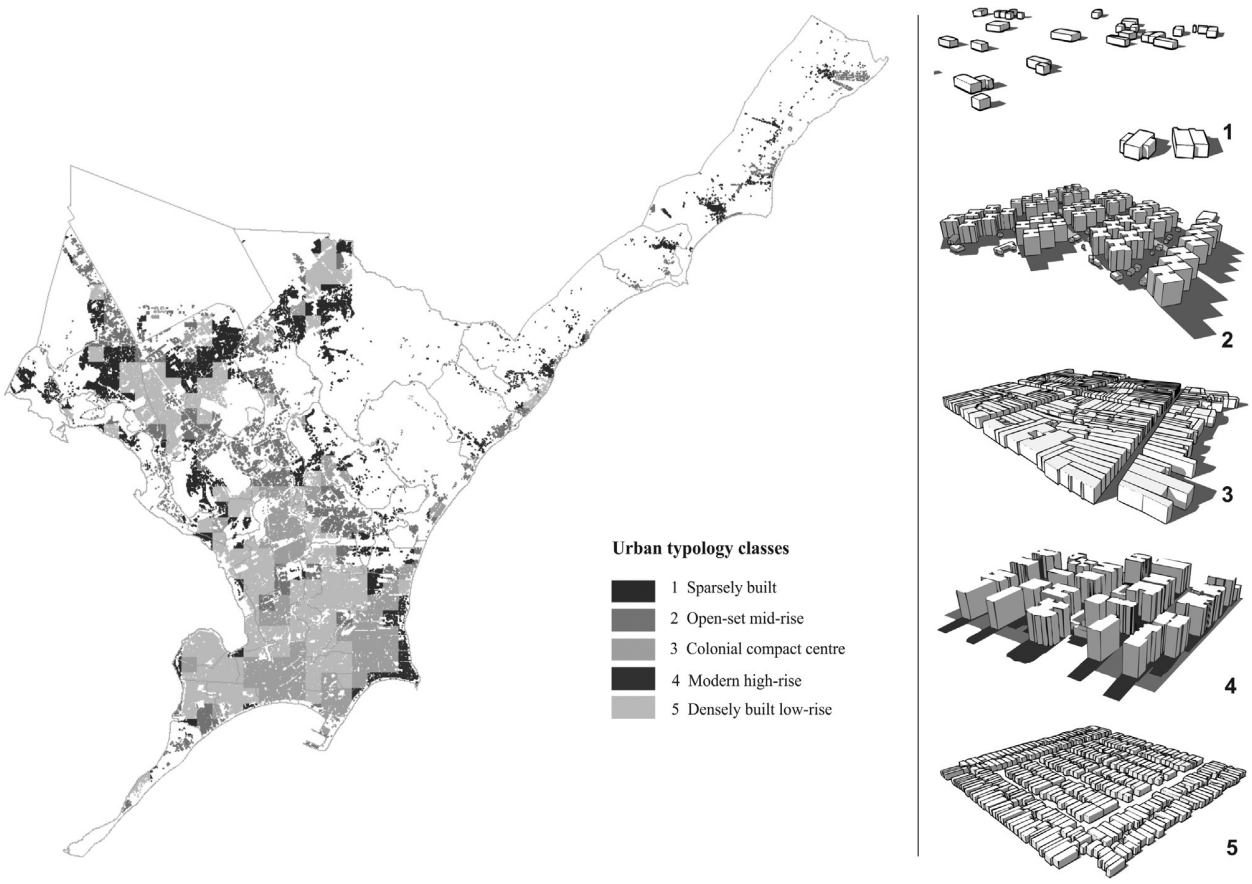


Figure 12, above: Representing the five different types of urban morphologies studied in (A.L. Martins et al., 2014, p. 49)

Other studies have also considered the value of photovoltaic cells for reducing the energy consumption of cities. Authors such as Byrd et al. have argued for using rooftop photovoltaic cells as an active means of converting solar radiation into usable solar energy. The study calculates the maximum potential energy that can be generated through efficiently installing PV systems on buildings throughout the city – from central business district to low density suburbs. The objective of this calculation is to evaluate the contribution from solar energy towards the energy needs of the city A.L. Martins et al. (2014, pp. 44-48). The analysis conducted in this

study showed that the low-density suburbia remains not only the most efficient collector of solar energy, along with their electricity generation capacity – enough to fulfill the energy needs of local suburban transportation and contributing to the day time peak electricity needs in the city center. City of Auckland in New Zealand is used as a case study. Areas of study spread from central business district (CBD) to low-density suburbs as shown in the picture below.

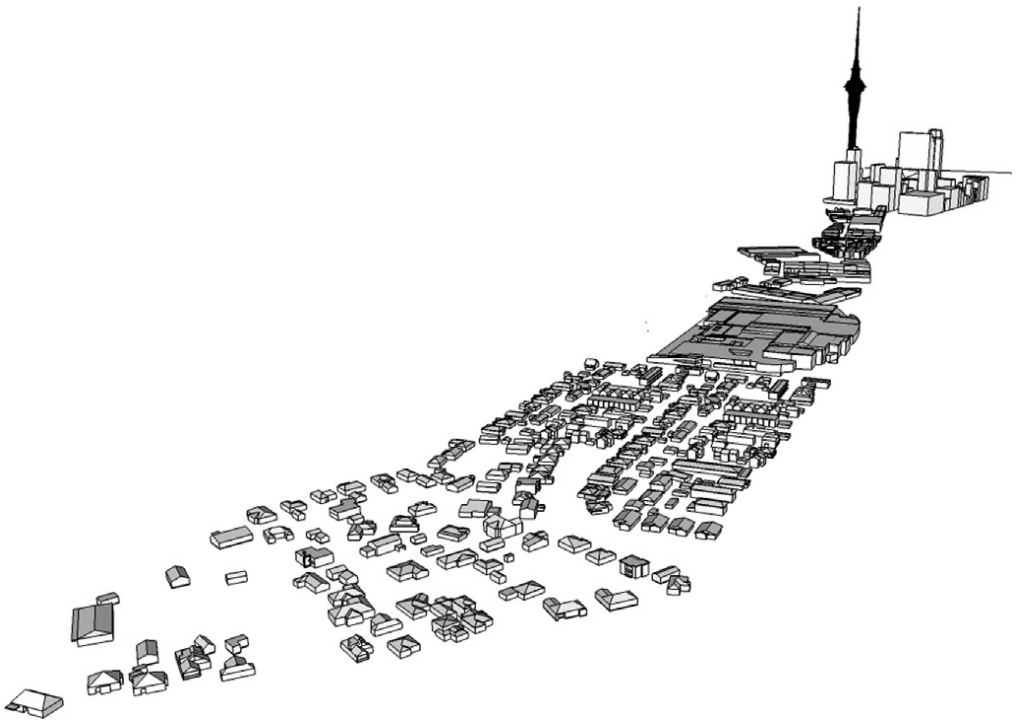


Figure 13, above: Different densities considered for evaluation of effects on PV potential due to density. A.L. Martins, Adolphe, and E.G. Bastos (2014)

The authors found Auckland as a peculiar example for several reasons – car dependency, dispersed urban form and dependency on imported oil. About half of New Zealand's energy consumption is imported oil, and hence utilizing solar energy makes for an attractive option. Future energy policies in this country would be a more effective if due consideration is given to

the evaluation solar gains through PV collectors, as shown by the authors in this study. More over, the solar potential investigated by this study further shows the areas that can feed back surplus energy into the grid, as shown by the figure below. Integration of energy policies with urban policies is found to be of significant importance for utilizing a renewable source of energy, sunlight, for energy demands of the city and its building stock (Byrd et al., 2013, pp. 949-952) (Bahadori & Nwaoha, 2013) (Miller, Buys, & Bell, 2012) (Dowling, McGuirk, & Bulkeley, 2014).

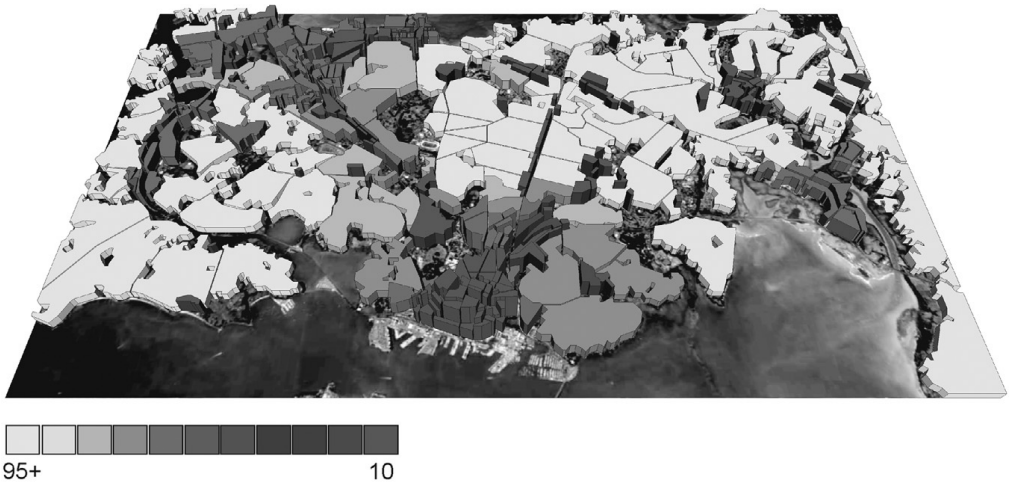


Figure 14, above: Solar energy generation potential (kWh/m2 floor area/year)
(Byrd, Ho, Sharp, & Kumar-Nair, 2013, p. 950)

Section 2.7: Solar access - from an ethical standpoint

Mere energy efficient building based on solar envelope is an incomplete consideration. Constructing a building with a design conscious to solar access, "ought to" guarantee solar access of the neighbors. Knowles mentioned that every action has an actor and a person who is affected; in the case of solar access, it is between one building owner and his/her neighbor. Moral grounds must be tested, between these two parties to ensure equity and preservation of benefits for both actor and the affected, evenhandedly. In other words, solar access can always be understood from two different perspectives. Regulatory policy instruments have to bear in mind both perspectives. While permit, covenant and easement approaches restrict our neighbor's action, solar envelope limits our actions. However, "solar envelope zoning", can bring the benefit of same effect on both, the actor and the affected, since zoning applies evenly over a piece of land. Knowles advocated solar envelope zoning as the most promising way of guaranteeing solar access in a neighborhood.

Section 2.8: Solar access – from a legal standpoint

In legal terms, guarantee of solar access requires changes and more clarifications in existing laws. Legal precedents[7] play an important role in assisting new laws and modifications in them. One of the most important precedents for cases of solar access is that of English Doctrine of Ancient Lights[8]. It has been researched and studied extensively by William Thomas. Some other authors such as Mary R. White, a writer from Colorado Law Review, advocated the usefulness of "Water Law" as a potential precedent. The analogy between solar access law and water law was seen in two ways. Firstly, both resources, water and sunlight, are used, rather than sold and

[7] A case or issue decided by a court that can be used to help answer future legal questions. Definition sourced from http://www.law.cornell.edu/wex/precedent

[8] Knowles refers to this doctrine as a precedent outside of United States.

captured. Secondly, both may be consumed, but both are renewable. White also saw, the changing nature of utility from water, given the upstream and downstream nature of streams, and the "geometry of solar shadow" as similar and thus comparable. The doctrine of prior appropriation[9] - "he who gets there first, gets the most." For water-based resources, was also recommended as an important lead for developing solar laws. However, the probability of conflicts from this appropriation and its ethical basis remains contestable. The other water law mentioned by White is the Riparian doctrine[10] – where everybody has an equal share. Knowles advocates the arguments of legal experts like Gail Boyer Hayes, who pointed out that it is the local administration and the rules formulated by them that can greatly affect the sunlight allocation and also implement the zoning approaches. Local zoning was argued as the legal foundation for solar envelope.

Historically[11], right for solar access have been relevant. Several cities like Olynthus, Priene & Delos, in ancient Greece and Rome were planned as per the concept of solar architecture. Given the valuable role of interaction between buildings and solar exposure, and the potential disputes that could arise from the economic and social benefits of solar access, the Romans were the first to set down laws to regulate sun rights. However, it is noteworthy to mention that unlike the democratic & egalitarian approach of Greek solar architecture in 2nd century AD, the Roman adjudication functioned as per the socioeconomic status and class.

[9] In dealing with water rights, the prior appropriation doctrine states that water rights are determined by priority of beneficial use. This means that the first person to use water or divert water for a beneficial use or purpose can acquire individual rights to the water. Definition sourced from: http://www.law.cornell.edu/wex/prior_appropriation_doctrine

[10] In dealing with water rights, the riparian doctrine states that water belongs to the person whose land borders a body of water. Riparian owners are permitted to make reasonable use of this water provided it does not unreasonably interfere with the reasonable use of this water by others with riparian rights. Definition sourced from: http://www.law.cornell.edu/wex/riparian_doctrine

[11] Paragraph borrowed from the text of Term paper proposal for NTRES 6310, submitted on 17th September 2014.

In order to successfully implement solar access in urban development context, solar access must be understood as a strategy beyond legal and ethical issues. It must work in response to existing land use and other related regulations. It would also be critical for the success of the solar access regulations to study the existing behaviors, social capital, social constructs and other characteristics of the associated institution as a concept like solar envelope and solar access that restricts the typical property rights of land owners, brings with it high probability of negative reactions from the citizens of the chosen region.

Section 2.9: Solar envelope through zoning

Ralph Knowles argued for ensuring solar access through local zoning and presented two advantages through it. Firstly, zoning is a form of local governance. Being a local governance scheme enables it to incorporate the immediate local needs of the surrounding environment. Consideration for local conditions is very important as an envelope is created on a piece of land, in response to local conditions such as weather conditions, topography, needs of the biosphere, and other requirements of the physical ecology and society. Secondly, solar zoning can be implemented through changes in the current "hard" guidelines for building height, bulk and setbacks. Given that zoning is based on height and bulk restrictions, it would be convenient to extend the existing restrictions for solar access. As per Knowles the envelope restrictions would potentially simplify the zoning processes.

"Zoning prescribes developable space by specifying the envelope" – local zoning ordinances mandate the height and setbacks. Further, the land use pattern and conventional land use activities of the region define the setbacks. Commonly, as densities and land coverage increase, setbacks tend to decrease. For instance, higher density commercial land may not require setbacks

on all sides of the property, as opposed to setback requirements of a single-family house. Modern zoning has two ways of specifying the height of the envelope of the developable area – through fixed height and unlimited height districts. The latter option contains some ambiguity and could be misleadingly interpreted as "no limits" height zone. However, the limits of development over a piece of land are determined through the floor area ratios[12] (FAR). This provides the developer with some flexibility to alter the form of the building within the limits of the FAR.

Zoning has typically focused on development and seldom has it taken into consideration the issue of solar access. The encouragement for development, as seen in United States, has correlated the land values and Floor Area Ratios. Land values have become a function of "development opportunities", with least attention to local climate or solar access. Knowles argued that unlike the usual zoning and limits imposed, solar envelope's volumetric limits are a "construct of space and time" and ply through two premises. To begin with they limit on-site building heights and thus prevent unacceptable shadows to be casted by any building. Empirically, small constructions do not disturb neighboring properties with excess shadows, but large-scale (and market based) constructions that demand large developable volume do come with high probability of overshadowing the neighbors. Such developments include shopping centers, schools and educational institutions, and office buildings. Time constraints form the second premise. For success of solar envelope, the developable volume has to confine within specified times – such that no shadows are cast during certain specified times of the day. These times are called cut-off times. The envelope volume must not cast any shadows during the cut-off times.

[12] The floor area ratio is a computation determined by dividing the total gross building floor area (square feet) by the land area of the lot. Definition sourced from: http://qcode.us/codes/napa/view.php?topic=17-17_52-17_52_120

Given the heterogeneity and diversity of the needs of urban layouts, it is essential for solar access to have more than one form of planning regulation to provide for the variety. Knowles presented three levels at which solar envelope and growth regulation can be addressed for which he discussed three levels of planning strategies based on – order, structure and system – the framework for community development (Moore, Horne, & Morrissey, 2014, pp. 30-33).

1. The first or minimum level of regulation occurs when the region has uniform housing sites and subdivisions; envelopes vary only in shapes and sizes, and solar envelope is regulated through the periods of solar access. This level is relatively simple.

2. The second or moderate level of regulations takes place with more complex and heterogeneous conditions – the envelope's boundaries vary around the perimeter. The complexity associated with this regulation provides for the changing and dynamic surroundings of the chosen region. It can also be understood as a "self-regulating control" that establishes itself with changes in surrounding landscape. An example could be, older parts of a city that contain a variety of sites, existing buildings and land use activities – from past and for future growth. This regulation assists more complex urban scenarios that require different spatial treatments and cut off times.

3. The most complex level of regulation comes with the third tier of regulation, along with the highest level of control. Such regulation works when projects involve large landscapes that are dynamic and highly heterogeneous. The solar access regulation in this case has to match up to a large variety of external and internal conditions of urban areas. Instead of individual building, these regulations deal with collection of buildings. Such regulation is most relevant for large-scale urban sites that have a variety of land uses. A

commonly found example would be of redevelopment site that can have potential changes to the surrounding and the land use activities around it. The gradation in the complexity can be seen from simpler envelopes to increasingly complex ones, are responsive to the variety of diversity and need for greater control for each case.

Section 2.10: Solar access legislation

Infrastructure relying on solar energy and sunlight for operation requires direct access to sunlight that helps them to function passively. Several state and local governance institutions around the world have instituted laws to protect the rights of the stakeholders who use sun light and warmth for their built structures such as residences, and commercial spaces. Legal academicians have argued that sunlight may be thought of as a part of the property, that it strikes. They have also argued that the distinction between sunlight as a part of the property and a resource is ambiguous (Knowles, 1981, pp. 28-29).

Others have also sought inspiration from historical forms of solar access. For the last 2000 years, man has utilized solar energy for comfort, heat and warmth and designed such buildings with access to the required sunshine[13]. The Greeks built passive solar homes as early as 500 B.C. Similar knowledge in building construction techniques was found in roman culture as well, which also recognized the need for a legal right to sunshine (Flavin & Lenssen, 1993, pp. 212-213). The field of solar access legislation recognizes "the English doctrine of ancient lights" as one of the most important legal institution in the history of this field of study. 'Ancient Lights' is a doctrine based on English law that refers to a negative easement that prevents the owner and occupier of an adjoining building from constructing or placing on his land anything that has the

[13] 22 Nat. Resources J. 21 (1982) Access to Solar Energy: The Problem and Its Current Status; Eisenstadt, Melvin M.

effect of obstructing the light of the dominant tenement. This law also included the prescription act of 1832 that created a statutory prescription for light.

It mandated that,

> "When the access and use of light to and for (any building) shall have been actually enjoyed therewith for the full period of 20 years without interruption, the right thereto shall be deemed absolute and indefeasible, any local usage or custom to the contrary notwithstanding, unless it shall appear that the same was enjoyed by some consent or agreement, expressly made or given for that purpose by dead or writing."

Solar access issue can be divided into two distinct areas: solar easements and solar rights. Solar easements have been defined as "the ability of one property to continue to receive sunlight across property lines without obstruction from another's property (buildings, foliage, or other impediment)." Solar rights can be defined as "the ability to install solar energy systems or residential and commercial property that is subject to private restrictions, i.e. covenants, conditions, restrictions, bylaws, condominium declarations, as well as local governments ordinances and building codes."

Land use planning has also been found to be an effective local and municipal strategy to ensure solar access[14]. Local governments have the potential to adopt solar-access policies within the framework of the local land use plans. They can create public policies that recognize the benefits of solar energy and support implementation of solar access in buildings. Incorporating requirements for solar-site analysis planning in land use planning also guides the developers, on

[14] 50 Nat. Resources J. 211 (2010) Has the Sun Set on Solar Rights - Examining the Practicality of the Solar Rights Act; Stromberg, Scott F.

how to maximize utilization of sunlight in their built structures. Besides, it also specifies the placement of neighboring structures like trees, vegetation and other taller buildings, such that none shadows the other neighboring structures.

Development of solar access legislation can be best supported by analysis of legal precedents in this field. The earliest developments in the legal protection of solar access were seen in the United States. Academics and knowledge banks advocated the issue of solar access. Institutes and foundations such as Solar Energy Research Institute, the American Bar Foundation and the environmental law institute are few examples of the knowledge banks that propelled the matter of solar access legislation. The momentum created by these led to the adoption of solar access laws by several state legislatures. Twenty-four states of the US were seen adopting solar easements as the resolution to the issues arising from shadowing and other blockages to a building owner's access to sun. Several exemplars of solar access laws exist. It would be important to note that these solar access laws are not motivated solely by passive design and architecture that relies on renewable sources of energy, such as solar insolation, rather their aim is to encourage operation and maintenance of built structures through solar photovoltaic cells and panels.

Some legal experts also noted that that easements and restrictive covenants have been increasingly in recent years as an attempt guarantee solar access. Recognition of the legal validity of the solar easements, however, will not completely eradicate the problem of solar access[15]. Some of the reasons discussed for this were – need for negotiating easement and covenants on individual basis, with the negotiation having possible requirement for legal

[15] 30 J. Energy & Nat. Resources L. 511 (2012) Sustainable Energy Law: The Past and the Future; Bradbrook, Adrian J.

assistance, and danger that neighbors might ask for inflated and unrealistic price for agreement for the easement and covenant.

Section 2.11: Framing solar access as planning law

Another important issue brought up through studies in solar access legislation has been that – "solar access should be a question of planning law, not property law. Planning law considers solar access through zoning regulations, whereby every property has to adhere to height and setback restrictions. Zoning ordinances result in uniform restrictions across a region and vests power with the local councils as opposed to state based property laws. Property law functions when there is a nuisance for a private property owner, such as in the case of shadowing the solar PV panels of a property owner. Solar access legislation in United States is based on property law, whereas solar access legislation in Australia is based on planning law (Butti, 1980). Arguments conveyed that altering exiting planning laws than relying on property law principles could provide better solar access protection. The reasons quoted were that local agencies are handed charge of controlling land development by the planning law; and also that property law is looked over by the state governments, without much say of local government participation. Secondly, solar access issues can be resolved by planning issues like building features like building height, setback requirements, block sizes and orientation and orientation of streets. Solar access protection process would be very difficult to achieve if these planning issues are not taken into consideration in the associated legal processes.

