

Chapter 2

Background to Australian House Energy Rating

This chapter discusses the context of space heating and its associated energy use in Australian residential buildings. The use of heating is then considered in the context of Australian greenhouse gas emissions and the recent acceptance of the need to stabilise and then reduce emissions. To achieve a reduction in residential greenhouse gas emissions, a range of measures have been developed by industry and government. One of these measures to reduce the energy for heating and cooling due to poor building envelope designs was to introduce residential house energy star-ratings for new Australian housing (Delsante 1996). A number of industry groups raised concerns with regard to the effectiveness and capabilities of the HER star-rating softwares. These are discussed in Chaps. 2 and 3 then discusses the history and complexities of house energy rating software validation.

2.1 Historical and Human Perspective

Even before the first built shelters, humans utilised elements to improve thermal comfort. As the first shelters evolved, the hearth was used to both cook and provide warmth (Fig. 2.1). In warmer climates dwellings provided shade and ventilation, whilst in cooler climates shelters became more structured and enclosed. In the cooler climates the evolution of the house included the desire to keep the cold out and the warmth in. As these built structures grew to two or more rooms, the number of heating sources increased accordingly.

When Europeans settled in Australia, it was not uncommon for each room of the house to have an open fireplace (Fig. 2.2). For households on a wood budget, the family would gather around the combustion stove in the kitchen, which also provided a place for cooking and provided hot water. For wealthier households, friends and family would gather around the much less efficient but physiologically and psychologically appealing, large open fire. In the twentieth century, when wood became scarcer in urban environments, other alternatives for heating were explored including: coal, petrochemical, gas and electrical. However in both urban and non-urban locations the fireplace prevailed (Fig. 2.3).

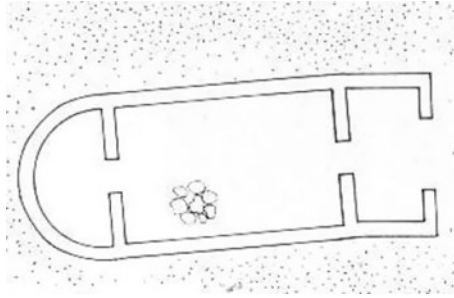


Fig. 2.1 Dwelling with hearth ~1,500 BC (Kostof 1995, p. 99)

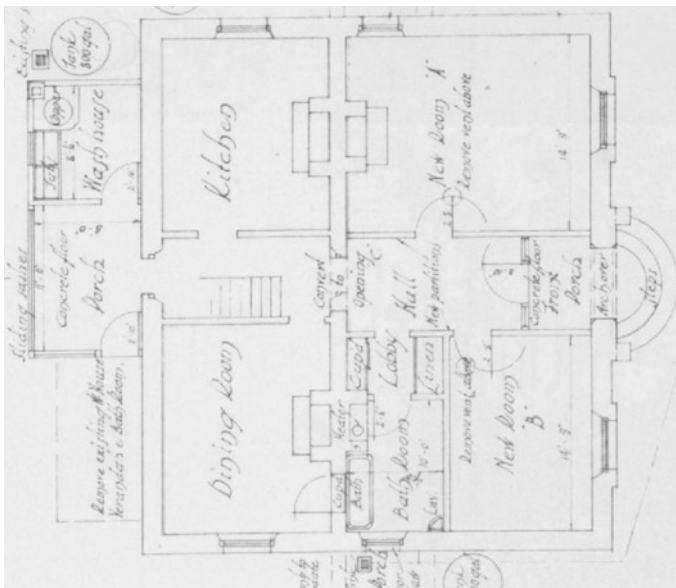


Fig. 2.2 School building and dwelling with hearth in each room, mid-1800s Tasmania (Department of Public Works 1850)

As Australian residential development evolved in the twentieth century, society was moving from a principally agrarian type, where the house was used throughout the day, to a society of commuting workers. This had many impacts on the use of the home. In the agrarian model, all meals were usually prepared and eaten in the house. The house was regularly opened up for ventilation and windows, doors and blinds were used to assist in the control of heat gain or heat loss. These houses often had small windows, as the house was seen as a refuge from the outdoors (Tawa 1988). As more people became commuters to the interiors of other buildings, the desire to have a more transparent relationship between the house and the outdoors increased