Legal experts have also evaluated several forms of local solar access controls. These include solar access permits and registration, that was enacted by Claremont, California in 1980, solar envelope system developed by Ralph Knowles in 1970's, that is known to be the basis of

Wisconsin's Solar Access Act of 1981, as well as hypothetical solar fences that was used in the city of Boulder, Colorado in 1982. The evaluation results of legal experts showed that these local solar access control mechanisms suffered from problems like costly and time consuming bureaucracy, and complexity for layman understanding. The system of hypothetical solar fences was found to be the most suitable from amongst the discussed solar access control forms – with few drawbacks like inapplicability in high-rise and inner city areas. Some of the future recommendations for solar access laws included evaluating cost effectiveness of restrictions that protect solar access, recognition of solar access laws as integral part of energy conservation legislation, linking solar access controls to siting requirements in planning legislation, addressing the issue of compensating the burdened landowners, linking solar access protection with wind access, amongst several others.

Part 3: Survey of significant legislations and policy schemes for solar access

Section 3.1: United States

Some exemplars[16] of solar access controls can be seen in the United States in the State of Florida, Hawaii, Massachusetts, New Jersey, New Mexico, Oregon, Virginia Islands, California, Colorado, Wisconsin and some others. The city of Gainesville of Florida allows the removal of regulated or protected trees, where they prevent the installation of solar energy equipment. The State of Hawaii, provides a comprehensive list of instruments that are affected and declares that no person shall be prevented by anyone from installing a solar energy device on any single family residential dwelling or townhouse that the person owns, making all kinds of provisions in

[16] All examples sourced from: http://www.dsireusa.org/solar/solarpolicyguide/?id=19

lease, or contract to support the installation and successful operation of solar energy installation. The state legislature also encourages the community to adopt such controls that assist in placement of solar collectors, and also mentions the risks and responsibilities involved when installing solar energy equipment on common property. The state of Massachusetts provides a system of solar access permit, along with solar easements, voids restrictions against use of solar energy, and provides guidelines for solar access in subdivision regulation. The zoning ordinances of Massachusetts also give guidance for solar access and include regulations for planting and vegetative cover on public property to protect solar access for public and private solar energy systems. The solar permit process also lays out a process for hearing appeals and grievances of burdened landowners and also encourages for establishment of 'Solar Map' identifying all local properties burdened or benefitted by solar access permits. The State of New Jersey provides for enforcement of laws that prohibit deeds that oppose solar energy utilization, through the state's department of community affairs, such that all needs for expensive litigation are omitted. The State of New Mexico provides that a homeowner can record ownership of a solar energy system and allows the owner to establish a solar easement. The City of Ashland in Oregon State establishes a procedure for obtaining a solar access permit to protect a solar energy system from vegetation that could potentially shade the collector PVs. It also provides for recording the easement. The detailed ordinance provides a level of protection that a voluntary solar easement does not. The permit procurement processes are intensive, comprehensive and the aim to protect the interests of all parties involved (Reitze, 1976).

Section 3.2: Japanese *Nishhoken*[17]

The Japanese Solar rights scheme, called Nishhoken, for the right to access of sunlight is central to the Japanese ideology of a wholesome, healthful and esthetic lifestyle. The Japanese constitution supports this ideology by declaring, " All people shall have the right to maintain the minimum standards of wholesome and cultured living." Acting as a pillar of support for both culture and legal system, access to sunlight is, provided by a highly detailed and complex zoning and building construction code – the Building Standard Law. This law operates through creation of a "multi-level, restrictive zoning urban plan." Restrictive zoning has been practiced in other parts of the world as well and is not unique to Japanese urban planning system. The Japanese urban planning system is distinctive due to its zoning scheme that contains within itself the regulations for solar access. All real property sites are divided into eight "use zones" and each zone restricts the properties from engaging in certain usage type - from purely residential, to quasi commercial to quasi industrial to purely industrial. Some specific sites require prior approval from the city for construction, such as slaughterhouse and crematorium, etc.

Fundamentally, the law for solar access aims to control the building height, area and the percentage of site that it occupies. The zone and lot determine the floor area consumed by the building above the area of the land. This is a form of "horizontal zoning" and its stringency ensures adequate distances between buildings for light and ventilation, by the regulation of the site perimeter surrounding a building or structure. Another extension of the zoning process is the "circumscription" of the height of the buildings and structures within each use zone. The remaining seven zones mandate the building height by multiplying the distance from the building to the nearest neighbor's boundary line by a certain numerical figure (the numerical figure is

[17] 4 Brook. J. Int'l L. 221 1977 – 1978

decided as per the zone the building is situated in). The most significant aspect of the law is the restriction for the building height in accordance with the number of hours a day the building is found to cast shadow. Some decisions in this law and associated processes are taken by the local commissioner – he/she is empowered to set the length of hours when the building will be allowed to cast shadow (the building developers/owners will have to keep these hours in consideration to calculate the height of the building). Exemptions are only allowed in cases where there is no way for the building to damage the surrounding built environment or the building is situated adjacent to road, sea or river. This law can also be understood as a means for Japanese urban planning system to allow constant access to both air and light.

The Japanese regulatory system is a sophisticated grievance resolving mechanism. This is the second characteristic of Japanese regulatory system and provides help to the landowner deprived of sunlight. The process of grievance resolution comprises of a building official and a building review council, to which the appeal of the deprived landowner is forwarded by the building official. The ultimate authority still remains with the Building Standard Law. Violation of the decision taken by these decision-making authorities is met with monetary fines and imprisonment, if needed. The obstruction creating party can appeal for a judicial hearing, if they are not satisfied with the ruling of the review council. This appeal facility is provided under *Kokoku* – Appeal litigation law.

Conclusively, Japanese regulatory system provides immediate rights to light to each individual automatically and also provides for further contestation of the law and the consequences with the help of grievances resolution system. Legal experts describe the presence of solar access regulations in zoning as the a valuable characteristic – “Zoning envisages uniformity of

application." Unlike easements and nuisance laws[18], zoning can take into account external benefits of solar energy, such that protection of solar access is a collective effort of the society.

Section 3.3: Germany

In Germany, building an obstacle to harm others is considered an illegal act (Schukane rights, the Civil Law Clause 226) but, most general architectural buildings are not considered as an Immission (the Civil Law Clause 906) or against Schukane rights that disturbs view or sunshine from neighbors. The only possible legal protection to solar access rights is the state's Building Codes based on property rights. Each state's Building Codes have different requirements of distance or degrees of angle between neighbor's property lines and new construction. But these requirements were also established for rights of light not for direct sunlight. Solar access rights in Switzerland are similar with those of Germany. The damage to solar access from general building construction also is not considered an an Immission (the Civil Law Clause 684) and the only possible legal protection for solar access rights is the state's Building Codes for right to light.

Section 3.4: France

In France, the French Civil Code provides for a right to light indicating regulations against the property owner who seeks solar access over a neighbor's property such as minimum distance of his/her windows from neighbor's land or dwelling. The code has lack of utility as a solar access regulation because it is based on normal exercise of rights of ownership and does not represent any claim. The body of solar access law from the French Administration Code leaves the details of building construction and zoning measures at the Departmental level and allows

[18] A private nuisance is when the plaintiff's use and enjoyment of her land is interfered with substantially and unreasonably through a thing or activity. Definition sourced from: http://www.law.cornell.edu/wex/nuisance

recommendation of control is not practical (Cohan, 1978). In 1972, the highest court of France found shadow nuisance law to regulate the right to light.

In Ste' civ. Immob. Residence Washington c. Auzelic, the court held that the defendant's construction of a foul-leceel building in the center of the city of Hagen wrongly operated to deprive absolutely the plaintiff's villar of sunlight under a neighborhood nuisance rule (Cohan, 1978).

Section 3.5: Australia

Example of solar access legislation and planning can also be seen in Australia. Studies in the field of solar access legislation have noted that legal protection of solar access in Australia developed at a much slower speed in than in the United States, since Australia could remedy the problems created by 1973 oil embargo through increase in oil extraction from the Bass Strait fields (Bradbrook, 1988). Several states and knowledge banks together took action for protection of solar access late in the seventies. The law reform committee of South Australia produced the first official report recommending the introduction of solar access laws, in 1978. The New South Wales government incorporated the results of a study done by the Total Environment Centre. Several states also took help of leading academicians and legal experts to devise solar protection strategies for their states. The National Energy Research, Development and Demonstration Council (NERDDC) and the Victorian Solar Energy Council worked on a joint study authored by an eminent author in this field, Prof. Adrian J. Bradbrook. Multiple studies supported the formation of solar access protection. It would be critical to note that in the introductory phase of the adoption of solar access protection in Australia, no state legislature enacted solar access protection laws. Rather, several municipalities include solar access as a relevant consideration in

land development. The most progressive state in regard for solar access protection has been Victoria, which formed the Victorian Solar Energy Council under the Victorian Solar Energy Council Act of 1980. The purpose of establishing this body as a statutory wing was "to encourage and coordinate the general development of solar and solar –related energy resources within the state." Despite the listed efforts pertaining to solar access protection, legal experts have found that Australia's actions for this issue have been limited to local government level. Other problems and hindrances for establishing advanced solar access protection in Australia have also been mentioned – lack of awareness of alternatives to renewable sources of energy, financial costs of bringing such law into place, and other observed nuisances.

The Victoria state of Australia restricts building construction and other related features such as building height, setback, and number of dwelling through the policies laid out in the planning scheme of each city within this state. These mandates ensure solar access protection for individual building owners, as well as for spaces of public use. The Planning & Environment Act of 1986[19] is central to the functioning of Victoria's goals for sustainable environment and city planning strategies. Environmentally sustainable development, and Neighborhood character preservation are some other actions that are being taken extensively at the local government and city level. While the state government supports related initiatives led by the local government, the goals of state government often conflict with those of the local government. The State of Victoria also has a grievance appeal cell, called the "Victorian Civil and Administrative Tribunal[20] (VCAT)", where citizens of any of the Victorian city can file an appeal for issues about building & properties, residential tenancies, land valuation, planning and environment and other related concerns.

[19] Information about legislative acts in Victoria, Australia sourced from http://www.legislation.vic.gov.au
[20] Information about VCAT sourced from http://www.vcat.vic.gov.au/disputes

Part 4: The City of Boroondara

The City of Boroondara is a local government area, located in eastern inner suburbs of Melbourne, Victoria, Australia. It is located at a distance of 5-10 kilometers from the Central Business District (CBD) of Melbourne. The city was formed in 1994, upon amalgamation of three neighboring cities – Camberwell, Hawthorn and Kew. The area was originally belonged to the hunting grounds of a Wurundjeri clan of the Woiwurrung people. The first European settlers in the area were John Gardiner and his family. The same year Robert Hoddle, while surveying the area, declared it the "Parish of Boroondara". Given the densely wooded area, he named it Boroondara. In Woiwurrung language, the word translated as, "where the ground is thickly shaded".

Figure 15, above: Tree lined street in Camberwell, Boroondara. Picture source: Clicked by author.

The first local government body was the Boroondara District Road Board, formed in 1854 and included the areas which were to become Hawthorn, Kew and Camberwell (Bradbrook, 1988).

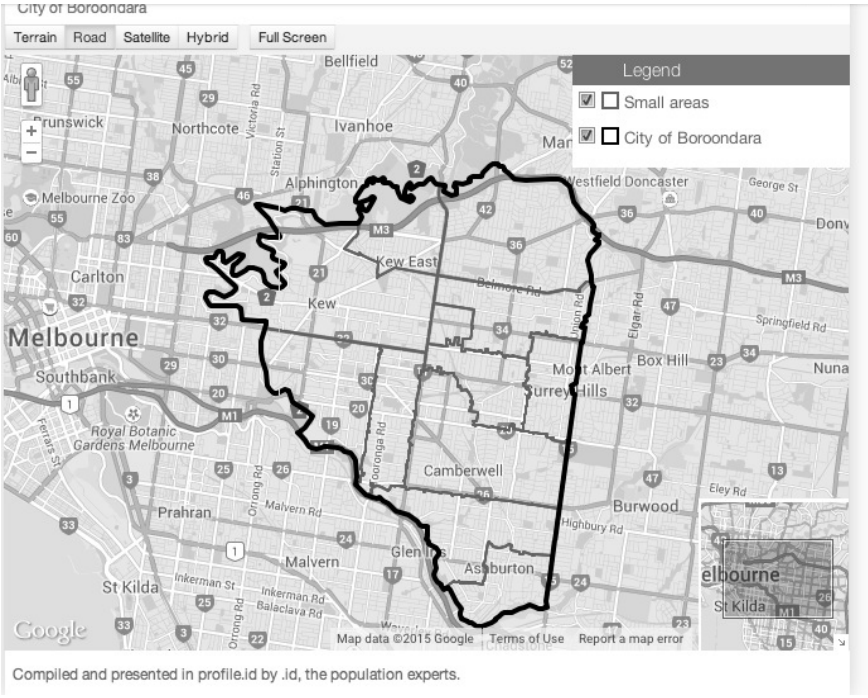


Figure 16: Map of the City of Boroondara, with various suburbs. Source: http://profile.id.com.au/boroondara

The City of Boroondara comprises of the following suburbs within it: Ashburton, Balwyn, Camberwell, Canterbury, Hawthorn, Hawthorn East, Kew, Kew East, North Balwyn, as well as Glen Iris, Mont Albert and Surrey Hills that are shared with neighboring councils. The Yarra River flows south of Boroondara and is surrounded by a region of think vegetation in that area. The[21] Estimated Resident Population for the City of Boroondara for 2014 is 172612, with a population density of 28.79 persons per hectare. The total land area of the city is 5996 hectares

[21] Facts on population, density and land area sought from http://profile.id.com.au/boroondara

(60km^2). The three largest ancestries[22] in the City of Boroondara in 2011 were English, Australian and Irish. 45,031 people[23] who were living in the City of Boroondara in 2011 were born overseas, and 26% arrived in Australia within 5 years prior to 2011.

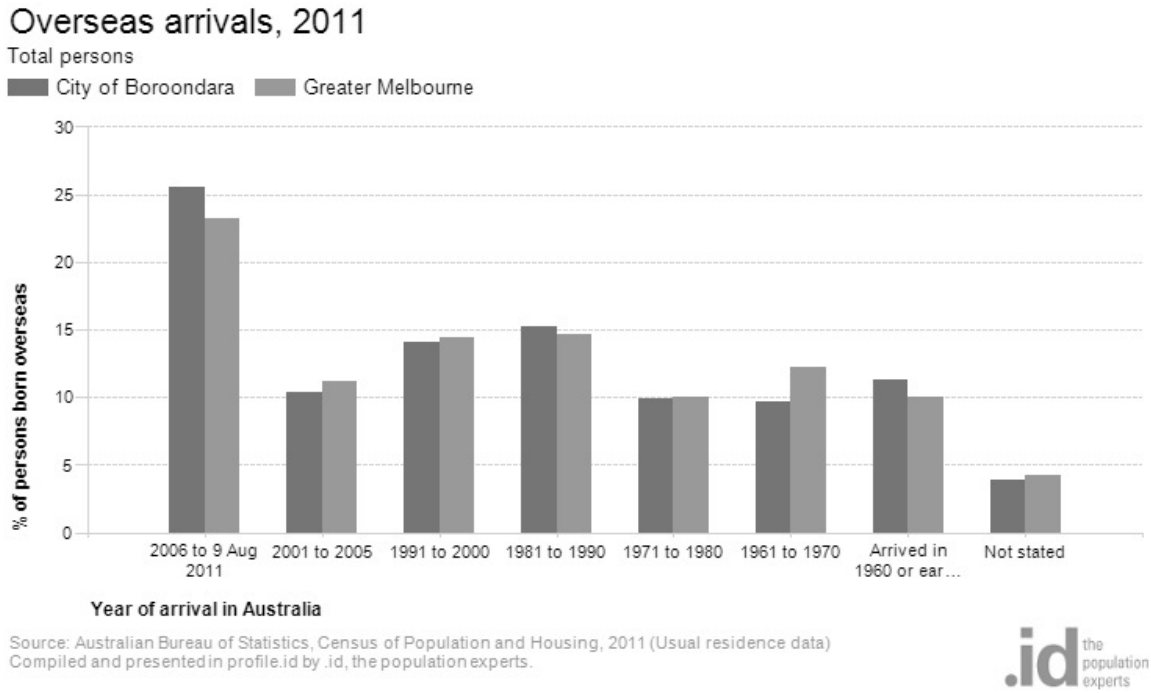


Figure 17: Graph showing overseas arrival in Boroondara. Source: http://profile.id.com.au/boroondara/overseas-arrivals

[22] Facts on ancestry of Boroondara residents sought from http://profile.id.com.au/boroondara/ancestry
[23] Facts on overseas population sought from http://profile.id.com.au/boroondara/overseas-arrivals

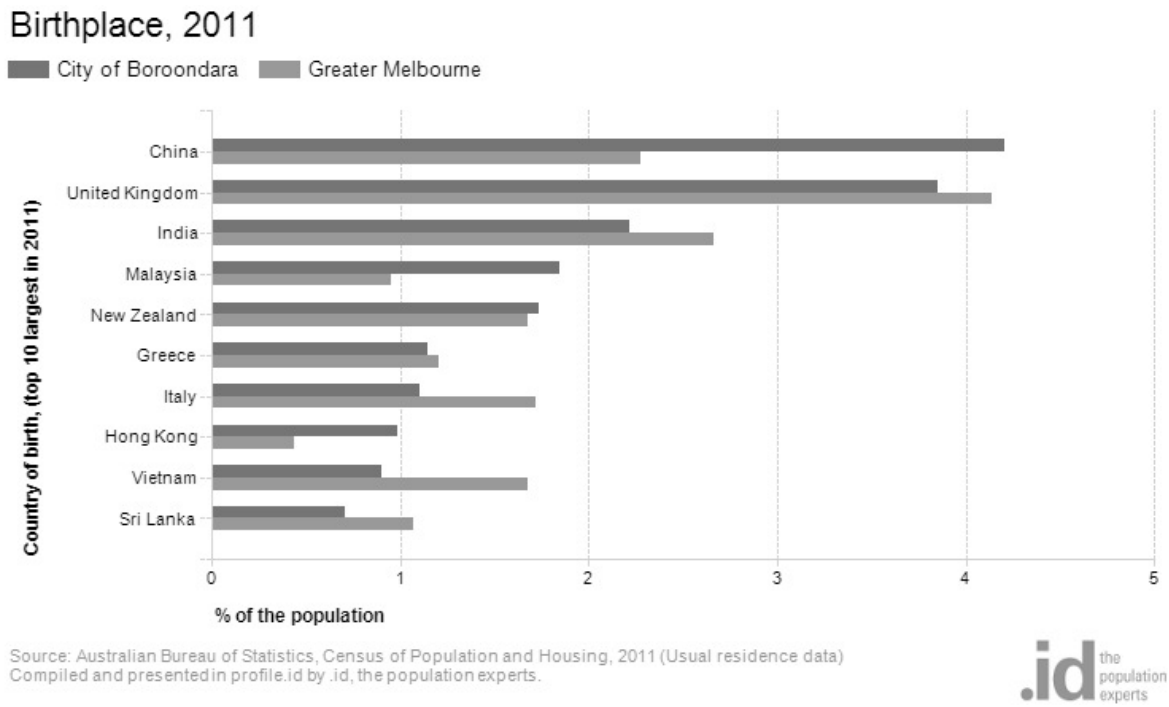


Figure 18: Graph showing birth place of immigrants in Boroondara. Source: http://profile.id.com.au/boroondara/birthplace

At June 2014, the City of Boroondara had a median house rental of $650, $300 higher than the median house rental for Victoria. At the same time, the City of Boroondara had a median house valuation[24] of $1,396,527, $944,897 higher than the median house valuation for Victoria. The housing valuation and rental valuation have been seen as measure of economic desirability of living in the area.

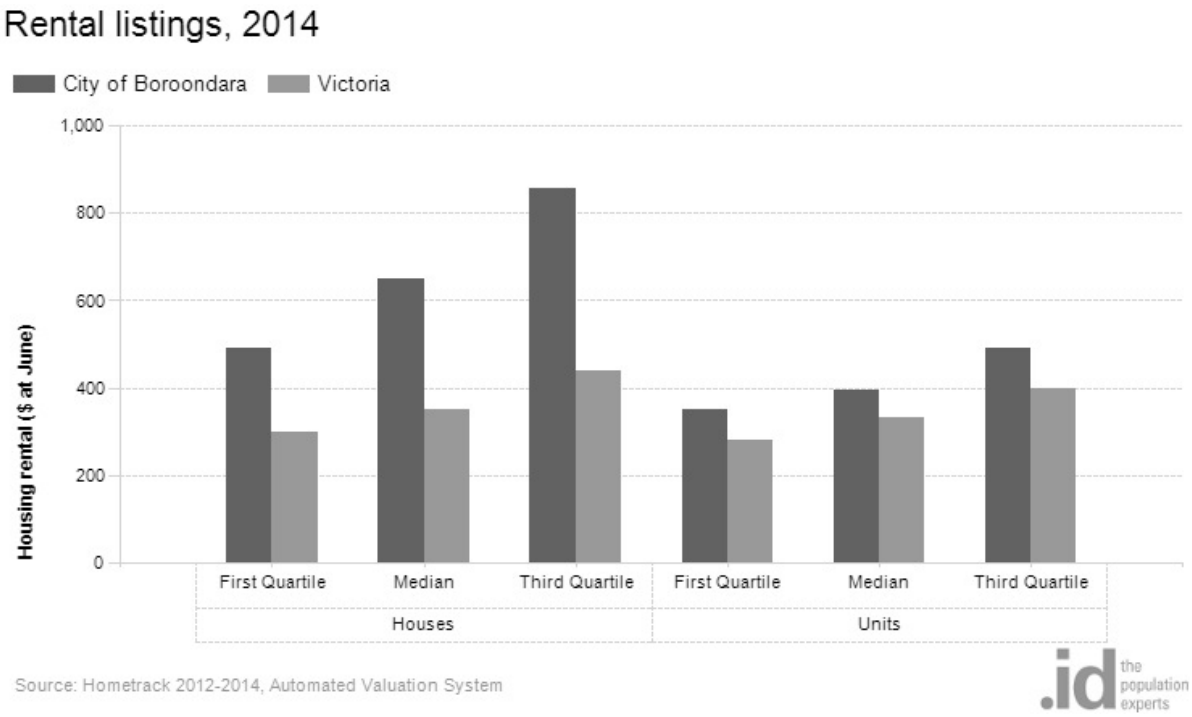


Figure 18: Graph showing housing rental in Boroondara. Source: http://profile.id.com.au/boroondara

The City of Boroondara is renowned for its high quality urban environments, which include heritage residential buildings, low-rise development, open spaces like home gardens, community parks and gardens, tree lined streets. These built and natural environment features are integral parts of social and cultural identity of Boroondara. And also has a major stake in real estate value

[24] Facts on median house valuation and rental valuation have been sought from http://economy.id.com.au/boroondara/housing-values

of buildings in the city. The community members are fiercely protective of the low scale and leafy lifestyle and residential environment of Boroondara.

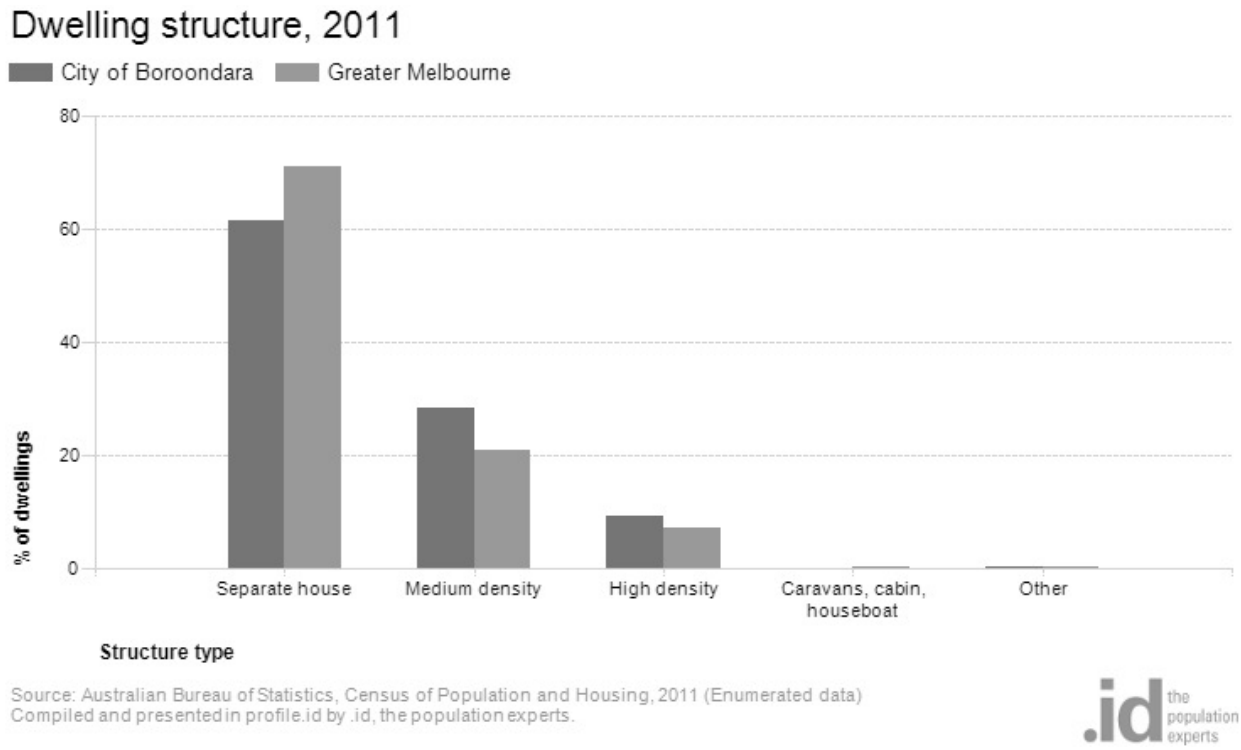


Figure 19: Graph showing dwelling in Boroondara. Source: http://profile.id.com.au/boroondara/dwellings

Figure 20-23, top to bottom: Images of heritage architecture of Boroondara, low rise development, representing the look and feel of the built environment design in Boroondara. Picture source: Clicked by author.

Residential buildings in Boroondara reflect heritage of the local area and are built in Queen Anne style, Victorian, Federation, Post War and Interwar homes. Since the last thirty years several historical and heritage preservation groups have come into action in Boroondara. The city council has obtained heritage overlays in order to protect areas of extreme heritage value from over development or excessive development (C. o. Boroondara, 2015, pp. 150-151). This has also led to continued concerns amongst community members for loss of heritage.

Figure 24, above: Door sign expressing the dissent of Boroondara residents for real estate growth. Camberwell, Boroondara. Picture source: Clicked by author.

The community and the city council highly value the neighborhood character of the various areas in Boroondara and frequently lobby to gain more control over residential design through mandatory height limits, setbacks, and number of subdivisions on a block and visual bulk from a dwelling. The council also highly regards amenity in residential dwellings and ensuring that high quality amenity outcome from a dwelling/residential construction. Amenity planning field terminology and stands for the ability of a landowner to enjoy the benefits from his land, such as a healthy lifestyle, recreational goals, providing facilities for domestic and family purposes. High amenity outcome includes prevention of overlooking, visual bulk and noise from neighboring properties, overshadowing, direct solar access and daylighting in homes, and the open spaces surrounding the homes. The council guides the construction of residential buildings in Boroondara with the help of the policies given in the planning scheme. However, these policies are only guidelines (soft rules) and are not mandatory legislations.

For the purpose of this thesis research project, the focus will be on policies pertaining to solar access in dwellings of Boroondara. The clauses 15, 21, 22, 54, 55 and 56 of the Planning scheme of Boroondara promote provision of solar access in dwellings (C. Boroondara, 2003). These clauses guide the height, setback, number of storeys, number of dwellings on a plot, permissible visual bulk on a neighboring property. See Appendix 2 for details. The clauses pertaining to solar access use setbacks in residential properties, number of storeys of a residential building, overlooking, orientation, provision of open spaces, site response, and prevention of excess visual bulk from neighboring properties, passage of daylight in rooms for ensuring solar access. It is critical to note that clauses for solar access in residences do not rely solely on restricted heights of the properties. The City council of Boroondara guides the provision of solar access in

residential buildings through features of the residential design that generate high amenity outcomes such as setbacks, less visual bulk, orientation of rooms in a residence and open spaces around a residential property. For example, clause 54.04, one of the many clauses for promotion of solar access, provides guidelines for the amenity impacts in buildings through following objectives:

1. Side and rear setbacks
2. Walls on boundaries
3. Daylight to existing windows
4. North facing windows
5. Overshadowing open space
6. Overlooking open space

The City of Boroondara ensures solar access in residential properties through control measures created with a combination of regulatory setbacks, overlooking, visual bulk, and controlling other features that ensure daylight provision in habitable rooms of the dwellings. These regulatory measures benefit amenity as well as the neighborhood character and other aesthetic concerns for the city.

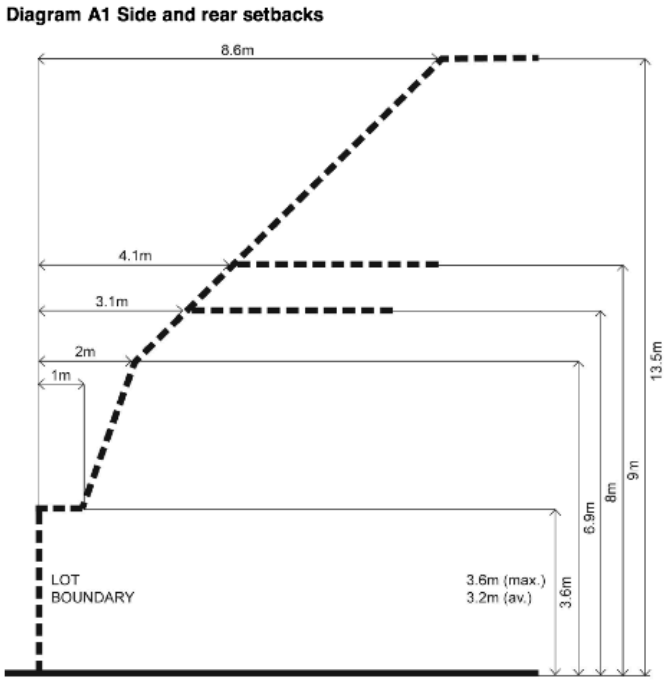


Figure 25, above: side and rear setbacks. Source: http://planningschemes.dpcd.vic.gov.au/schemes/vpps/54_04.pdf

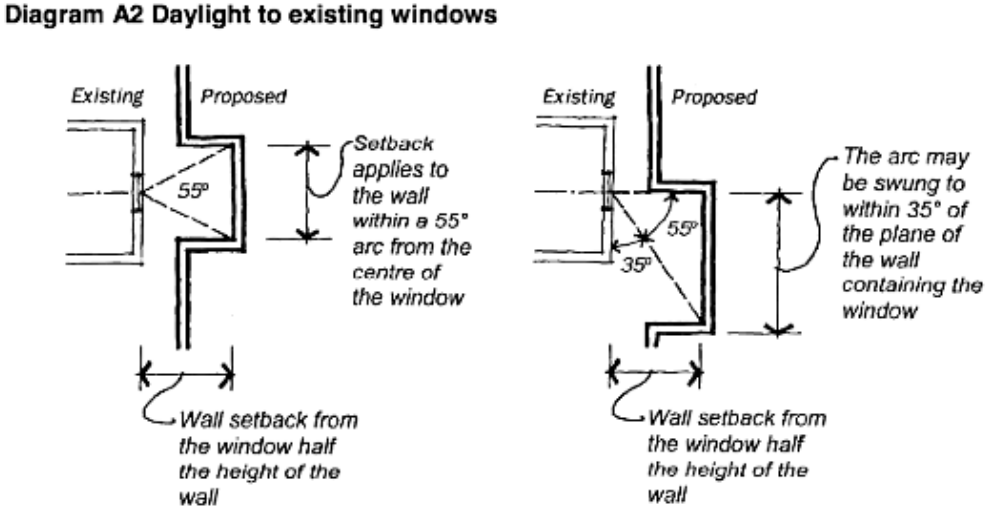


Figure 26, above: daylight to existing windows. Source: http://planningschemes.dpcd.vic.gov.au/schemes/vpps/54_04.pdf

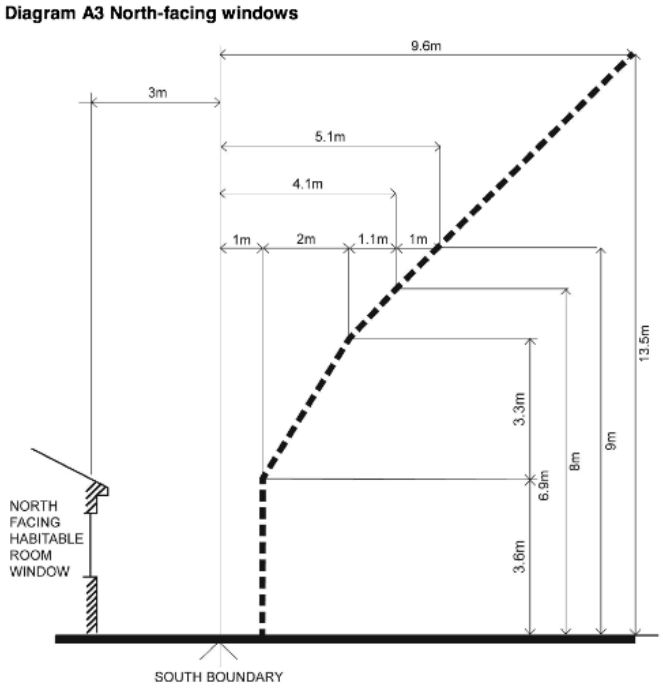


Figure 27, above: north-facing windows. Source: http://planningschemes.dpcd.vic.gov.au/schemes/vpps/54_04.pdf

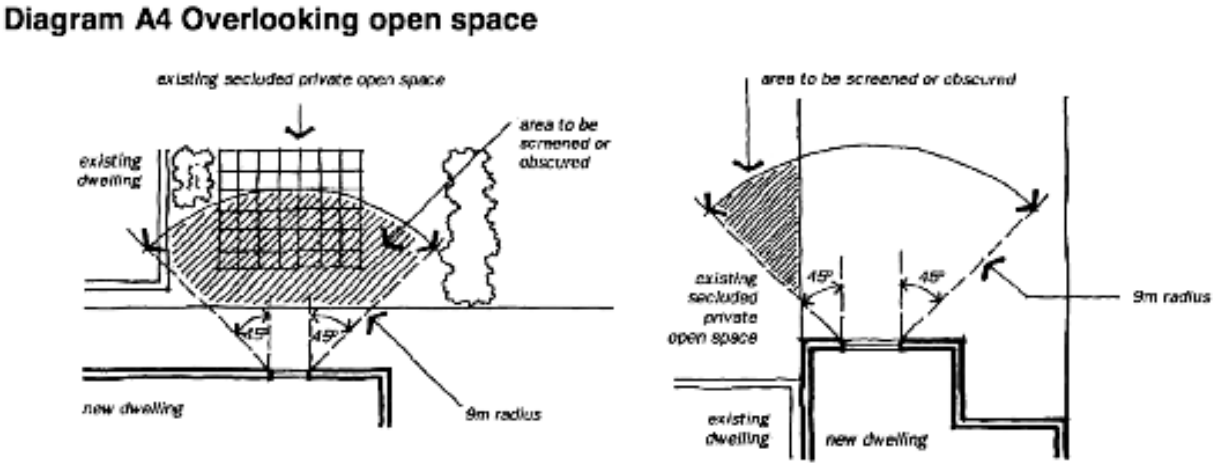


Figure 28, above: overlooking open space. Source: http://planningschemes.dpcd.vic.gov.au/schemes/vpps/54_04.pdf

Chapter 2

Methodology

Part 1: Research questions

Researches in the field of solar envelope, urban development and sustainability building practices thus far have not addressed the challenges posed by governance procedures. Implementing policies and frameworks for bringing solar envelope based urban development of built environment in mainstream fields like urban planning, green building architecture and associated public policy issues, requires critical assessment of environmental governance regimes pursued by stakeholders responsible for it. None of the studies on solar access, overshadowing and solar rights in cities, neighborhoods and buildings have considered the impacts of political economy and political ecology – central components of environmental governance. Lack of adequate contextual and historical analysis of the international and local sites chosen for these studies is another area of critical concern. Studies remain limited to investigating new technologies for simulating solar access on built environment and devising economic schemes such as tax subsidies for incentivizing use of solar energy through rooftop photovoltaic cells. Most of the research studies have concentrated on quantifying the impacts of adequate solar access in buildings and cities, in terms of energy consumption, climate change, street layout and urban microclimate. Examination of agendas of actors such as local governments, federal lawmakers, city planners, business owners, community members and environmentalists is lacking as well. Benefits of using passive solar energy and sunlight have been scientifically established for long and in great number. Along with being an abundantly available renewable source of energy, sunlight has significantly positive impacts on human

health, wellbeing, and building occupant comfort. As a clean source of energy, passive solar design of built environment has several environmental and economic benefits. Current studies based around the concept of solar envelope have largely been derivations of the invention of Ralph Knowles from 1970's, but failed to completely address Knowles' advocacy to make solar envelope a tool for solar zoning, policies and rights. In spite of proven benefits of passive solar design in buildings and cities, application of solar access based urban planning are scanty. In order to understand solar access based planning, it is important to study an existing urban plan with similar focus along with the agendas of the actors associated with such planning for city and neighborhoods. This analysis would bring forward the practical limitations and opportunities that can be addressed in upcoming urban planning and governance schemes that target implementation of solar access in buildings and infrastructures. It would also assist in identifying the role of environmental governance in constructing sustainable built environment.

Due to unprecedented implementation of solar access policies, the City of Boroondara was chosen as the site for analysis. Boroondara is a middle ring suburb located in northeast of Melbourne, Victoria, Australia. Through an exploratory case study research, the following research question was explored:

***Why* is the City of Boroondara implementing policy for solar access in dwellings of its neighborhoods?**

Following sub questions were included under the above research question:

1. Why is solar access in residential dwellings important for the City of Boroondara?
2. What are the social, environmental and economic impacts of solar access for the City of Boroondara?

3. How did the policies of solar access come into existence in the planning scheme of the local government of Boroondara?

4. How does the apparatus of ensuring solar access in building construction work in the local government of Boroondara?

5. How did the Planning and Environment Act of 1987 (PEA) come into existence in Victorian legislation?

Part 2: Rationale for research methodology – philosophical foundation

Research conducted in this study investigate and analyze solar access policies as stipulated in the Planning scheme of Boroondara. Through examination of above research questions, a deeper understanding of the local government of Boroondara and their agendas pertaining to solar access policies for residential dwellings, within various stakeholder groups, can be attained. Analysis of Boroondara's solar access policies will uncover the strengths, weaknesses and opportunities for new urban and suburban developments that want to rely on passive solar energy as the steady source of energy for their buildings. Research methodology and objective, presented in the following paragraphs, include epistemological foundations from the field of policy and institutional analysis, apart from focusing on research method traditions followed in social sciences. This research study uses a multi methodology, exploratory case study research design. Study of context (historical, political, economical and environmental agendas and associated conflicts) was an integral component of this research. The embedded unit of analysis were the clauses pertaining to solar access in Planning Scheme of Boroondara (C. Boroondara, 2003).

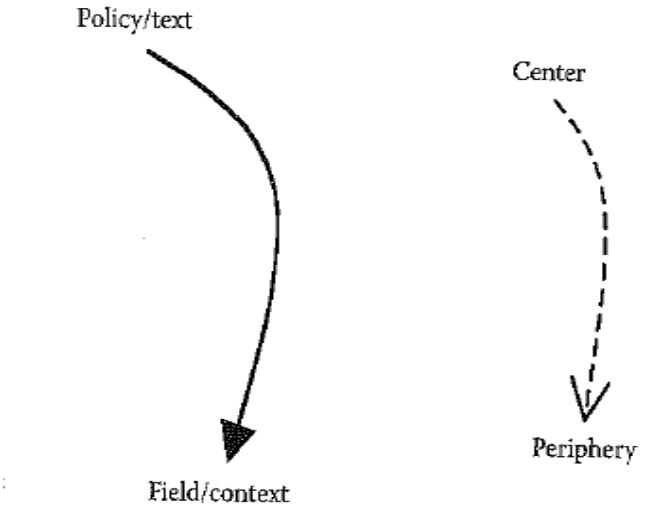


Figure 29, above: Visual representation of context around a policy. Source: (Lejano, 2006, p. 168)

The literature analysis expanded across a wide range of research studies and journal articles that showed the gap between 'theory and practice' in the field of solar access (Yin, 1989, p. 38). While most of the studies advocated the benefits of solar envelope based urban developments and solar access in buildings, the analysis of what makes these policies about solar access more effective in everyday decision making of policy makers, local governments and other actors, remains unaddressed.

To capture the effects of context and experiences of various actors related to formulation and implementation of solar access policies of Boroondara, the methodology for this study was inspired by post-positivist and post-constructionist foundation in policy analysis field.

Post-positivists argued that scientific studies were based in social constructs and were subject to other context created by the institutions. Habermas, a key sociologist of Frankfurt School of

Critical Theory, ideated that reason might be found in intersubjective communication, instead of a 'privileged' subject. Other phenomenologist such as Heidegger argued that truth did not lie in rational calculation but in experience (Lejano, 2006, pp. 89-93). They also discouraged the dichotomy between subjective and objective analysis in research studies. Post-positivists also brought forth the idea of 'constructedness', where truth is subject to interpretation (Heidegger, 2010, p. 17). The underpinning thought amongst post-positivists was to reveal how modern day institutions structure themselves and maintain their status quo, based on the influences and interests of powerful stakeholders.

Post constructionists base their policy analysis techniques on the differences between the interpretation of policy makers and the people who use these policies in their everyday lives. They challenge the view that policies can be spread uniformly across different contexts. They further bring forth the multidimensional nature of policies and hence policy analysis (Lejano, 2006, pp. 187-188). Explains the complexity of policies and their analysis through a geometric analogy- and advocating prevention of reducing complex policies into simple utilitarian models. Lejano also mentions that separating policy guidelines from the context deepens the rift between policy formulation and policy implementation. The picture below represents the geometric analogy.

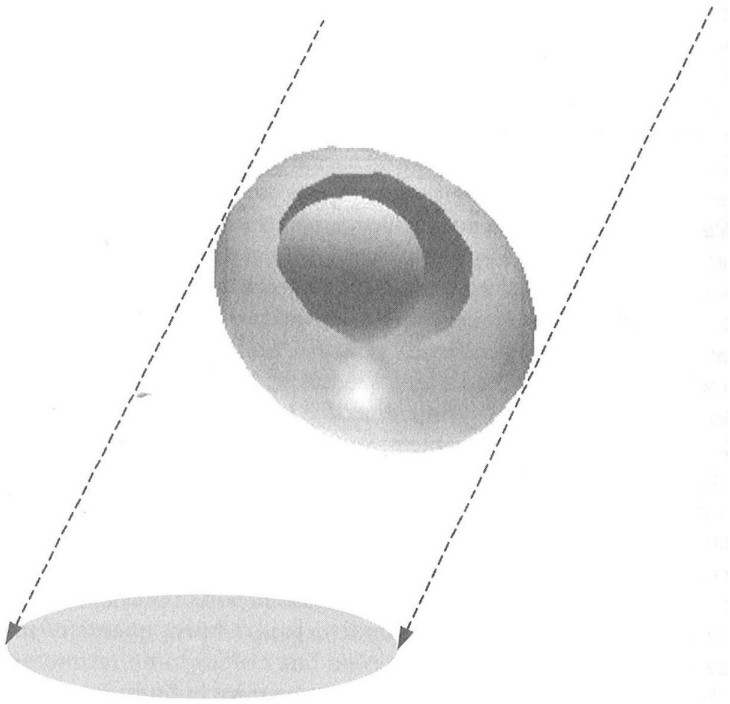


Figure 30, above: Multidimensionality of policy analysis. A geometric representation. Source: (Lejano, 2006, p. 179)

Policies for solar access in buildings remain very limited in number; hence existing examples of such policies in action need analysis of their formulation and implementation. They also need investigation of the context and complexities associated with them. Post constructionist school of philosophy considers Experiential Model of Analysis EMA Lejano (2006, pp. 167-168), which includes the following suite of tools for an analyst engaging in study of a policy:

- Participant observer techniques
- Personal narratives (through interviews, testimonies, etc.)
- Participatory research

- Multimedia techniques

EMA integrates various components of information collected into a coherent whole. This model promotes the concept of multiple ways of knowing about a policy or research area. The logic behind experiential model relies on a lateral approach that is inclusive of the context (historical, societal, cultural aspects) surrounding the area of research. It is highly nonlinear and generates hypotheses through integration of information and knowledge, brought by stakeholders and reflection on it. Further leading into grounded theory. Information analysis in experiential model means integration – merging of different lines of information, fitting various pieces together and completing the story. While the objective of positivist model of analysis is to show statistical proof, for EMA the objective is to generate a set of recommendations, i.e. actions that can be taken to improvise the policy area. The figure below shows the process diagram for experiential approach.