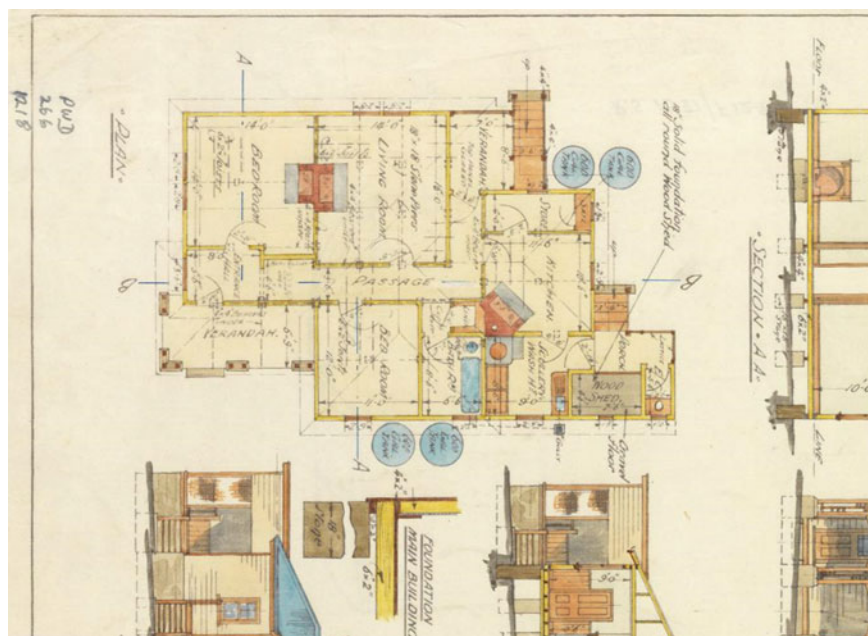


Fig. 2.3 Dwelling with hearth in each room, 1926 Tasmania (Department of Public Works 1926)

(Mithraratne et al. 2007; Tawa 1988). To allow for the experience of the outdoors, there was an increase in the area of glazing and doors and a resultant decrease in wall area. Even an uninsulated wall had a better insulation value than a single glazed leaky door or window. Depending on climatic region, this reduction in the insulation qualities of the built fabric resulted in an increased requirement for heating and/or cooling, to maintain human comfort. This change in house type and occupant wealth also created a change in heating patterns, where the heating or cooling of the entire house instead of a single room became more common (Hastings and Wall 2007).

In a medium-to-large sized town, like Launceston (Tasmania), residents might have had access to coal-based town gas and if the house was near a pipeline, gas was available for cooking, heating and lighting. The household wood budget migrated to gas. As the gas heater was placed in a more enclosed room, there was less heat loss, but health issues with regard to air quality and moisture became apparent, and are still present today in some low-income housing (enHealth 2007).

The advent of grid-supplied electricity and the kerosene heater introduced the principle of portable heating. The dirty fireplace was removed and the heater was moved from room to room, depending on household budget. As electricity became more accessible, the development of portable electric heating became increasingly attractive, as it involved less fuel fetching and associated cleaning. Launceston (Tasmania) had hydro power available in 1895. The use of the clean and portable electric heating became more common but was still more expensive than wood or coal. Due to the cost difference between firewood and electricity, there was and still

is, a significant reliance on wood-based heating in many parts of cool temperate Australia, which included 34.5 % of Tasmania’s residential heating requirement in 2007 (DEWHA 2008).

At the time of establishing benchmark values for greenhouse gas emissions, (from 1990 to 1998), 21 % of space heating was provided by wood fuels. For most of Australia, with the exception of Tasmania, electricity was used to provide the majority of space heating and cooling requirements (DEWHA 2008). For Tasmania, the majority of non-wood-based space heating and space cooling was provided by portable electrical appliances (AGO 1999). The recent advances in personal wealth and residential “heat pump” technology has allowed for a cleaner alternative to the open fire, but with a corresponding increase in electricity consumption. Despite house improvements (including the installation of insulation), more energy was being used to make the entire house comfortable (AGO 1999). The method of building houses had not changed for some time in Australia. The most visible change was a gradual shift from timber to brick veneer cladding. Most jurisdictions in 2002 had a minimal or nil requirement for the installation of subfloor, wall or ceiling insulation in new homes (ABCB 2002). For Tasmania, as in many other Australian states, new personal wealth was used to make houses larger, rather than better insulated, as shown in Tables 2.1 and 2.2.

There is evidence of new Tasmanian homes, (even in 2010), having internal temperatures similar to those of the outdoor environment in both summer and winter (Dewsbury 2005–2010). Regardless of the approach adopted, depending on financial capability, the householder was heating a room or the whole house for their comfort. As the general wealth of Australians has grown, houses that were uncomfortable by design became comfortable through the use of artificial heating and cooling (Table 2.3). In Tasmania, 50 % of residential energy was used for space heating, as in Table 2.4 (AURORA 2006; Pearman 1987). The Australian Greenhouse Office report in 2008 (DEWHA 2008), documented that 43 % of national household energy use in 1990 was for space heating or cooling (Table 2.3).