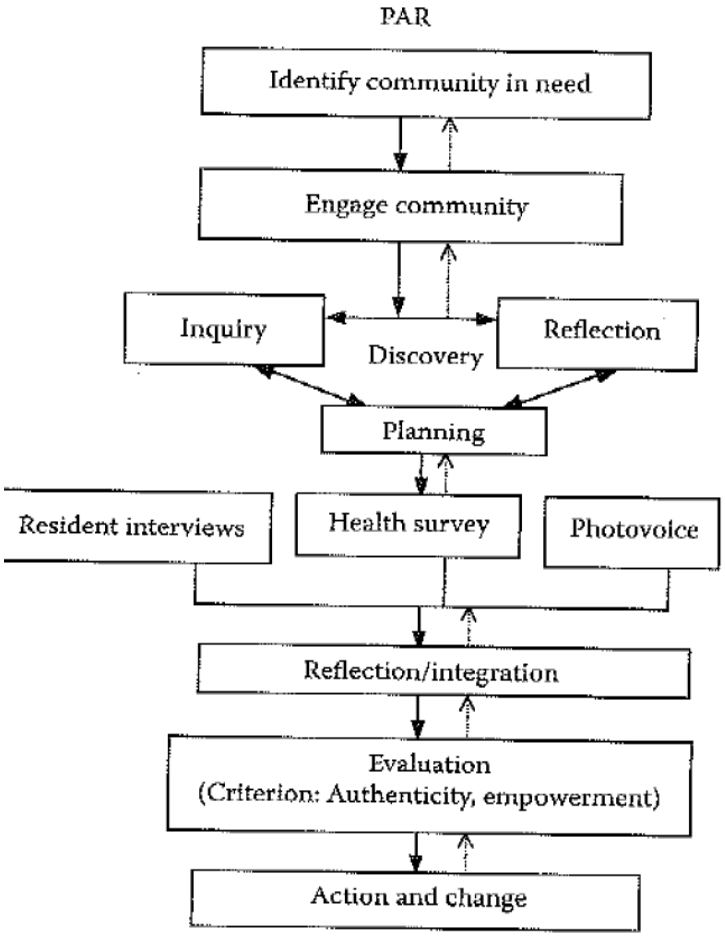


Figure 31, above: Experiential Model Analysis diagram, representing the dynamic process of analyzing a policy. (Lejano, 2006, p. 191)

To study solar access policies, their implementation, and agendas of various actors, a research design based on Experiential Model of Analysis was used. It was deemed important given the lack of literature on how the historical, political and cultural context can play in implementing ecological urban planning and governance concepts such as Solar Access based planning.

Part 3: Research Approach

In order to capture the subjective context surrounding the solar access policies of local government of Boroondara, this study uses a qualitative research approach. Understanding the scenario under which different stakeholders perceive the solar access policies influences the way they use the policies for their neighborhoods, residence and the other civic purposes. Given the uniqueness of these policies and their implementation by the City of Boroondara, the objective behind the research approach was to get comprehensive knowledge about the apparatus of solar access policies, the historical, social and political factors behind its execution and the role of local government, governance scheme and stakeholder relationship in it.

Several notable authors like Uwe Flick and John Creswell have defined Qualitative research. Flick argues that the field of qualitative research has been rendered with a multiple definitions, however some common ground rules of this field that help in identification and ways to pursue this research approach (Lejano, 2006, pp. 180-182). Qualitative research is meant to approach, describe and explain social phenomena in various ways. Some of the ways qualitative research works is as follows:

- Inquiring the experiences of individuals and groups – through their biographical life histories, everyday practices, and related stories, accounts and other pieces of knowledge. Equal emphasis is given to the source of this knowledge and stories.
- Analyzing interactions and communications that take place in order to create a social system or phenomena.
- Studying documents – texts, visuals, videos, or audios – for understanding the experiences and communication associated with the area of research.

Qualitative research is based on uncovering and deconstructing the surroundings people create around themselves. The natural context of experiences and interactions is thoroughly studied and brings to the surface unique characteristics of the research area. Qualitative research is not completely focused on formulating a hypotheses for testing. Rather, hypotheses are generated as a result of the research conducted, towards the end of the project. Methods and theories for exploring the research questions are developed as appropriate to what is being studied (Creswell, 2014, p. 67; Flick, 2007, pp. 28-29; "Qualitative inquiry & research design; choosing among five approaches, 2d ed," 2007).

Part 4: Research strategy – plan of action

The strategy for researching the focal point of this thesis, included a mix of social science research methods, along with methods used for investigating policies and institutions – such as the present case of local government of Boroondara and its solar access policies. Each research strategy is driven by three conditions, as stated by Robert Yin (Flick, 2007, pp. 108-110):

1. The type of research question
2. The control of investigator on actual behavioral events.
3. The focus on contemporary as opposed to historical phenomena

Given the "why" research question that aims to analyze the agendas of Boroondara behind solar access policies for buildings, this research study used a case study research method. The "Why" questions focus on real life contexts such as those found in policy, political science, community psychology, sociology, city and regional planning research for understanding their plans and public agencies, and other fields in social sciences. Given the necessity for investigating the

context of the solar access policies as found in the planning scheme, history and culture of the city of Boroondara, this case study is an "Exploratory Case Study". While hypotheses based studies propose a causal relationship that they try to prove, exploratory case studies are based on a purpose. The purpose is stated in the form of a research question and the sub questions.

Since exploration of solar access policies of Boroondara requires analysis of context, procedures and processes associated with it, an epistemologically plural standpoint was taken for designing the methodology of this study. As opposed to relying and using only rational and scientific methods of enquiry, support from multiple techniques was taken. In order to understand the 'system' of solar access policies and their implementation by the local government of Boroondara, it was important to seek more than one type of source of evidence.

Given the uniqueness of the solar access policies and the unprecedented implementation of these policies in Boroondara, a single case study research was designed and pursued. The following are the five components of a case study research design:

1. Study's questions
2. Its propositions (if any)
3. Its units of analysis
4. The logic linking the data to the propositions
5. The criteria for interpreting the findings

In this research the units of analysis were the policies based on solar access in residential dwellings written in the planning scheme of the local government of Boroondara. Single case studies suffer from issues of validity, such as construct validity, and reliability. Given the

investigation of Boroondara's solar access policies through subjective inquiry into the experiences and interests of the various stakeholders, this case study remains vulnerable due to the lack of objective measures. Construct validity is defined as the ability of a research study to generate inferences from the theoretical constructs being studied – if cause construct is causing the effect construct. It is establishment of correct operational measures for the concepts being studied. Construct validity is also promoted as the criteria for evaluating the quality of research design. The image below describes the construct validity (Yin, 1989, p. 33).

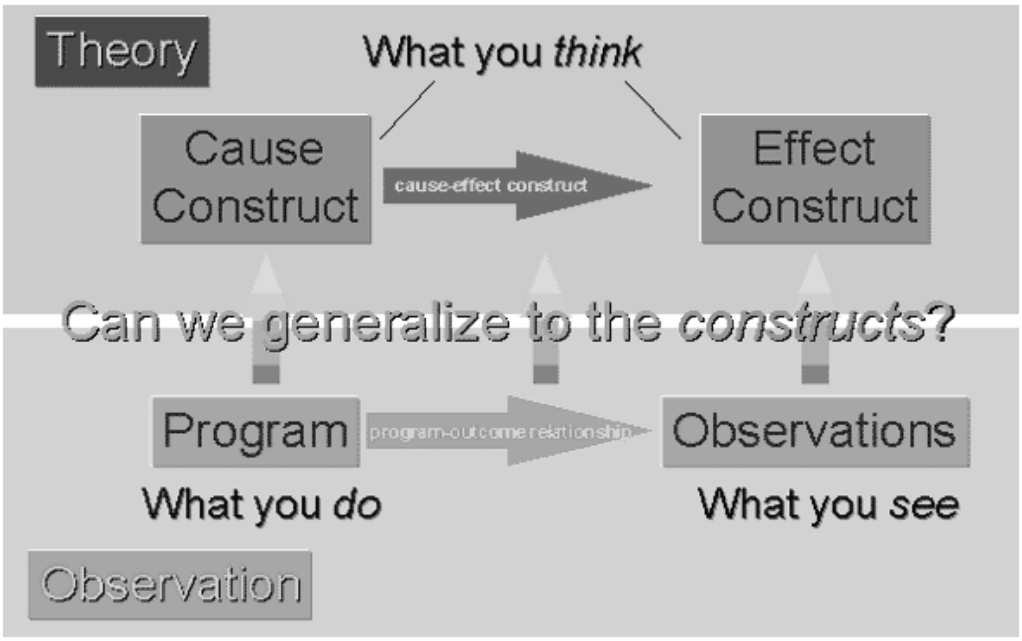


Figure 32, above: Addressing the issue of construct validity for case study research.
Source: (Trochim, 2015)

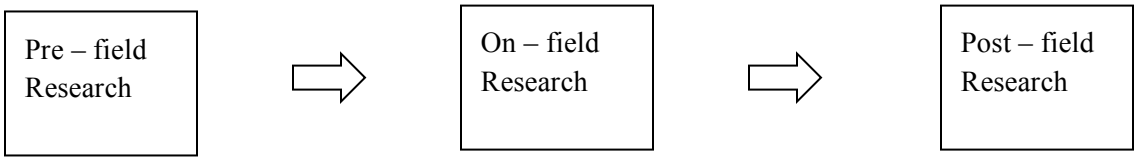
Multi-method research approaches were used in this study to order to overcome the threats of low construct validity and increased reliability. Using more than one method of collecting data is also known as the process of methodological triangulation. For this exploratory case study on Boroondara's solar access policies, multi method approach was used to design the research study

and multiple sources of evidences were gathered. Yin has advocated that use of multiple sources of evidence is an important 'tactic' while conducting case study research and can be taken care of in the phase of data collection (Trochim, 2015). The multi-method approach aims at convergence in data collected from various sources. Convergence means "evidence from different sources gathered in different ways all indicate the same or similar meaning of the construct" (Yin, 1989, pp. 95-97). In this study various research methods such as document analysis, interviews, media analysis, and photo-documentation were used.

Another precautionary measure to be resolved in this case study research was of reliability. Reliability is defined as "demonstrating that the operations of a study – such as the data collection procedures – can be repeated, with the same results". In this research, a protocol or interview guide was used to direct the interviews with the interviewees in Boroondara to maintain a basic consistency in the questions asked from the participants.

Part 5: Stages of Research

The following steps were taken at the three stages of research, namely: pre-field, on field and post field research work. Each of the stage included distinct steps, as given below.



Part 6: Research Methodology

Design – Case study research design was used for this study. The nature of investigation was exploratory. Through single case study method, the agendas of stakeholders associated with the City of Boroondara's solar access policies for neighborhoods were investigated. Instead of hypotheses, this research study was driven by "how" and "why" based research questions. Qualitative, multiple methods were used for investigating the planning scheme clauses of Boroondara and included the following methods:

1. Semi-structured interviews – Interviews were conducted with research participants. 9 interviews were conducted on field in Boroondara and one interview was conducted in off field through phone conversation. The format of the interview was open ended such that the participants could openly converse about their opinions and ideas about solar access policies in the city of Boroondara. An interview guide/protocol (See Appendix 1) was used to steer the interview, with due attention to ensure uninterrupted flow of information from the research participants. The interviews were taped and transcribed for further analysis.

2. Document analysis – Documents related to urban and environmental planning, policies of Victoria, Melbourne and Boroondara were collected through in person library research at the State Library of Victoria located in Melbourne, City libraries in Boroondara – Camberwell and Balwyn. Recent and archival documents from state and local government records were collected. Museums and exhibits related to city planning and urban environment of Melbourne and Boroondara were also visited for sourcing relevant documents about the research topic. Some of the interviewees also provided

informational documents such as articles on city council agenda regarding residential design, planning scheme amendments, correspondence between resident groups and city council, application for residential construction and the response of city council based on overshadowing of neighboring houses. Many other documents such as the planning scheme of Boroondara, residential design guidelines and statutory documents pertaining to solar access in residential buildings were also collected from the official websites of the city of Boroondara, and the Victorian government.

3. Media analysis – given the sociological analysis associated with this research, media reports such as newspaper dailies, magazine articles and newsletters were collected and analyzed. National newspapers as well as local newsletters of Boroondara, online and physical paper copies were reviewed. The Age, Herald Sun, and Progress Leader were used for the purpose of this study. Chronological records of these documents was kept to ascertain the development and changes pertaining to solar access policies of Boroondara, along with other media reports related to urban politics, planning and social issues arising from revisions in the planning scheme of Boroondara. Some of the television series based on lifestyle of residents in Boroondara's suburbs were also reviewed. Media analysis was also important to analyze the ideologies of those who produce the media reports and how they try to spread this ideology. Media analysis provides useful data to see how society reacts to the media and different players use the media for promotion of their interests.

4. Visual Research methods – visual research methods used in this research study were a form of ethnographic techniques such as photo documentation and other visual research formats used to excavate aspects of social life surrounding the research area under observation (Kerlinger, 1973, pp. 456-459). Given the importance of perspective of civil

society in Boroondara towards solar access, related environmental and urban policies, capturing the current tendencies towards housing design through photo documentation was a critical component of the data collection process. Traces of public attitudes and every day life such as concerns for water depletion, use of public transport, car dependency and treatment of domestic garbage were also captured through photography tours conducted during field research in Boroondara (Spencer, 2011, pp. 68, 70-71). Walking photography tours were conducted at different times of the day to learn and observe citizens lifestyles. The principal investigator lived in the city of Boroondara to interact and get first hand exposure of Boroondara, its lifestyle, and environmental features as well as for interaction with the people of the city. Visuals of architectural details, trail ways and public transport were collected through review of archival documents and books in the local libraries in Boroondara. Old and recent maps of Boroondara's suburbs and the areas within Greater Melbourne were also studied in the visual research part of this research study.

Sense of place and neighborhood character is two of the most widely known traits of Boroondara and its citizens around Melbourne area. Hence, visual research and photography were an instrumental procedure in this research for recording aesthetic, physical and other features of urban environment of this city. Spencer has argued that place is a complex social science phenomenon to study. He also argues that cityscapes, town centers, housing estates, parks, wilderness and countryside are all socially mediated.

Aerial views generated through Google Earth were also used to understand the geography of the City of Boroondara. Given the recent sprawl experienced by middle ring suburbs around Melbourne such as Boroondara, the aerial views provided a bird's eye view for

visualizing urban development in and around Boroondara. The history feature of Google Earth assisted in visualizing the urban development and sprawl around Boroondara in the recent years.

Participants – Participants convened for interviews ranged from city council officers, local politicians, urban planners, and journalists to community action groups. A total of ten participants were interviewed. The age range of participants ranged from 22 to 80 years. The participants were invited for interview through email-based invitation. Their contacts were found through website of Boroondara and documents on planning scheme. All names found from these documents and website of Boroondara were sent interview invitations. In total fifty invites were sent and those who responded were interviewed during field visit at Boroondara.

Setting and Procedure of Interview- Interview locations were chosen by the research participants and ranged from coffee cafes in Boroondara to Camberwell City Hall, i.e. Boroondara city council office. All interviews were audio recorded through smartphone App and were transcribed for the purposes of coding in Atlas.ti software. All participants signed the IRB research participation consent form prior to beginning the interviews. Interview conversation durations ranged from 15 minutes to 88 minutes.

Pilot study – in order to create a more comprehensive and increase the reliability and validity of the interview guide, a pilot study was conducted. The interview participant was a female, from the field of environmental psychology from a major research university of northeast United States. Based on the pilot study and the responses gathered during the pilot interview, several revisions were made to the interview guide. Order of questions was changed, such that most relevant questions are asked at the beginning of the interview and are given more time.

Vocabulary used in the interview guide was also made more relevant keeping in mind the professional backgrounds of the interviewees. Finally, some syntactical and grammatical changes were made to the questions.

Interviewees were informed of the ground rules as stated by International Review Board (IRB) at the beginning of the interview. Permission for audio recording of interview conversation was sought at the beginning as well. This was followed by brief explanation of interview questions and protocol. The interview guide/protocol, as attached in the appendix, was used to guiding the interview questions and topics. Interview conversation began with direct question about awareness of solar access policies as stipulated in the planning scheme of Boroondara. Further questions were asked based on response to this questions. The interview guide assisted in keeping the questions and dialogue with interviewees very focused around the topic of solar access policies. The diagram below shows the flow of interview questions.

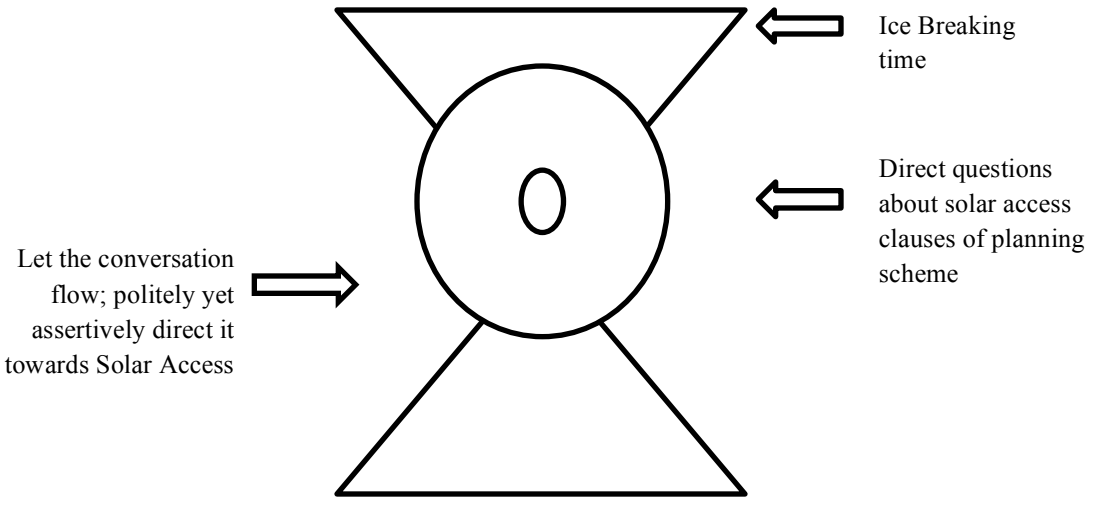


Figure 33, above: Strategy devised by author for conducting semi structured interviews during field study.

Data analysis procedure – All data collected was converted into Microsoft word documents, PDF and Jpeg format and was prepared for qualitative analysis with Atlas.ti. All the interview audiotapes were transcribed with through 'Wreally' software and stored as word documents. Due attention was paid in maintaining anonymity for research participants in interviews. Names of all participants were coded for this purpose and none of the names were revealed in the thesis or any external documents related to the thesis.

After data collection and field research at the City of Boroondara, a research outline was created that stated major arguments as understood from field work, and helped in revision of research questions based on the data collected. The outline created assisted in visualizing the bigger picture and the storyline surfacing in this research study. Next step was identification of source of answer for each of the question associated with this case study research.

Given the multimethod nature of this research study, different sub-research questions were answered by different research techniques or combination of research techniques from the methodology adopted for this research study. In order to identify the source of answer for each of the sub-research question within the over-arching research question, the table given below was created. The table "*Evidence Source Protocol Table (ESPT)*", assisted in understanding the source of answer of each sub- research question of the study.

Table 1, below: Evidence Source Protocol Table (ESPT)

Question	Purpose of the Question	Evidence
1. Why is solar access in dwellings important for the	A. To explain the socio – cultural & socio – economic factors that	I. Interview text II. Document analysis III. Media reports

City of Boroondara?	play a role in making solar access important.	
2. What are the social, environmental and economic benefits of solar access as seen by the city of Boroondara?	A. To explain how the Boroondara and the various stakeholders within it perceive the benefits from solar access in residences.	I. Interview texts II. Media reports III. Documents of City council
3. How did the policies related to solar access come into existence in the planning scheme of the local government of Boroondara? How do solar access policies work in Boroondara (the apparatus that ensures solar access in existing and new residential constructions)?	A. To underscore the various directly and indirectly related policies those are used for ensuring solar access in residences. B. To describe the procedure taken up by the city council in order to ensure adequate solar access in residences. C. To critique it with the help of existing literature on solar access and solar envelope.	I. Planning scheme documents II. Documents handed during interviews III. Interview text IV. Existing literature on solar access in dwellings
4. How did the Planning & Environment Act 1987 (PEA), come into existence? (This bill was initiated by the Minister of Housing of the Australian Labor Party in 1985.)	A. To explain under the circumstances that led to creation of PEA and some of the major amendments that the act has been through since 1987. B. The amendments would also highlight the conflicts in opinion between liberal and labor party.	I. Parliamentary documents (Hansard) on legislative history of PEA

All collected data was exported to Atlas.ti software, in which a hermeneutic unit created. This was followed by creation of codes through in-vivo coding[25] and initial[26] coding. Both in-vivo coding and initial coding form a part of elemental coding methods as described in (Saldaña, 2013, pp. 51-54). Most poignant and relevant statements and components in the data files were converted into quotations in Atlas.ti and were assigned a code. After the coding stage, the codes were analyzed and merged together as needed. Many codes seem to fall into similar line of thought and hence were assigned a group, with a relevant group name. The codes were also linked when two or more codes repeatedly showed a connection in between them. The network tool in Atlas.ti was used to portray the links between codes. The picture below shows an example of coding a picture, clicked during field study at Boroondara, in Atlas.ti:

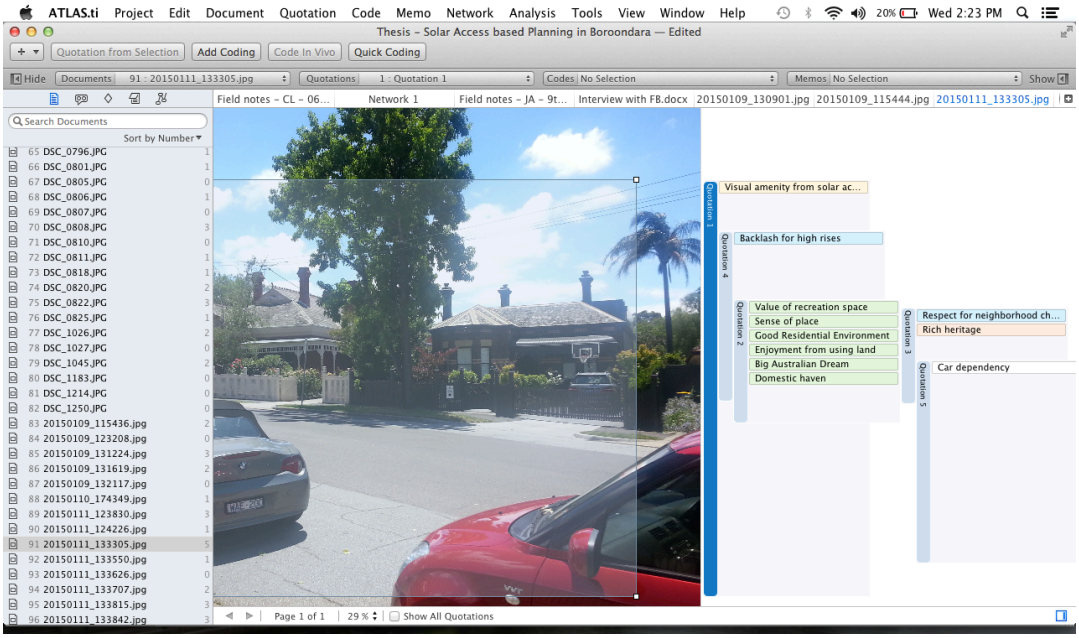


Figure 34, above: Depiction of data analysis procedure in Atlas.ti software.

[25] In vivo coding refers to using the statements and actual language used in the qualitative data, as codes. They could be made by the interviewees and could be in the form of sentences, phrases and words present in the data.
[26] Initial coding is an open ended coding method that breaks down the qualitative data corpus into discrete parts, closely examining them and identifying the similarities and differences in between them.

The coding process was also guided by the field notes and other written outlines created after the field study in Boroondara. The written outlines captured the immediate information gathered from the field research and prevented any loss of information due to memory of principal investigator. The outline also contained important keywords and facts about the solar access policies of city council in Boroondara and assisted the principal investigator in focusing on the relevant areas of concerns for the thesis research project.

Chapter 3

Results

Part 1: Results from coding of qualitative data

In total 189 data files were coded. These included pictures (147), interview transcripts (7), field notes (memos) (8), media reports (20) and other documents obtained during the field research in Boroondara. In total 86 codes emerged. Code families were color-coded. Through several iterations and analysis of the codes, 11 code groups were created. The codes are given in the table below, generated by Atlas.ti outcome function. The codes are alphabetically arranged.

Table 2: List of codes generated through Atlas.ti outcome function.

Code Info	
Aesthetic needs	■
Affluence of Boroondara	■
Affordability issues	■
Amenity	■
Anxious due to population growth	■
Awareness for environmental issues	■
Baby boomers	■
Backlash for high rises	■
Backyards/front yards in homes	■
Balancing development with preservation	■
Big Australian Dream	■
Big Macmansions	■
Borrowed light	■
Car dependency	■
Communication with community	■
Concealed racism	■
Concerns for high density	■
Conservation efforts	■
Conservative ways	■
Dislike change	■
Dislike development	■
Domestic haven	■
Engaged and vocal residents	■
Enjoyment from using land	■
Expectations from the local council	■
Family life	■
Fashionable suburb	■
Few pockets of residents concerned for environment	■
Free market ideology	■
Garden Suburb	■
Gardens and bush	■
Good Residential Environment	■
Health benefits	■
History of controversy	■
Hold great pride in their heritage	■
Impact of public transport	■
In my mind the access to sunlight is side effect of the zoning laws in a way	■
Inappropriate development	■
Like a quaint English village	■
Like having open spaces	■
Low density	■
Maintaining existing character	■
Mandatory height limits	■

Material detriment	■
Medium density	■
NIMBY	■
Need for change	■
Overseas migrants	■
Overshadowing	■
People love trees	■
Potential for using solar energy	■
Problems with state government	■
Progressive ideas	■
Providing people an opportunity to actually be able to live in this area is important, but you cant do that if you don't have some degree of development, some degree of intensification.	■
Public power	■
Racial differences	■
Real estate developer related	■
Relationship with nature	
Respect for neighborhood character	■
Rich heritage	■
Role of women in maintaining homes	■
Sense of place	■
Sharing the outcomes of population growth	■
Siting issues	■
Smart and thorough residents	■
Solar PV panels	■
Solar access	■
Stigma for flats	■
Stop the sprawl	■
Sympathy from liberal party	■
That's what Boroondara is famous for	■
The very things that make it attractive are the very things that increase the pressure on growth and change	
Threatened by other countries	■
Threats from neighboring cities	■
Unspoilt nature	■
VCAT	■
Vague information	■
Value of recreation space	■
Very real vested interest	■
Visual amenity from solar access	■
Visual bulk	■
Want autonomy	■
Want power	■
We like controlling things	■
Lifestyle of Boroondara residents	■
Price paid to live in Boroondara	■

Table 3: alphabetically arranged code groups, generated by Atlas.ti outcome function.

Code Group	**Codes**
Aesthetics	Rich heritage Aesthetic needs Relationship with nature Gardens and bush Like a quaint English village Fashionable suburb Unspoilt nature
Community activism	• Public power • Threats from neighboring cities

	• We like controlling things • Want autonomy • Communication with community • Smart and thorough residents • Engaged and vocal residents • Sympathy from liberal party • Want power • Very real vested interest • VCAT
Community concerns	• Visual bulk • Maintaining existing character • Rich heritage • Big Macmansions • Material detriment • Anxious due to population growth • Overseas migrants • Low density • Mandatory height limits • Concerns for high density
Conservatism	• Stigma for flats • Role of women in maintaining homes • Inappropriate development • Backlash for high rises • Hold great pride in their heritage • History of controversy • Sympathy from liberal party • NIMBY • Respect for neighborhood character
Council's desires	• VCAT • Want autonomy • We like controlling things • Problems with state government • Want power
Demographics	• Lifestyle of Boroondara residents • Fashionable suburb • Affluence of Boroondara • Baby boomers • Garden Suburb • Price paid to live in Boroondara
Housing and development related	• Affordability issues • Real estate developer related • Threatened by other countries • The very things that make it attractive are the very things that increase the pressure on growth and change • Free market ideology • Anxious due to population growth

Impact of transportation	• Stop the sprawl • Impact of public transport • Car dependency • Problems with state government
Look and feel of the area	• Sense of place • Like having open spaces • People love trees • That's what Boroondara is famous for • Relationship with nature • Big Australian Dream • Amenity • Backyards/front yards in homes • Value of recreation space • Family life • Gardens and bush • Domestic haven • Enjoyment from using land • Good Residential Environment
Solar access	• Visual bulk • Borrowed light • Dislike change • Potential for using solar energy • Conservative ways • In my mind the access to sunlight is side effect of the zoning laws in a way • Health benefits • Dislike development • Overshadowing • Solar access • Conservation efforts • Solar PV panels • Visual amenity from solar access
Sustainability and environmental issues	• Few pockets of residents concerned for environment • Need for change • Providing people an opportunity to actually be able to live in this area is important, but you cant do that if you don't have some degree of development, some degree of intensification. • Medium density • Siting issues • Awareness for environmental issues • Progressive ideas • Stop the sprawl • Sharing the outcomes of population growth

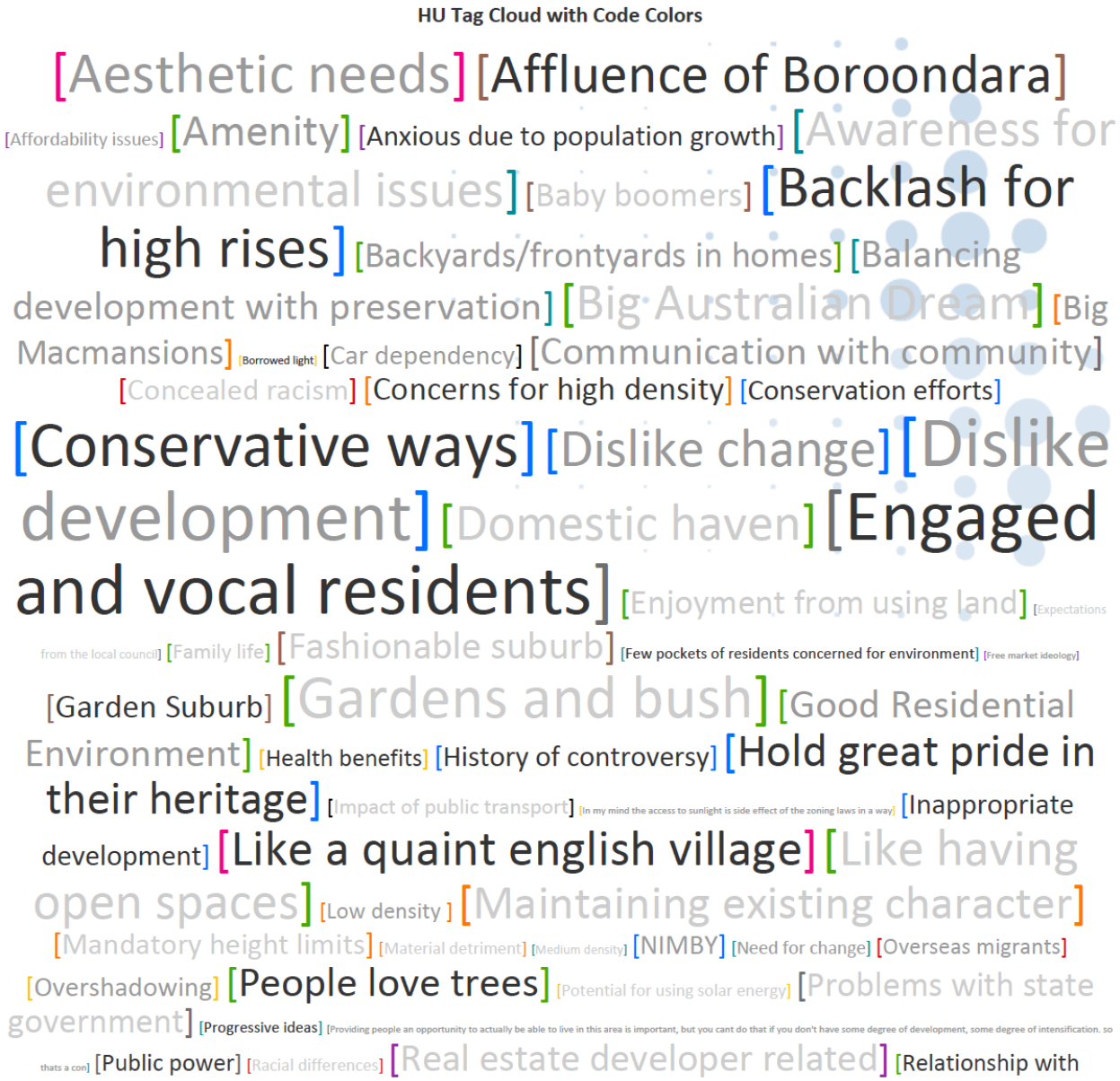
Through further analysis and going back and forth between data files, literature review and other components of the field research, several codes were merged together in Atlas.ti. The iterative coding procedure also showed many links between codes. Thus, individual codes were linked together to show support from one code to the other, contradiction (negative relationship) between codes, association between the codes. The links between codes assisted in representing the purpose and agendas behind implementation of solar access policies by the city council in Boroondara, as well as the importance of sunlight and solar access in houses for the residents of Boroondara.

The Tag Cloud, given in the next two pages shows the codes that emerged in the Hermeneutic Unit of Atlas.ti for data analysis. Atlas.ti generates the tag cloud. All the codes are alphabetically arranged and carry with them the color code assigned to each. More frequently occurring codes are represented in larger font size. The tag cloud is a graphical representation and helped the researcher in identifying the major codes based on comparative frequency and hence getting an understanding of how these codes fit together to build a themes that could be further linked into prospective stories around the topic of solar access policies in the city of Boroondara and the importance of sunlight in houses as understood by the residents.

Based on the tag cloud graphic given in the next two pages, the most frequently occurring codes are (in alphabetical order):

- Aesthetic Needs
- Affluence of Boroondara
- Backlash for high rises
- Conservative ways
- Dislike development
- Engaged and vocal residents
- Gardens and bush
- Hold great pride in their heritage
- Like a quaint English village
- People love trees

- Real estate developer related
- Respect for neighborhood character
- Rich heritage
- Sense of place
- Solar access
- That's what Boroondara is famous for
- We like controlling things
- Lifestyle of Boroondara residents




HU Tag Cloud with Code Colors
[Aesthetic needs] [Affluence of Boroondara] [Affordability issues] [Amenity] [Anxious due to population growth] [Awareness for environmental issues] [Baby boomers] [Backlash for high rises] [Backyards/frontyards in homes] [Balancing development with preservation] [Big Australian Dream] [Big Macmansions] [Borrowed light] [Car dependency] [Communication with community] [Concealed racism] [Concerns for high density] [Conservation efforts] [Conservative ways] [Dislike change] [Dislike development] [Domestic haven] [Engaged and vocal residents] [Enjoyment from using land] [Expectations from the local council] [Family life] [Fashionable suburb] [Few pockets of residents concerned for environment] [Free market ideology] [Garden Suburb] [Gardens and bush] [Good Residential Environment] [Health benefits] [History of controversy] [Hold great pride in their heritage] [Impact of public transport] [In my mind the access to sunlight is side effect of the zoning laws in a way] [Inappropriate development] [Like a quaint english village] [Like having open spaces] [Low density] [Maintaining existing character] [Mandatory height limits] [Material detriment] [Medium density] [NIMBY] [Need for change] [Overseas migrants] [Overshadowing] [People love trees] [Potential for using solar energy] [Problems with state government] [Progressive ideas] [Providing people an opportunity to actually be able to live in this area is important, but you cant do that if you don't have some degree of development, some degree of intensification. so thats a con] [Public power] [Racial differences] [Real estate developer related] [Relationship with

Figure 35 and 36, above: Tag cloud generated through Atlas.ti Software.

Through the network function of Atlas.ti, the following semantic networks were generated. These networks helped in understanding the how various codes and quotations are interlinked. The networks created also graphically represented the story line based around the solar access policies in the City of Boroondara. Networks helped the principal investigator to visualize the code connections and develop the main arguments pertaining to the research questions of this thesis research project (Saldaña, 2013, pp. 150-151) (Friese, 2012, pp. 19-20). The semantic network below shows the links between various codes of the qualitative data.

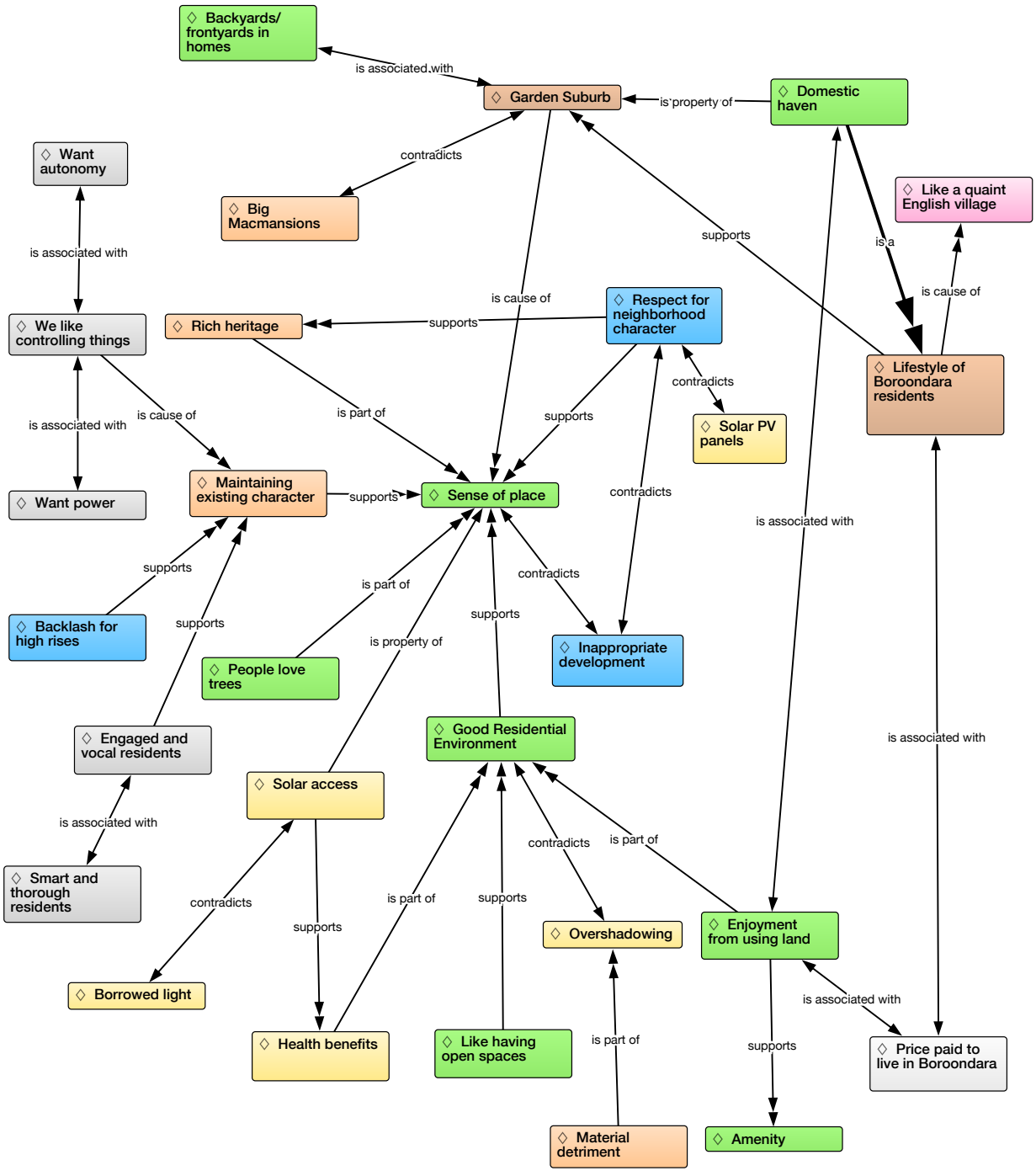


Figure 37 above: Semantic network generated through Atlas.ti software

Part 2: Using coded data to answer research questions

***Why* is the City of Boroondara implementing policy for solar access in dwellings of its neighborhoods?**

Answer to the following sub questions explains the above research question:

1. Why is solar access in residential dwellings important for the City of Boroondara?

Solar access policies enable the city council and the community members to protect their neighborhood character and hence regulate real estate growth to suit the aspirations of the city and those inhabiting it. As opposed to using the solar access policies for ecological benefits, the city is using planning scheme clauses for prevention of overshadowing, presence of direct access to sunlight in residences for the purpose of maintaining sense of place in the residential neighborhood. Solar access policies are implemented through restrictions on height, number of storeys and dwellings on a plot, visual bulk of a building construction. The shadow casted on neighboring properties of an upcoming construction is a deciding factor in approval of a building permit by the city council of Boroondara. Restriction on building features such as height and setbacks for solar access enables regulation on form of buildings. This makes sure that the buildings fit into the low-lying urban layout, low-density housing and promote the overall sense of place in Boroondara. Sense of place contributes to home ownership in Boroondara, which is a crucial milestone in a Melbournian's life. It requires significant effort and financial investment to own a lot or home in suburbs of Boroondara. As one participant mentioned, *"entertainment is inside, not outside", "we host people at home"*[27]. This also ties into the well-known concept of

[27] Member of BRAG, Boroondara Resident Action Group; during the interview

"The big Australian Dream of a quarter acre plot"[28]. Traditionally, dwellers in Australia purchased a quarter acre plot and built a home on it, keeping in mind the open spaces on all four sides of the house, more specifically the front yard and the backyard. The open spaces were mostly converted into ornamental gardens and were also used for families to spend time during weekends and other holidays. Ensuring solar access enables homeowners to enjoy their property investment with their families, and build a good lifestyle with it.

It was found through the interviews conducted during the field study at Boroondara that ecological objectives are not a part of stakeholder agenda behind making and implementing solar access policies in the city of Boroondara, even though the community of Boroondara frequently lodges complaints about overshadowing by neighboring and adjacent properties. The use of solar access policies as tools for controlling high rise development in Boroondara and for preventing intensification of housing density, in fact, is leading to undesirable affects on the ecology of not only Boroondara, but of neighboring cities like Melbourne. Supporting solar access policies for the residential buildings is a mechanism for refusing more 'building-up' housing developments and the required intensification of urban layout, for the growing population of overseas immigrants from Asian countries in Boroondara. Majority of stakeholders described accommodating growing population as the responsibility of the federal government, with clear dissent for sharing the burden of growing population by providing housing opportunities to the incoming people. Conclusively, solar access policies have been set up in a way that promoting solar access in residential buildings is a sufficient, formal evidence for saying no to high rise, medium density and other forms of growth in real estate development in Boroondara.

[28] Mentioned by another interviewee, also a member of the City Council

2. How does the apparatus of ensuring solar access in building construction work in the local government of Boroondara?

   The city council has laid out in-depth planning permit issuance procedures, which also takes care of documentation and evidence of adequate solar access for the neighboring properties. The evidence is in the form for shadows diagrams that demonstrate shadows falling on neighboring properties on equinox days. The council then puts notices on all sides of the up-coming property to inform the neighboring property owners of the possible impact on their properties. The neighbors can object to the development and in case of certain number of objections (approximately 8), the planning application then reaches the council meeting, where a decision is made by the councilors, in addition to the technical review provided by the planning officer.

   The council then addresses the objections and gives the grieved party (s) multiple chances to voice their specific objections. If needed, the council then stipulates corrections in the building proposal. See appendix 2 for example of planning application with shadow diagrams based on equinox.

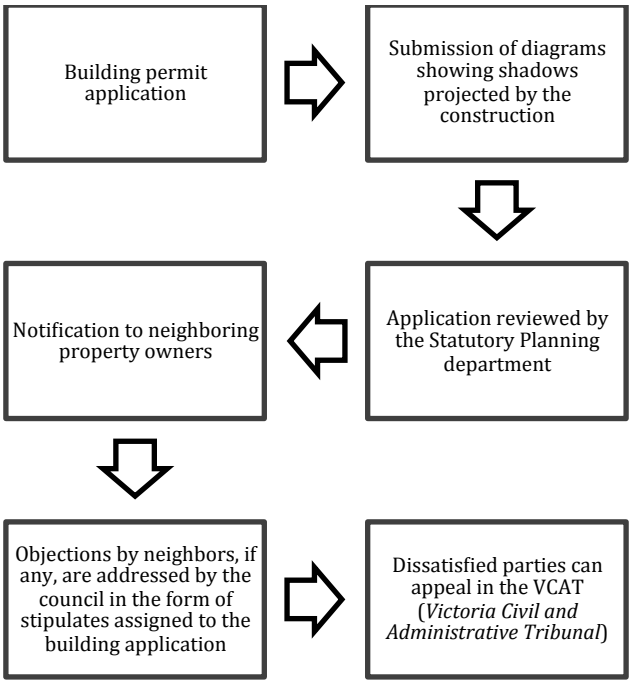


Figure 38, above: Procedure for obtaining building permit for construction of residential buildings in Boroondara.

Dissatisfied parties have the option of filing a suit with Victoria Civil and Administrative Tribunal and getting a De Novo review of their objections. The city council and the community members oppose the mechanism of review of VCAT, as it does not give any weight to the local policies and needs. As mentioned by one of the interviewees, *" We try not to give a lot of stipulates (corrections in the planning applications), as then people tend to take their applications to VCAT. It then completely takes the matter out of our hands".*[29] The solar access policies also bring autonomy to the city council of Boroondara for increasing the autonomy in matters of overshadowing and exposure to sunlight in residences, and prevent interference from state based agencies like VCAT. The implementation process of solar access policies through shadow diagram based technical

[29] The interviewee was a member of the city council.

evidence helps the city council in denying building applications based on high-rise development and those that are misfits with the neighborhood character of Boroondara. None of interviewees were in favor of VCAT, the tribunal set up by the state government under the planning and environment act of 1987. Interviewees described it as "inaccessible" in terms of the procedure and the cost. One of the interviewee also added that the council tries not to give a 'stipulate' in a planning permit, as that inspires the applicant to submit an appeal to VCAT and causes the case to be lost from the council's hand completely. In case of any developments that do not fit the neighborhood character of the location, the council and its planning team try to negotiate changes in the construction plan and try to bring it closer to the neighborhood character as identified for each precinct. This is because the city council has limited statutory powers in the form of planning scheme clauses.

Another interviewee defined VCAT as a consortium of unelected litigators, who depend on the development industry for their income. He described VCAT as *"Boys Club"*. Due to its dependency on the development industry, VCAT mostly overruled the council's decisions and provided judgments in favor of large development projects. Many 'inappropriate developments' have resulted due to VCAT appeals. Another interviewee described VCAT as 'hit and miss', quoting another friend of hers who had made an appeal to VCAT.

3. What are the social, environmental and economic impacts of solar access for the City of Boroondara?

Many social, environmental and economic impacts arise from existence and implementation of the solar access policies in the city of Boroondara. These factors share

a dynamic relationship with the solar access policies and other related governance schemes in Boroondara. Making the institutional set up of Boroondara, the impacts of solar access policies in return feed back into the norms and conventions of Boroondara.

The social, environmental and economic factors around solar access policies bring both desirable and undesirable effects on the city. Economic impacts of the solar access policies include highly valuable residential properties in the city. Restrictions on building height, number of storeys, etc. through solar access policies promotes low-rise urban layout and protects heritage properties, many of which are in commercial areas of the city as well. Heritage properties in the commercial, shopping precincts of Boroondara attract a lot of businesses in the city. The shopping precincts of the city like Hawthorn, Camberwell, and Maling road area are some of most famous in the Greater Melbourne Area. High prices of the residential properties also make home purchase extremely expensive and unaffordable for first homebuyers of Boroondara i.e. young couples and singles who are born and brought up in Boroondara. As a result, they are forced to move out and find housing options out of the city. The interviewee mentioned lack of affordable housing was disrupting the social ties of the youth of Boroondara. Hence, lack of housing affordability not just has an economic cost but also a social cost. One of the interviewee expressed concerns over affordability of housing in Boroondara and mentioned, *"Boroondara has about 30,000 dwellings and only 6 of them can be considered affordable"*.[30] The restriction on intensification of housing and 'building up' for ensuring solar access, as given in the related clauses of the planning scheme, allows the community to refuse accommodation for overseas immigrants, creating racial issues.

[30] Interviewee was a member of the city council.

The residents of Boroondara consider overseas immigrants who are investing in properties in the city, such as Chinese immigrants, as a threat to their lifestyle.

Solar access policies for residential design and the political economy of Boroondara share a two-way relationship. The need for a built environment design, which matches with the aspirations of the community and history of Boroondara shapes the political economic surroundings in the city, and vice versa. Political economic factors are reflected in the form of policy agendas, governance mechanisms and schemes, and lobbying done related to city planning, land use and residential design.

Environmental benefits through the policies for solar access help the city council and community of Boroondara to maintain aesthetic features of their neighborhood like low-rise houses, open spaces and gardens around the residences, high amenity, and good residential environment. Overall, environmental benefits serve the local needs. However, the aesthetic and amenity needs served from the environmental impacts associated with the solar access policies do not match ecological needs, rather produce desirable outcomes, for instance spread out, low density housing scheme is highly unsustainable. Low density of the city also increases the distance between various locations, increasing the dependency on car travel. Simultaneously increasing car ownership in the city. Overall, all these factors increase the ecological footprint of the city of Boroondara.

4. How did the policies of solar access come into existence in the planning scheme of the local government of Boroondara?

   Majority of planning scheme clauses related to solar access have been a part of neighborhood character strategy, open space strategy, heritage overlays, environmentally

sustainable development guidelines. ResCodes, which are regulations of Good Residential Design Guide developed in 2001, also regulate solar access in residential buildings.

5. How did the Planning and Environment Act of 1987 (PEA) come into existence in Victorian legislation?

   The Planning and Environment Act 1987 (PEA) was initiated in the parliament when labor party was in leadership and the bill was initiated by the *Minister of Housing, Mr. Frank Noel Wilkes in 1985*. The PEA replaced the Town Planning Act of 1961 and was intended to become the framework for all purposes related to land use, development planning and environmental preservation in Victoria. It is interesting to note that most debates about housing and urban density issues of Melbourne city, talk about better utilization of vast spaces in suburbs of Boroondara like Hawthorn, Kew and Camberwell for building houses for incoming population in the near future and sharing the burden of high population growth in Melbourne.

Part 3: Other important findings from the data analysis

1. The leafy and shaded character of Boroondara is known to be a cause of envy amongst neighboring local governments. The city has done an extensive 'Significant Tree Study' with the help of a landscape architecture consultant and his team, along with the city council's arborist to identify trees that were significant historically, aesthetically, from aboriginal culture, with particular age value, a rare species, had curious growth form, or had other significant features. The process of identifying significant trees was done with the help of residents, who were asked for nominations for trees around their dwellings or

any other location in the city of Boroondara. The initial list of tree nomination also included the trees identified by the National Trust of Australia. Later, the consultants filtered the nominations through the two-phase assessment process, based on the criteria decided by them. The study also mentioned the vegetation around Boroondara to be one of the key drivers behind high real estate prices. The trees are seen as providers of shade and aesthetics to the urban scape. However, the document also expressed concerns about the threat to the vegetation due to the development and construction that is taking place in the area. *One interviewee[31] mentioned the trees of Boroondara to be the most unique feature of Boroondara. He also quoted an incident, where during a field visit with an architect/urban planner, who said, " in Boroondara, if a house can look beautiful even after removing all the vegetation from around it, then it is really is a beautiful house". As per him, trees around the house were an important driver of the aesthetics of the house.* The same interviewee, while giving a tour of the area, also mentioned that old trees on a property tend to hike the property value. Though strikingly, there was no mention of other possible benefits from presence of such extensive vegetation, like carbon sequestration, reduction in soil erosion and surface run off, in the significant tree study document.

A tree standing on public land was to be taken care off (pruning, trimming, etc.) by the city council and the tree standing on private lands was the responsibility of landowners (mostly homeowners). One of the interviewee, who also showed me around part of his ward, mentioned that the city has hired a professional arborist to give technical explanations to parties, in case they disagree to invest in the maintenance and care of a

[31] Member of the City Council, during the interview

significant tree. Residents must also get a permit before chopping any tree from their property. He also mentioned that the residents value trees, because it is connected to the prices of their real estate.

2. Residents and the city council value the amenity of a dwelling. One of the interviewees mentioned *"visual amenity of dwellings"* and *"material detriment"*[32] as few of the most important factors that the city council pays attention to. The city council also finds these directly impacted by lack of adequate solar access. Matters of pleasure and quality of life lent by the features in a dwelling are important to both. Boroondara is known for its high quality urban environment and good residential environment. Cases of overshadowing occur frequently, where one resident complains about a neighbor, whose property overshadows his/her property. The city planning department has an extensive procedure to ensure that the residents comply with the solar access policies given the planning scheme. *While many interviewees hoped that the residents had environmental concerns when they complained about overshadowing, they mentioned that the city residents on an average did not bother much about environmental issues, "they think the whole issue of global warming is a conspiracy". "Sadly not", "the city is largely conservative and they don't accept issues like global warming and related matters", "there are small pockets of residents who are concerned about environmental issues like the lighter footprints group",* when asked about the environmental disposition of the residents of Boroondara. Two of the interviewees expressed their opinions and mentioned health benefits as the first benefit from provision of adequate solar access in homes. Three interviews

[32] Interviewee was the member of the city planning department of the city

expressed that adequate sunlight *"felt better[33]", "the house looks better when it isn't dark, but is lit up[34]".* Another interviewee brought up the emphasis that the mayor of Boroondara puts on daylight and borrowed light.

3. The policies stated in the planning scheme of Boroondara, are not statutes, but guidelines. Only the clauses related to ResCodes are statutes of the state government and require compliance. The city's policies can be trumped over by VCAT, and can be altered any time by the state government. For instance, the city conducted the 'Neighborhood character study' (NCS) in 2012 to identify distinct architectural and urban features of various precincts around the city. The aim of the study was to guide the new constructions in a give precinct as per the identified neighborhood character and prevent the character from being marred by mismatch of architectural styles. This is based on the statements made by interviewees such as, *"the issue of this council is that we like controlling things in a conservative way"*. Restrictions on building heights were an important component of preserving the neighborhood. The rationale developed during the NCS was used by the city while submitting application for a rezoning procedure initiated by the then Planning minister, Mr. Mathew Guy of the Liberal party of Australia. The application was successful, with approximately 85% of city's propositions approved by the minister. Only two other city councils in Victoria achieved similar approval. Many questions were raised in the media for the scanty number of winners. *One interviewee mentioned that this success came in about 20 years and was like a lifetime opportunity for the city council.[35]* However, the minister also asked for more growth corridor, which the city responded with identification of *"activity centers with capacity of about 53,000*

[33] BRAG member during the interview
[34] Past resident of Balwyn North, Vic.
[35] Interviewee was the member of the planning team.

housing" in few areas[36]. The approval resulted in three zones, which in the terms of labor party[37] are: no-go, slow-go and go-go. The new rezoning left many residents happy and many unhappy as well. With the new government from December 2014 onwards, there are high chances of a review by the labor government.

In past, the labor government had initiated the Good Design Guide, for medium density housing in suburbs of city councils like Boroondara. The *ResCodes* are another example of initiative led by a labor minister, Steve Bracks in 2001.

This city has one of the largest numbers of senior citizens as property owners in Victoria state. Most of the senior citizens are 'Baby Boomers'. They are also extremely affluent and often live financially independent lives. Evidence of their affluent lifestyle and related choices can be seen in cafes, restaurants and shopping precincts of Boroondara like Balwyn, Hawthorn and Canterbury. Many newspaper articles and prominent academic authors have identified affects of rising number of boomers on the housing market. Many of the senior citizens live independently in large houses (4-5 bedroom houses).

4. The residents of Boroondara are extremely affluent, vocal and proactive in matters related to the community. They are also very well educated and mostly have professional backgrounds. *One of the interviewee said, "they are heard, they can influence and lobby"*[38]*. He also mentioned that during open public meeting in the city councils, the halls are "choc-o-block" due to the number of residents in audience.* For instance, the recent rezoning done by the state government met with tremendous arguments and heated debates by the community members, who were fierce in protecting their areas from high-

[36] An interviewee from the planning department at the council of Boroondara
[37] An interviewee mentioned them as labor party terms.
[38] Member of BRAG

rise development. One interviewee quoted a recent incident from his ward while the neighbor character study was taking place. Given the purpose of the NCS was to find out distinct features of various precincts in the city, *a few residents of Balwyn upon finding themselves in a precinct described differently by the city council, conducted a small study of their neighborhood character themselves and argued that they belonged in a different precinct.* The interviewee said, *"They were using our argument against us"*[39]. He also described the community as extremely smart, and that they don't wait to be reached out to, but instead, *"they always find us".* Two interviewees described the community as *conservative and traditional*[40]*,* respectively. Largely, the community is politically conservative, i.e they vote for the Australian liberal party.

5. The city council also has extensive community outreach and feedback seeking programmes. Surveys are letterboxed to each house of the city for critical decisions such as the recent rezoning. Residents are well informed on state government's interventions in the city's plans and the strategies that the city council aims to adopt to fulfill the needs of the residents. One of the interviewee[41] was very aggressive in his answer, when asked how often feedback of residents is collected. He spoke about the intensive community consultation strategy that the council adopted, through which the residents got multiple opportunities to voice their feedback and concerns for planning issues.
6. Historic preservation and fierce reaction of the community against 'inappropriate development' are 'controversial' topics of debate in the City of Boroondara. Few of the

[39] In Balwyn – read articles about this case. The residents argued that their neighborhood was a unique cul-de-sac neighborhood setting of Boroondara and due to the misinterpretation of the NCS there residences were in threat of inappropriate development in their area. After the rezoning in Boroondara, this neighborhood fell into the zone with less restrictions on building height.
[40] Interviewee was a member of the council and resided in Canterbury Road
[41] Member of the Planning Department in the city of Boroondara

interviewees also described Boroondara to be a "controversial area" that had "contentions" based in planning. When interviewees were asked if they were aware of clauses in the planning scheme that aimed for ensuring adequate solar access in the dwellings, they did not give a complete and immediate yes. However, when in the same question, it was spelled out that these clauses are related to restriction in height, number of storeys, etc. they immediately identified with the clauses. A few areas such as Maling Ward has obtained heritage overlay in order to protect to the heritage buildings of the area. It was a long fight, as mentioned by an interviewee. She also mentioned that *heritage preservation and opposing real estate development* were two different concepts. One didn't lead to the other. She also mentioned about an activist called Mary Drost (also mentioned in another interview), who is about 85 years old and has fought against inappropriate development throughout her life, as *"her life's mission"*. She also organized a consortium of a large number of resident action groups across cities facing the threat of inappropriate development into one group called, "Planning Backlash", which collectively represents the interests of the resident groups across Melbourne, to the state government. It was *Mary Drost* who played a large role in getting approval for the new zones that brought with them restrictions and additional controls for the city council on building heights, setbacks, number of dwellings on a plot, through the planning minister, Mr. Mathew Guy. She lives in Camberwell, one of the richest suburbs of Boroondara and was one of the most important activists who lobbied for additional controls for residential design in Boroondara with the then minister of planning. While giving interview to The Age, she quoted herself as a NIMBY.

7. One of the interviewee mentioned about *concealed racism* that is taking place in Australia. One interviewee mentioned that due to the loose immigration rules of the Australian government, Chinese immigrants primarily (and people of other Asian ethnicities) were buying houses at inflated prices and thus becoming the prime target customers for the development industry in places like Boroondara. Another interviewee showed a controversial project, currently in VCAT, in Maling Road. Upon asking if the immigrant population would be more acceptable if they followed and appreciated the neighborhood character, one of the interviewee mentioned about the differences in lifestyle, and that migrants would be acceptable if they did not try to alter the lifestyle of Boroondara residents.

Chapter 4

Conclusions

Solar access in residential dwellings of Boroondara contains issues such as overshadowing, presence of daylight in rooms, and preventing reliance on borrowed light in absence of windows. Solar access in dwellings is one of many issues that form a part of amenity, such as leafy and shady streets, low rise, low density housing, preservation of neighborhood character, backyards & front yards in homes, prevention of excess noise from traffic and other related concerns. The protection of amenity results in fulfillment of community aspirations towards the built environment design. Solar access policies bring with them stringent restrictions on height, open spaces around a residence, number of storeys, which gives the council and the community a chance to control the neighborhood character. Additionally, concerns about lack of amenity and prevention of material detriment, have been provided for the state planning 'statutes' such as the Planning and Environment Act 1987, along with local planning 'policies'. Provision of amenity protection clauses in the planning and environment act gives another advantage to those trying to preserve the neighborhood character in the city of Boroondara. Protection of access to sunlight becomes symbolic of adherence to the amenity preservation clauses of the planning and environment act. In reality, it serves a multitude of purposes other than ecological benefits, namely racial, economic, political and other deeply rooted social and cultural agendas.

Protecting and controlling the neighborhood character of the city increases the perceived livability in the city, making the city attractive for those looking to buy houses. This benefits the real estate value, giving property owners massive return on their property investments. Any change in the neighborhood character of the city would result in loss in property valuations.

Building and owning a home that is careful of including amenities like open spaces around the house, low-rise housing is also a matter of socio – economic status for homeowners in Boroondara. It helps in achieving the Big Australian Dream and is the foremost sociocultural norm in the city of Boroondara. Residents hold great pride in having smaller homes set backed for open spaces on all sides, instead of building a large house devoid of setbacks (popularly called Mac-mansions in Boroondara).

The residential buildings and the open spaces around them are a cultural identity of the community, which is what the community is known for. Solar access policies assist in preservation of this identity. A scenario without the restrictions on residential building construction, such as those brought by solar access policies, would mean more compact housing scheme, intensification of the urban plan and overall an opportunity to house more people and a bigger population. Given that the population infill mostly brings migrants of Chinese origins, the city would see more oversees homeowners and the rising threat of drastic change in their lifestyle. This also ties into the political tensions of the city with the state government, whose agendas include serving all the incoming population and earning out of the overseas investment in property in Victoria, across various local city governments, as opposed to Boroondara's locally focused agendas.

Many lessons emerged at various stages of this study. Communication with stakeholders, analyzing planning scheme and legislative documents and conducting field visit to Boroondara provided an exposure to the culture of the place, lifestyle of the residents and important urban built environment design of the city. The insights gathered from various stakeholders demonstrated the goals for each group from the solar access policies. The conclusions and

implications written here can benefit many professionals groups including policy makers dealing with urban and environmental policies, city planners and sustainability advocates.

Boroondara's heritage, political background, and economic pressures form an important context and help in understanding the controversies that are produced as a result of solar access policies and those that are served through the presence of solar access policies for residential design in this city. Through the exploratory field research and analysis it was found that the political-economic, social and racial drivers dictate the governance schemes for protection of sunlight access in residences. In this case, the solar access policies and other environmentally sustainable development schemes made by the city council symbolize ecologically beneficial initiatives but actually only focus on preserving the neighborhood character and heritage of the area. Even though the solar access policies have the form, rhetoric and technical soundness as progressive environmental policies, they remain regressive due to promotion of socially regressive ideals, which in the longer run can potentially hamper the effectiveness of the sustainability agendas for the built environment design in Boroondara and of the neighboring cities.

Conclusively, the mere appearance of environmental policies, such as solar access policies in the City of Boroondara's planning scheme, should not be assumed as the result of merely ecological intentions. Environmental policies are fiercely driven by economic gains, political agendas and other socio-cultural propagandas of the stakeholders.

The case of Boroondara's solar access policies represents use of ecology as a lever for advancing agendas of built environment design. This case reminds us of the environmental politics, in which policies and programs are made and implemented for fulfillment of objectives of agenda setting actors. Mere faith in scientific discoveries and advancements in the field of sustainable

architecture and city planning are not enough for building ecologically sustainable built environment (Bulkeley & Betsill, 2005, p. 61). However well engineered the solution to the issue may be, clean air, energy efficiency in buildings, curtailment of dependency on fossil fuel, it is influenced by the context. Environmental management plans, policies do not exist in vacuum. The context alters the way these engineered innovations are used. Similar patterns of environmental politics are seen at local, state, national and international scales as well, where actions of agenda setting stakeholders are though symbolic of ecological ambitions, but in reality drive other economic, political, and social objectives.

Policies, and regulatory programs for sustainable built environment design must consider the historical, social, political and economic conditions of the particular area as governance remains dependent on these factors for the desirable and undesirable outcomes brought by them. Local conditions shape the governance of resources (Pammett, 2015, pp. 559-560). Regulatory schemes flow out of the history of the area. How a resource is perceived within the various stakeholder groups plays a huge role in deciding the extent of control exercised on it. In the case of Boroondara, the established socio-cultural and socio-economic norms like home ownership and other political economic ambitions are achieved through the governance of natural resource like sunlight in residential design. Having this knowledge will provide the policymakers, planners and built environment designers an opportunity to critically analyze the outcomes of their plans and be cautious in systemically addressing the conditions of the area.

Cities are made of centuries of human labor and thinking. Implementing change and regulatory measures, for environmental to economic growth, in them must come with thorough understanding of how the city was built, what has worried and interested the inhabitants over the

years, and other competing interests held by the people. The goal is not to match the environmental and other policies with the aspirations of the people and to give into the demands of the stakeholders. But it is to generate policy solutions that are cautious of potential misuse of the policies, urban or suburban context they are going to ultimately perform in and potential undesirable outcomes from the implementation.

APPENDIX

Appendix 1: Interview guide

Theme Sequence	Questions/Probes
Job description of interviewees – Roles and Responsibilities (Ice breaking time)	What is a typical day like? – Walk through? Since when in this job What interests them the most Unique aspect of their position Challenges Why work in Boroondara? – How is it different?
Solar Access (onto the focal point)	Are you aware of the clauses in the planning scheme of Boroondara pertaining to Solar access, such as clause 15, 21, 22, 54, 55 (Rescodes) – that guide the building's height, setback, # dwellings, etc.? Who initiated these clauses? How valuable is sun light for buildings? And why? Benefits? Even though these clauses are guidelines and not hard rules, how do you ensure that the building developers adhere to them? What conflicts do you see? What role does it play for the city's plans for development? Instances? How did you overcome them? VCAT? Elaboration of VCAT process? How helpful is it? Could you walk me through a VCAT appeal process? Resident's attitude towards solar access in their buildings? Feedback collection? How often? Amendment making procedure? Initiator? Who approves it? Changes in solar access rights due to rezoning? Steps for accommodating this change?
Most important feature of the landscape or environment of Boroondara	Why do you think so? What makes this feature unique? What does the city do to protect it?

	Who all are the stakeholders? Which clauses in the planning scheme that support this feature? Are they adequate and enough? Some threats to this feature?
Neighboring cities and adjoining areas	Relationship – positive/negative? Competition for resources? Other impacts from nearby metropolitan areas? How does the Victoria state government help in ____? Some instances? Sustainable city of the year award? How does the planning scheme help for competition?
City Planning (Includes concerns of Real estate as well)	Description of the department – strategic and statutory? Challenges? What do you think are future opportunities for BD? And challenges that need attention? Who all are the stakeholders?

Appendix 2:

Clauses related to solar access in the planning scheme of the City of Boroondara.

I. Clause 15.01-02
II. Clause 21.06 – Environmentally Sustainable Development fact sheet, Lot less than 500 square meter guidelines.
III. Clause 54.03
IV. Clause 54.04
V. Clause 55.04
VI. Clause 55.05
VII. Clause 56.04

Clause 15.01-2 Urban design principles

STATE PLANNING POLICY FRAMEWORK - CLAUSE 15

Objective

To achieve architectural and urban design outcomes that contribute positively to local urban character and enhance the public realm while minimizing detrimental impact on neighboring properties.

Strategies

Apply the following design principles to development proposals for non-residential development or residential development not covered by Clause 54, Clause 55 or Clause 56:

Context

- Development must take into account the natural, cultural and strategic context of its location.
- Planning authorities should emphasize urban design policies and frameworks for key locations or precincts.
- A comprehensive site analysis should be the starting point of the design process and form the basis for consideration of height, scale and massing of new development.

The public realm

The public realm, which includes main pedestrian spaces, streets, squares, parks and walkways, should be protected and enhanced.

Safety

New development should create urban environments that enhance personal safety and property security and where people feel safe to live, work and move in at any time.

Landmarks, views and vistas

Landmarks, views and vistas should be protected and enhanced or, where appropriate, created by new additions to the built environment.

Pedestrian spaces

Design of interfaces between buildings and public spaces, including the arrangement of adjoining activities, entrances, windows, and architectural detailing, should enhance the visual and social experience of the user.

Heritage

New development should respect, but not simply copy, historic precedents and create a worthy legacy for future generations.

Consolidation of sites and empty sites

- New development should contribute to the complexity and diversity of the built environment.
- Site consolidation should not result in street frontages that are out of keeping with the complexity and rhythm of existing streetscapes.
- The development process should be managed so that sites are not in an unattractive, neglected state for excessive periods and the impacts from vacant sites are minimized.

Light and shade

- Enjoyment of the public realm should be enhanced by a desirable balance of sunlight and shade.
- This balance should not be compromised by undesirable overshadowing or exposure to the sun.

Energy and resource efficiency

All building, subdivision and engineering works should include efficient use of resources and energy efficiency.

Architectural quality

- New development should achieve high standards in architecture and urban design.
- Any rooftop plant, lift over-runs, service entries, communication devices, and other technical attachment should be treated as part of the overall design.

Landscape architecture

Recognition should be given to the setting in which buildings are designed and the integrating role of landscape architecture.

Policy guidelines

Planning must consider as relevant:

- Design Guidelines for Higher Density Residential Development (Department of Sustainability and Environment, 2004) in assessing the design and built form of residential development of five or more storeys.
- Activity Centre Design Guidelines (Department of Sustainability and Environment, 2005) in preparing activity centre structure plans and in assessing the design and built form of new development in activity centres.

- Safer Design Guidelines for Victoria (Crime Prevention Victoria and Department of Sustainability and Environment, 2005) in assessing the design and built form of new development.
- Urban Design Charter for Victoria (Department of Planning and Community Development 2009).

Environmentally Sustainable Development guidelines – Clause 21.06 and Clause 15

Information sheet

City of Boroondara

1

ENVIRONMENTALLY SUSTAINABLE DESIGN

This information Sheet aims to increase knowledge and awareness of environmentally sustainable development and design, recognising the contribution that everybody can make to assist Council in achieving its long term vision for a 'Sustainable City of Boroondara'.

The City of Boroondara has developed a long term vision for the future called **"Our Boroondara - Our City Our Future"**. The Vision has four key themes that revolve around community connectedness and sustainability:

- **Vision theme 1 Community Wellbeing**
- **Vision theme 2 Managing a Sustainable Environment**
- **Vision theme 3 Planning a Well Designed & Sustainable City**
- **Vision theme 4 Connecting Our City**

These four themes connect to the strategic objectives in the adopted Council Plan 2008 - 2013, which articulates Council's future vision, **'Our Boroondara - Our City Our Future'**. 'Sustaining our environment', is a key objective in the Corporate Plan stating that Council will provide leadership in the area of ESD by incorporating sustainable practices in the provision of its services and assets.

Council's vision is reflected in many strategic planning policies, in particular those included in the Boroondara Planning Scheme.

Clause 15 of the State Planning Provisions in the Planning Scheme is entitled "Environment" and provides objectives and guidelines in various areas, including water, salinity, air quality, noise etc, all of which aim to achieve a healthier and more sustainable environment.

Clause 21.06 of the Local Planning Policy provides more detailed objectives and strategies that are specific to Boroondara. It is Council's intention that a more rigourous assessment is used to ensure that environmental sustainability is embedded in the design of new development.

ESD or 'environmentally sustainable development' is becoming increasingly important in our everyday life. It is our responsibility towards future generations to ensure that what we enjoy today can be protected for them to enjoy in the future.

'Environmentally/ecologically sustainable development', at its broadest meaning, is defined by the World Commission on Environment & Development in its 1990 report, as: *Our Common Future:*

Sustainable Development – development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Ecologically Sustainable Development is a very broad term in its application and covers all aspects of life, including natural, social, cultural and economic.

The focus of **this Sheet** is on the built environment, which involves both the built form and open spaces.

The Sheet aims to provide guidance to residents, developers, applicants and any other groups who may be involved in the design and planning of our environment. Achieving a more sustainable environment requires that both Council and developers/applicants work collaborathely to reduce their greenhouse gas emissions and carbon footprints.

This Information Sheet therefore provides some simple, yet effective measures, which applicants need to consider in their planning applications to demonstrate that an environmentally sustainable outcome is achieved for their proposals.

Council's initiatives in the ESD area include the 'Low Carbon Strategy' and the 'Eco Living Centre', which can be accessed on Council's website: http://boroondara.vic.gov.au/environment

Passive Solar Design

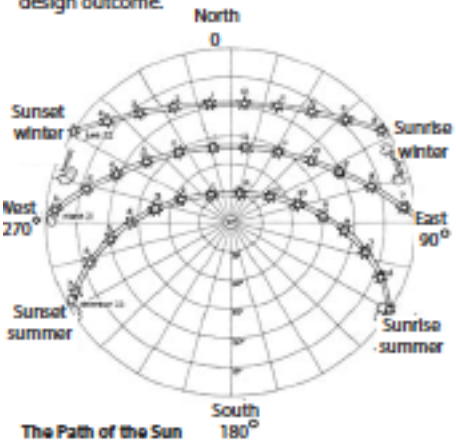
This fact sheet provides guidance to applicants by highlighting a number of simple, yet cost effective measures reducing greenhouse gases and improving environmental performance of new deveolopment. As part of the planning assessment process, Council will be evaluating the environmental performance of new proposals, focusing on the following areas:

1. Passive solar design: e.g. north orientation, sunlight access and cross ventilation.
2. Energy efficiency: e.g. heating, cooling, lighting & insulation.
3. Water conservation: e.g. water use, recycling grey water and Water Sensitive Urban Design (WSUD).
4. Sustainable transport: e.g. bike storage and facilities.
5. Building materials: e.g. energy efficient materials, re-use and recycling of existing materials.
6. Indoor air quality.
7. Waste management: e.g. recycling.
8. Light and noise pollution.
9. Building management systems.
10. Landscaping.
11. Sustainable Transport.

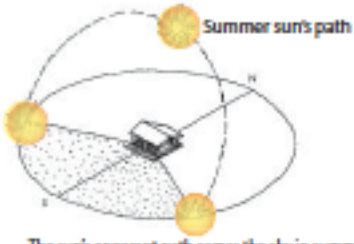
Information contained in this brochure is sourced from:
http://yourdevelopment.org/
https://museumvictoria.com.au/DiscoveryCentre/Infosheets/Planets/The-Path-of-the-Sun/
The Nature of Sustainable Development, Sharon Beder, Earth Foundation Australia, second edition 1996

The first stage in any concept development should focus on producing a site analysis that documents all existing conditions. Solar access is the most important factor when considering design layout and siting. Working out the best orientation to get adequate sunlight access to the development without compromising solar access to neighbouring properties and the public domain is the first step towards achieving a sustainable design outcome and can provide enormous environmental and monetary benefits in the long term.

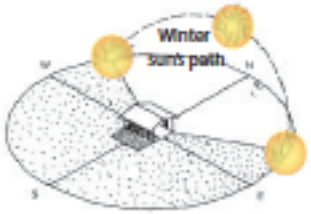
Understanding the manner in which the sun interacts with buildings is therefore critical for a good site analysis and an environmentally responsive design outcome.



The Path of the Sun
The diagram below shows the path of the Sun across the sky in Melbourne for four important dates: the Autumn Equinox- March 21; the Winter Solstice - June 22; the Spring Equinox - Sep 23; & the Summer Solstice -Dec 22.



The sun's apparent path across the sky in summer in Melbourne



The sun's apparent path across the sky in winter in Melbourne

Passive Solar Design

Siting and orientation of buildings is one of the fundamental principles of climate responsive, passive design. Proper siting and orientation can achieve energy efficiency through maximising natural ventilation and solar access. The following are some basic strategies to apply to the internal layout of spaces, especially for residential development:

1. Orienting the long axis of buildings east-west to maximise exposure to north.
2. Locating living areas to face true north to maximise sun light access, especially in winter.
3. Placing bedrooms and kitchens to the east to access morning sun.
4. Locating outdoor areas and private open spaces to north to take advantage of winter sun.
5. Locating non-habitable areas on the western or southern side to enable activity areas to get good sun light.
6. Orienting and locating windows and openings to encourage natural ventilation and air flow by prevailing winds.
7. Maximising opportunities for cross ventilation by careful design, location of habitable rooms and placement of windows and openings.
8. Providing proper shading devices such as eaves, external screens and overhangs on east and west elevations.
9. Careful choice of materials and finishes for roof and walls can assist in reducing heat gain or loss e.g. lighter coloured materials absorb less heat and double glazing of windows can reduce winter heat loss.
10. Providing sheltered outdoor spaces that have access to sunlight in winter, but protected from the sun in summer.

References:
Your Development: Creating Sustainable Neighbourhoods, 2008, www.yourdevelopment.org

The Good Design Guide for medium-density housing, Department of Planning and Development, Vic

Australia's Guide to Good Residential Design, the National Office of Local Government & RMIT

Also, visit the following sites for more information:
www.abcb.gov.au
www.seav.vic.gov.au
www.seav.vic.gov.au/buildings
www.buildingcommission.com.au

A proper site analysis should identify the main opportunities & constraints of the land, which will influence the design, in particular north orientation and potential solar access.
Passive solar design means using the heat of the sun and natural air movement to maintain a comfortable internal environment all year round.

Factors that influence passive solar design include: building orientation, building siting and shape, zoning of activities, daylight access and potential heat loss, ventilation, thermal mass and insulation.

Lot less than 500 sq. meter guidelines

Information sheet
City of Boroondara

1

Lots Less Than 500sqm

Constructing or undertaking alterations & additions to a dwelling on a lot less than 500 square metres

This information sheet identifies the regulations and policies that Council will consider when assessing applications for the construction of, or alterations and additions to, a dwelling on a lot less than 500 square metres in Boroondara, for which a Planning Permit is required.

Specific land use and development controls are set out in a document known as the Boroondara Planning Scheme. The Scheme incorporates State Planning Policies as well as Boroondara's own planning policies.

The objectives and design standards for single dwelling development are found in Clause 54 of the Boroondara Planning Scheme.
http://boroondara.vic.gov.au/planning-scheme
This section of the Scheme is also known as Rescode. Rescode sets out objectives and a list of minimum standards that a development should meet.

Specifically, it covers matters such as:
- Neighbourhood Character – to ensure that a proposed development respects and responds to the physical context and streetscape in which it sits;
- External Amenity – to ensure that a proposed development does not overshadow, overlook or provide unreasonable visual bulk to surrounding neighbours;
- Internal Amenity – to ensure that a proposed development provides an appropriate site layout &design response to provide for the needs of future residents.

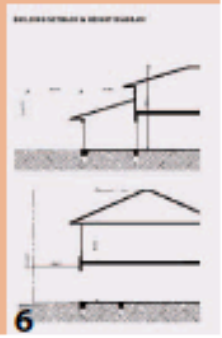
The objectives of Rescode must be met or a proposal will not be supported. The standards should also be met although this may not necessarily achieve an appropriate design solution. In order to assist planning officers in the assessment of neighbourhood character in particular, the City of Boroondara has prepared a Residential Urban Character Study (1996), which seeks to highlight the specific characterisitics of all neighbourhood areas within the municipality.

Applicable Rescode standards for assessment in lot less than 500 square metres applications:

1. Neighbourhood character and integration with the street
2. Site layout and building massing
   - Street setback
   - Building height
   - Site coverage and permeability
   - Energy efficiency
   - Significant trees
   - Parking
3. Amenity impacts
   - Side and rear setbacks
   - Walls on boundaries
   - Daylight to existing windows
   - North- facing windows
   - Overshadowing
   - Overlooking
4. On-site amenity and facilities

The Statutory Planning Department can be contacted on 9278 4888, or you may view Council's or DPCD's websites at:
www.boroondara.vic.gov.au
http://planningschemes.dpcd.vic.gov.au/boroondara/home.html

Visual bulk, solar access & overlooking are some of the issues to be addressed when developing a dwelling on a lot less than 500sq.m.
1, 2, 3, a variety of shading devices available for investigation and utilisation.
5 Solar access depends on lot orientation
6 Side setbacks can ameliorate any potential visual bulk



BOROONDARA

Clause 54.04 AMENITY IMPACTS

54.04-1 Side and rear setbacks objective

To ensure that the height and setback of a building from a boundary respects the existing or preferred neighborhood character and limits the impact on the amenity of existing dwellings.

Standard A10

A new building not on or within 200mm of a boundary should be set back from side or rear boundaries:

- At least the distance specified in a schedule to the zone, or
- If no distance is specified in a schedule to the zone, 1 metre, plus 0.3 metres for every metre of height over 3.6 metres up to 6.9 metres, plus 1 metre for every metre of height over 6.9 metres.

  Sunblinds, verandahs, porches, eaves, fascias, gutters, masonry chimneys, flues, pipes, domestic fuel or water tanks, and heating or cooling equipment or other services may encroach not more than 0.5 metres into the setbacks of this standard.

  Landings having an area of not more than 2 square metres and less than 1 metre high, stairways, ramps, pergolas, shade sails and carports may encroach into the setbacks of this standard.

  Diagram A1 Side and rear setbacks

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- Any relevant neighborhood character objective, policy or statement set out in this scheme.
- The design response.
- The impact on the amenity of the habitable room windows and secluded private open space of existing dwellings.
- Whether the wall is opposite an existing or simultaneously constructed wall built to the boundary.
- Whether the wall abuts a side or rear lane.

54.04-2 Walls on boundaries objective

To ensure that the location, length and height of a wall on a boundary respects the existing or preferred neighborhood character and limits the impact on the amenity of existing dwellings.

Standard A11

A new wall constructed on or within 200mm of a side or rear boundary of a lot or a carport constructed on or within 1 meter of a side or rear boundary of a lot should not abut the boundary:

- For a length more than the distance specified in a schedule to the zone; or
- If no distance is specified in a schedule to the zone, for a length of more than:
    - 10 meters plus 25 per cent of the remaining length of the boundary of an adjoining lot, or
    - Where there are existing or simultaneously constructed walls or carports abutting the boundary on an abutting lot, the length of the existing or simultaneously constructed walls or carports, whichever is the greater.

    - A new wall or carport may fully abut a side or rear boundary where the slope and retaining walls or fences would result in the effective height of the wall or carport being less than 2 metres on the abutting property boundary.
    - A building on a boundary includes a building set back up to 200mm from a boundary.
    - The height of a new wall constructed on or within 200mm of a side or rear boundary or a carport constructed on or within 1 metre of a side or rear boundary should not exceed an average of 3.2 metres with no part higher than 3.6 metres unless abutting a higher existing or simultaneously constructed wall.

Decision guidelines : Before deciding on an application, the responsible authority must consider:

- Any relevant neighbourhood character objective, policy or statement set out in this scheme.
- The design response.
- The extent to which walls on boundaries are part of the neighbourhood character.

- The visual impact of the building when viewed from adjoining properties.
- The impact on the amenity of existing dwellings.
- The opportunity to minimise the length of walls on boundaries by aligning a new wall on a boundary with an existing wall on a lot of an adjoining property.
- The orientation of the boundary that the wall is being built on.
- The width of the lot.
- The extent to which the slope and retaining walls or fences reduce the effective height of the wall.
- Whether the wall abuts a side or rear lane.
- The need to increase the wall height to screen a box gutter.

54.04-3 Daylight to existing windows objective

To allow adequate daylight into existing habitable room windows.

Standard A12

Buildings opposite an existing habitable room window should provide for a light court to the existing window that has a minimum area of 3 square metres and minimum dimension of 1 metre clear to the sky. The calculation of the area may include land on the abutting lot.

Walls or carports more than 3 metres in height opposite an existing habitable room window should be set back from the window at least 50 per cent of the height of the new wall if the wall is within a 55 degree arc from the centre of the existing window. The arc may be swung to within 35 degrees of the plane of the wall containing the existing window.

Where the existing window is above ground floor level, the wall height is measured from the floor level of the room containing the window.

Diagram A2 Daylight to existing windows

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- The extent to which the existing dwelling has provided for reasonable daylight access to its habitable rooms through the siting and orientation of it's habitable room windows.
- The impact on the amenity of existing dwellings.

54.04-4 North-facing windows objective

To allow adequate solar access to existing north-facing habitable room windows.

Standard A13

If a north-facing habitable room window of an existing dwelling is within 3 metres of a boundary on an abutting lot, a building should be setback from the boundary 1 metre, plus 0.6 metre for every metre of height over 3.6 metres up to 6.9 metres, plus 1 metre for every metre of height over 6.9 metres, for a distance of 3 metres from the edge of each side of the window. A north-facing window is a window with an axis perpendicular to its surface oriented north 20 degrees west to north 30 degrees east.

Diagram A3 North-facing windows

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.

- Existing sunlight to the north-facing habitable room window of the existing dwelling.
- The impact on the amenity of existing dwellings.

54.04-5 Overshadowing open space objective

To ensure buildings do not unreasonably overshadow existing secluded private open space.

Standard A14

Where sunlight to the secluded private open space of an existing dwelling is reduced, at least 75 per cent, or 40 square metres with minimum dimension of 3 metres, whichever is the lesser area, of the secluded private open space should receive a minimum of five hours of sunlight between 9 am and 3 pm on 22 September.

If existing sunlight to the secluded private open space of an existing dwelling is less than the requirements of this standard, the amount of sunlight should not be further reduced.

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- The impact on the amenity of existing dwellings.
- Existing sunlight penetration to the secluded private open space of the existing dwelling.
- The time of day that sunlight is available to the secluded private open space of the existing dwelling.
- The effect of a reduction in sunlight on the existing use of the secluded private open space.

54.04-6 Overlooking objective

To limit views into existing secluded private open space and habitable room windows.

Standard A15

A habitable room window, balcony, terrace, deck or patio should be located and designed to avoid direct views into the secluded private open space and habitable room windows of an existing dwelling within a horizontal distance of 9 metres (measured at ground level) of the window, balcony, terrace, deck or patio. Views should be measured within a 45 degree angle from the plane of the window or perimeter of the balcony, terrace, deck or patio, and from a height of 1.7 metres above floor level.

A habitable room window, balcony, terrace, deck or patio with a direct view into a habitable room window of existing dwelling within a horizontal distance of 9 metres (measured at ground level) of the window, balcony, terrace, deck or patio should be either:

- Offset a minimum of 1.5 metres from the edge of one window to the edge of the other, or
- Have sill heights of at least 1.7 metres above floor level, or
- Have obscure glazing in any part of the window below 1.7 metres above floor level, or
- Have permanently fixed external screens to at least 1.7 metres above floor level and be no more than 25 per cent transparent.

Obscure glazing in any part of the window below 1.7 metres above floor level may be openable provided that there are no direct views as specified in this standard.

Screens used to obscure a view should be:

- Perforated panels or trellis with a maximum of 25 per cent openings or solid translucent panels.
- Permanent, fixed and durable.
- Designed and coloured to blend in with the development.

This standard does not apply to a new habitable room window, balcony, terrace, deck or patio which faces a property boundary where there is a visual barrier at least 1.8 metres high and the floor level of the habitable room, balcony, terrace, deck or patio is less than 0.8 metres above ground level at the boundary.

Diagram A4 Overlooking open space

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- The impact on the amenity of the secluded private open space or habitable room window.
- The existing extent of overlooking into the secluded private opens space and habitable room windows of existing dwellings.
- The internal daylight to and amenity of the proposed dwelling.

Clause 55.04 - AMENITY IMPACTS
55.04-1 Side and rear setbacks objective

To ensure that the height and setback of a building from a boundary respects the existing or preferred neighbourhood character and limits the impact on the amenity of existing dwellings.

Standard B17

A new building not on or within 200mm of a boundary should be set back from side or rear boundaries:

- At least the distance specified in a schedule to the zone, or

- If no distance is specified in a schedule to the zone, 1 metre, plus 0.3 metres for every metre of height over 3.6 metres up to 6.9 metres, plus 1 metre for every metre of height over 6.9 metres.
- Sunblinds, verandahs, porches, eaves, fascias, gutters, masonry chimneys, flues, pipes, domestic fuel or water tanks, and heating or cooling equipment or other services may encroach not more than 0.5 metres into the setbacks of this standard.
- Landings having an area of not more than 2 square metres and less than 1 metre high, stairways, ramps, pergolas, shade sails and carports may encroach into the setbacks of this standard.

Diagram B1 Side and rear setbacks

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- Any relevant neighbourhood character objective, policy or statement set out in this scheme.
- The design response.
- The impact on the amenity of the habitable room windows and secluded private open space of existing dwellings.
- Whether the wall is opposite an existing or simultaneously constructed wall built to the boundary.
- Whether the wall abuts a side or rear lane.

55.04-2 Walls on boundaries objective

To ensure that the location, length and height of a wall on a boundary respects the existing or preferred neighbourhood character and limits the impact on the amenity of existing dwellings.

Standard B18

A new wall constructed on or within 200mm of a side or rear boundary of a lot or a carport constructed on or within 1 metre of a side or rear boundary of lot should not abut the boundary:

- For a length of more than the distance specified in a schedule to the zone; or
- If no distance is specified in a schedule to the zone, for a length of more than:
    - 10 metres plus 25 per cent of the remaining length of the boundary of an adjoining lot, or
    - Where there are existing or simultaneously constructed walls or carports abutting the boundary on an abutting lot, the length of the existing or simultaneously constructed walls or carports, whichever is the greater.
    - A new wall or carport may fully abut a side or rear boundary where slope and retaining walls or fences would result in the effective height of the wall or carport being less than 2 metres on the abutting property boundary.
    - A building on a boundary includes a building set back up to 200mm from a boundary.

- The height of a new wall constructed on or within 200mm of a side or rear boundary or a carport constructed on or within 1 metre of a side or rear boundary should not exceed an average of 3.2 metres with no part higher than 3.6 metres unless abutting a higher existing or simultaneously constructed wall.

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- Any relevant neighborhood character objective, policy or statement set out in this scheme.
- The design response.
- The extent to which walls on boundaries are part of the neighborhood character.

- The impact on the amenity of existing dwellings.
- The opportunity to minimise the length of walls on boundaries by aligning a new wall on a boundary with an existing wall on a lot of an adjoining property.
- The orientation of the boundary that the wall is being built on.
- The width of the lot.
- The extent to which the slope and retaining walls or fences reduce the effective height of the wall.
- Whether the wall abuts a side or rear lane.
- The need to increase the wall height to screen a box gutter.

55.04-3 Daylight to existing windows objective

To allow adequate daylight into existing habitable room windows.

Standard B19

Buildings opposite an existing habitable room window should provide for a light court to the existing window that has a minimum area of 3 square metres and minimum dimension of 1 metre clear to the sky. The calculation of the area may include land on the abutting lot.

Walls or carports more than 3 metres in height opposite an existing habitable room window should be set back from the window at least 50 per cent of the height of the new wall if the wall is within a 55 degree arc from the centre of the existing window. The arc may be swung to within 35 degrees of the plane of the wall containing the existing window.

Where the existing window is above ground floor level, the wall height is measured from the floor level of the room containing the window.

Diagram B2 Daylight to existing windows

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.

- The extent to which the existing dwelling has provided for reasonable daylight access to its habitable rooms through the siting and orientation of its habitable room windows.
- The impact on the amenity of existing dwellings.

55.04-4 North-facing windows objective

To allow adequate solar access to existing north-facing habitable room windows.

Standard B20

If a north-facing habitable room window of an existing dwelling is within 3 metres of a boundary on an abutting lot, a building should be setback from the boundary 1 metre, plus 0.6 metres for every metre of height over 3.6 metres up to 6.9 metres, plus 1 metre for every metre of height over 6.9 metres, for a distance of 3 metres from the edge of each side of the window. A north-facing window is a window with an axis perpendicular to its surface oriented north 20 degrees west to north 30 degrees east.

Diagram B3 North-facing windows

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- Existing sunlight to the north-facing habitable room window of the existing dwelling.
- The impact on the amenity of existing dwellings.

55.04-5 Overshadowing open space objective

To ensure buildings do not significantly overshadow existing secluded private open space.

Standard B21

Where sunlight to the secluded private open space of an existing dwelling is reduced, at least 75 per cent, or 40 square metres with minimum dimension of 3 metres, whichever is the lesser area, of the secluded private open space should receive a minimum of five hours of sunlight between 9 am and 3 pm on 22 September.

If existing sunlight to the secluded private open space of an existing dwelling is less than the requirements of this standard, the amount of sunlight should not be further reduced.

Decision guidelines

Before deciding on an application, the responsible authority must consider:

- The design response.
- The impact on the amenity of existing dwellings.
- Existing sunlight penetration to the secluded private open space of the existing dwelling.

- The time of day that sunlight will be available to the secluded private open space of the existing dwelling.
- The effect of a reduction in sunlight on the existing use of the existing secluded private open space.

55.04-6 Overlooking objective

To limit views into existing secluded private open space and habitable room windows.

Standard B22

A habitable room window, balcony, terrace, deck or patio should be located and designed to avoid direct views into the secluded private open space of an existing dwelling within a horizontal distance of 9 metres (measured at ground level) of the window, balcony, terrace, deck or patio. Views should be measured within a 45 degree angle from the plane of the window or perimeter of the balcony, terrace, deck or patio, and from a height of 1.7 metres above floor level.

A habitable room window, balcony, terrace, deck or patio with a direct view into a habitable room window of existing dwelling within a horizontal distance of 9 metres (measured at ground level) of the window, balcony, terrace, deck or patio should be either:

- Offset a minimum of 1.5 metres from the edge of one window to the edge of the other.
- Have sill heights of at least 1.7 metres above floor level.
- Have fixed, obscure glazing in any part of the window below 1.7 metre above floor level.
- Have permanently fixed external screens to at least 1.7 metres above floor level and be no more than 25 per cent transparent.
- Obscure glazing in any part of the window below 1.7 metres above floor level may be openable provided that there are no direct views as specified in this standard.

Screens used to obscure a view should be:

- Perforated panels or trellis with a maximum of 25 per cent openings or solid translucent panels.
- Permanent, fixed and durable.
- Designed and colored to blend in with the development.

This standard does not apply to a new habitable room window, balcony, terrace, deck or patio which faces a property boundary where there is a visual barrier at least 1.8 metres high and the floor level of the habitable room, balcony, terrace, deck or patio is less than 0.8 metres above ground level at the boundary.

Diagram B4 Overlooking open space

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- The impact on the amenity of the secluded private open space or habitable room window.
- The existing extent of overlooking into the secluded private open space and habitable room windows of existing dwellings.
- The internal daylight to and amenity of the proposed dwelling or residential building.

55.04-7 Internal views objective

To limit views into the secluded private open space and habitable room windows of dwellings and residential buildings within a development.

Standard B23

Windows and balconies should be designed to prevent overlooking of more than 50 per cent of the secluded private open space of a lower-level dwelling or residential building directly below and within the same development.

Decision guideline: Before deciding on an application, the responsible authority must consider the design response.

55.04-8 Noise impacts objectives

To contain noise sources in developments that may affect existing dwellings. To protect residents from external noise.

Standard B24

Noise sources, such as mechanical plant, should not be located near bedrooms of immediately adjacent existing dwellings.

Noise sensitive rooms and secluded private open spaces of new dwellings and residential buildings should take account of noise sources on immediately adjacent properties.

Dwellings and residential buildings close to busy roads, railway lines or industry should be designed to limit noise levels in habitable rooms.

Decision guideline

Before deciding on an application, the responsible authority must consider the design response.

Clause 55.05

55.05 ON-SITE AMENITY AND FACILITIES

55.05-1 Accessibility objective

To encourage the consideration of the needs of people with limited mobility in the design of developments.

Standard B25

The dwelling entries of the ground floor of dwellings and residential buildings should be accessible or able to be easily made accessible to people with limited mobility.

55.05-2 Dwelling entry objective

To provide each dwelling or residential building with its own sense of identity.

Standard B26

Entries to dwellings and residential buildings should:

- Be visible and easily identifiable from streets and other public areas.
- Provide shelter, a sense of personal address and a transitional space around the entry.

55.05-3 Daylight to new windows objective

To allow adequate daylight into new habitable room windows.

Standard B27

A window in a habitable room should be located to face:

- An outdoor space clear to the sky or a light court with a minimum area of 3 square metres and minimum dimension of 1 metre clear to the sky, not including land on an abutting lot, or
- A verandah provided it is open for at least one third of its perimeter, or
- A carport provided it has two or more open sides and is open for at least one third of its perimeter.

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- Whether there are other windows in the habitable room which have access to daylight.

55.05-4 Private open space objective

To provide adequate private open space for the reasonable recreation and service needs of residents.

Standard B28

A dwelling or residential building should have private open space of an area and dimensions specified in a schedule to the zone.

If no area or dimensions are specified in a schedule to the zone, a dwelling or residential building should have private open space consisting of:

- An area of 40 square metres, with one part of the private open space to consist of secluded private open space at the side or rear of the dwelling or residential building with a minimum area of 25 square metres, a minimum dimension of 3 metres and convenient access from a living room, or
- A balcony of 8 square metres with a minimum width of 1.6 metres and convenient access from a living room, or
- A roof-top area of 10 square metres with a minimum width of 2 metres and convenient access from a living room.

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- The usability of the private open space, including its size and accessibility.
- The availability of and access to public or communal open space.
- The orientation of the lot to the street and the sun.

55.05-5 Solar access to open space objective

To allow solar access into the secluded private open space of new dwellings and residential buildings.

Standard B29

The private open space should be located on the north side of the dwelling or residential building, if appropriate.

The southern boundary of secluded private open space should be set back from any wall on the north of the space at least (2 + 0.9h) metres, where 'h' is the height of the wall.

Diagram B5 Solar access to open space

Decision guidelines: Before deciding on an application, the responsible authority must consider:

- The design response.
- The usability and amenity of the secluded private open space based on the sunlight it will receive.

55.05-6 Storage objective

To provide adequate storage facilities for each dwelling.

Standard B30

Each dwelling should have convenient access to at least 6 cubic metres of externally accessible, secure storage space.

Clause 56.04

56.04 LOT DESIGN

1. **56.04-1 Lot diversity and distribution objectives**

    - To achieve housing densities that support compact and walkable neighbourhoods and the efficient provision of public transport services.
    - To provide higher housing densities within walking distance of activity centres. To achieve increased housing densities in designated growth areas.
    - To provide a range of lot sizes to suit a variety of dwelling and household types.

Standard C7

A subdivision should implement any relevant housing strategy, plan or policy for the area set out in this scheme.

Lot sizes and mix should achieve the average net residential density specified in any zone or overlay that applies to the land or in any relevant policy for the area set out in this scheme.

A range and mix of lot sizes should be provided including lots suitable for the development of:

- Single dwellings.
- Two dwellings or more.
- Higher density housing.
- Residential buildings and Retirement villages.
- Unless the site is constrained by topography or other site conditions, lot distribution should provide for 95 per cent of dwellings to be located no more than 400 metre street walking distance from the nearest existing or proposed bus stop, 600 metres street walking distance from the nearest existing or proposed tram stop and 800 metres street walking distance from the nearest existing or proposed railway station.
- Lots of 300 square metres or less in area, lots suitable for the development of two dwellings or more, lots suitable for higher density housing and lots suitable for Residential buildings and Retirement villages should be located in and within 400 metres street walking distance of an activity centre.

56.04-2 Lot area and building envelopes objective

To provide lots with areas and dimensions that enable the appropriate siting and construction of a dwelling, solar access, private open space, vehicle access and parking, water management, easements and the retention of significant vegetation and site features.

Standard C8

An application to subdivide land that creates lots of less than 300 square metres should be accompanied by information that shows:

That the lots are consistent or contain building envelope that is consistent with a development approved under this scheme, or

That a dwelling may be constructed on each lot in accordance with the requirements of this scheme.

Lots of between 300 square metres and 500 square metres should:

- Contain a building envelope that is consistent with a development of the lot approved under this scheme, or
- If no development of the lot has been approved under this scheme, contain a building envelope and be able to contain a rectangle measuring 10 metres by 15 metres, or 9 metres by 15 metres if a boundary wall is nominated as part of the building envelope.
- If lots of between 300 square metres and 500 square metres are proposed to contain dwellings that are built to the boundary, the long axis of the lots should be within 30 degrees east and 20 degrees west of north unless there are significant physical constraints that make this difficult to achieve.
- Lots greater than 500 square metres should be able to contain a rectangle measuring 10 metres by 15 metres, and may contain a building envelope.
- A building envelope may specify or incorporate any relevant siting and design requirement.
- Any requirement should meet the relevant standards of Clause 54, unless:

    - The objectives of the relevant standards are met, and
    - The building envelope is shown as a restriction on a plan of subdivision registered under the Subdivision Act 1988, or is specified as a covenant in an agreement under Section 173 of the Act.
    - Where a lot with a building envelope adjoins a lot that is not on the same plan of subdivision or is not subject to the same agreement relating to the relevant building envelope:

- The building envelope must meet Standards A10 and A11 of Clause 54 in relation to the adjoining lot, and

- The building envelope must not regulate siting matters covered by Standards A12 to A15 (inclusive) of Clause 54 in relation to the adjoining lot. This should be specified in the relevant plan of subdivision or agreement.

Lot dimensions and building envelopes should protect:

- Solar access for future dwellings and support the siting and design of dwellings that achieve the energy rating requirements of the Building Regulations.
- Existing or proposed easements on lots.
- Significant vegetation and site features.

56.04-3 Solar orientation of lots objective

To provide good solar orientation of lots and solar access for future dwellings.

Standard C9

Unless the site is constrained by topography or other site conditions, at least 70 percent of lots should have appropriate solar orientation.

Lots have appropriate solar orientation when:

The long axis of lots are within the range north 20 degrees west to north 30 degrees east, or east 20 degrees north to east 30 degrees south.

- Lots between 300 square metres and 500 square metres are proposed to contain dwellings that are built to the boundary, the long axis of the lots should be within 30 degrees east and 20 degrees west of north.
- Dimensions of lots are adequate to protect solar access to the lot, taking into account likely dwelling size and the relationship of each lot to the street.

56.04-4 Street orientation objective

To provide a lot layout that contributes to community social interaction, personal safety and property security.

Standard C10

Subdivision should increase visibility and surveillance by:

- Ensuring lots front all roads and streets and avoid the side or rear of lots being oriented to connector streets and arterial roads.
- Providing lots of 300 square metres or less in area and lots for 2 or more dwellings around activity centres and public open space.
- Ensuring streets and houses look onto public open space and avoiding sides and rears of lots along public open space boundaries.

- Providing roads and streets along public open space boundaries.

56.04-5 Common area objectives

To identify common areas and the purpose for which the area is commonly held.

To ensure the provision of common area is appropriate and that necessary management arrangements are in place.

To maintain direct public access throughout the neighbourhood street network.

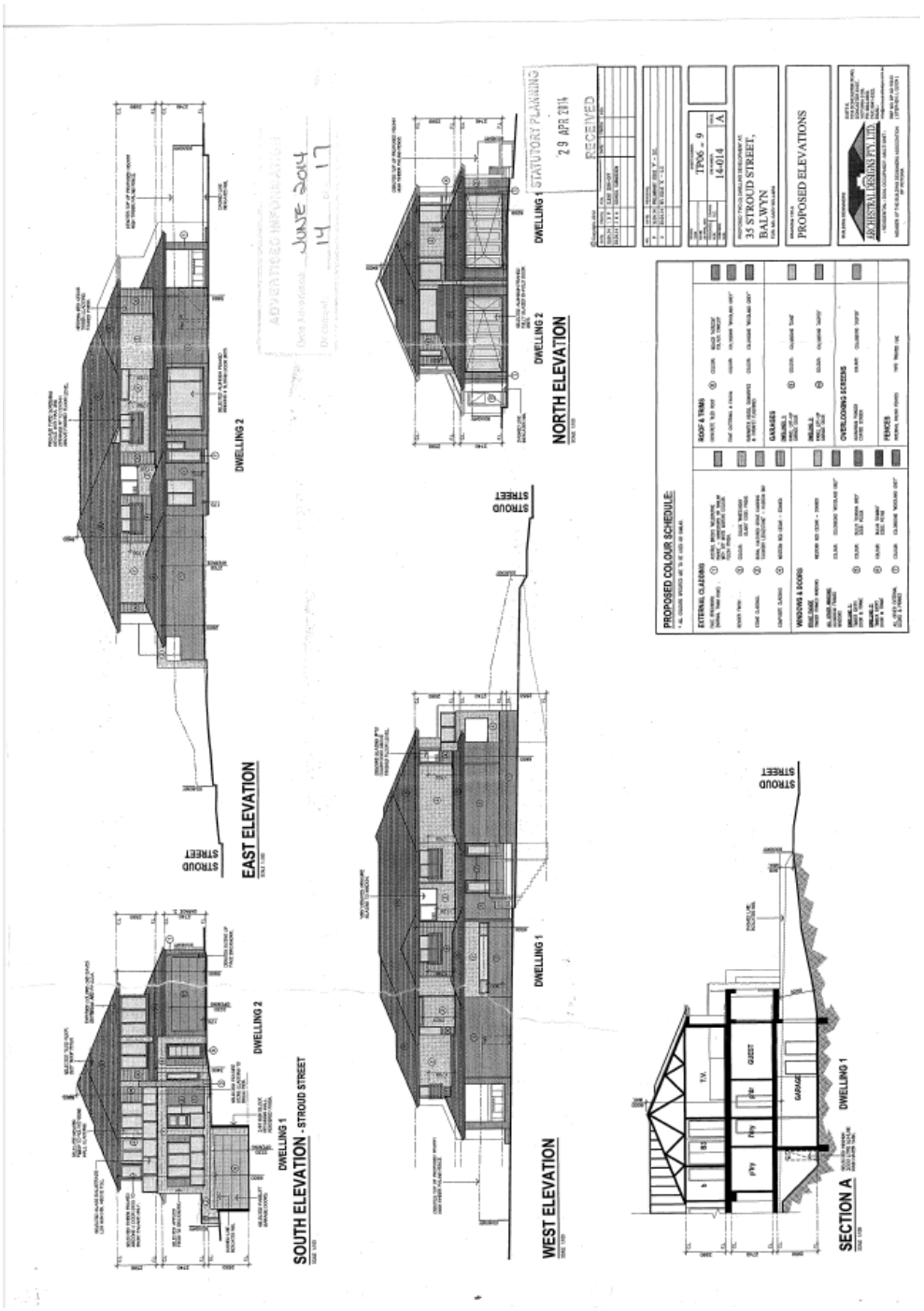
Standard C11

An application to subdivide land that creates common land must be accompanied by a plan and a report identifying:

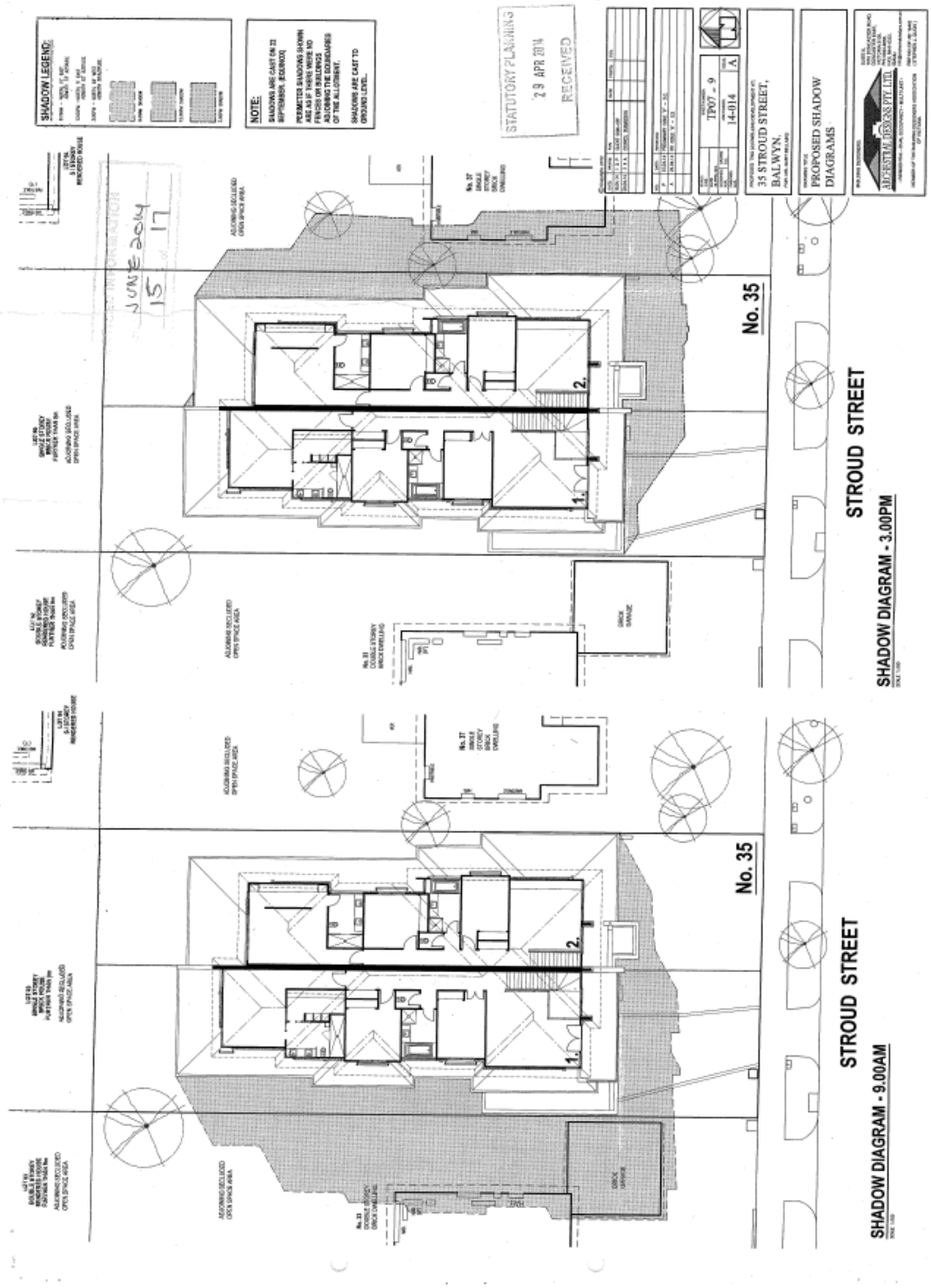
- The common area to be owned by the body corporate, including any streets and open space.
- The reasons why the area should be commonly held.
- Lots participating in the body corporate.
- The proposed management arrangements including maintenance standards for streets and open spaces to be commonly held.

Appendix 3

Buildings permit application with Shadow diagrams



Document below showing shadow diagrams provided with building permit application.



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