Table 2.1 Wall thermal resistance values for Tasmanian housing 1926 and 2002

1926 Tasmanian house (Fig. 2.3)		2002 Tasmanian house (ABCB 2002)	
Material	R Value	Material	R Value
OS Surface	0.03	OS Surface	0.03
25 Weatherboard	0.16	110 Clay brick	0.18
100 Stud/air space	0.13	40 Cavity	0.13
25 Plaster	0.02	90 Stud/Air space	0.13
IS Surface	0.12	10 Plasterboard	0.06
		IS Surface	0.12
Total R	0.46	Total R	0.65

Table 2.2 Ceiling thermal resistance values for Tasmanian housing 1926 and 2002

1926 Tasmanian house (Fig. 2.3)		2002 Tasmanian house (ABCB 2002)	
Material	R Value	Material	R Value
OS Surface	0.03	OS Surface	0.03
25 Plaster	0.02	10 Plasterboard	0.06
IS Surface	0.12	IS Surface	0.12
Total R	0.17	Total R	0.21

Table 2.3 Breakdown of residential energy end uses—1990 Australia

Purpose	Fuel source	Percentage (%)
Space heating	Electrical	4
	Wood	21
	LPG	1
	Mains gas	16
Space cooling	Electrical	1
Water heating	LPG	1
	Mains gas	11
	Electrical	16
Cooking	LPG	<1
	Mains gas	2
	Electrical	3
Appliances	Mains gas	<1
	Electrical	24

DEWHA (2008)

The growing use of energy to heat or cool homes had a direct impact on household energy use, energy expenditure and greenhouse gas emissions (Figs. 2.4 and 2.5). In an attempt to curb Australia’s growing greenhouse gas emissions, regulations were developed to improve the external fabric of buildings with the intention of making buildings more comfortable, while reducing heating and cooling energy and related greenhouse gas emissions (Delsante 1996).

Table 2.4 End use of residential energy consumption in Australia, 1979–1980

State	Space heating and cooling (%)	Water heating (%)	Other (%)
Tasmania	50	30	20
Victoria	50	25	25
South Australia	35	30	35
New South Wales	30	35	35
Western Australia	25	35	40
Queensland	15	45	40
Australia	35	35	30

Pearman (1987, p. 603)

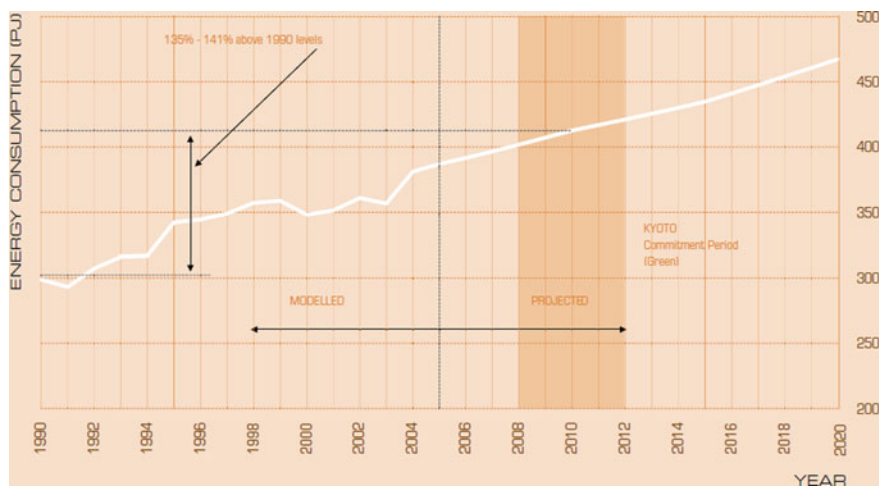


Fig. 2.4 Trends in residential total energy consumption—Australia (DEWhA 2008, p. 20)

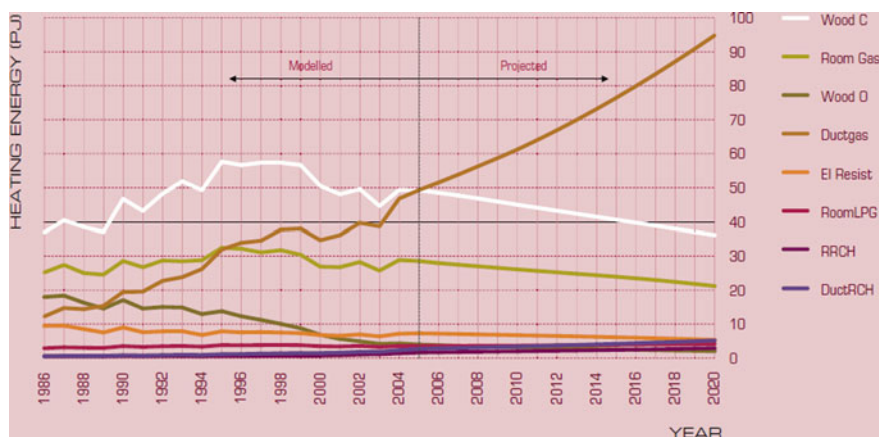


Fig. 2.5 Energy consumption (PJ)—Space heating in Australia (DEWhA 2008, p. 50)

2.2 Climate Change and Global Warming

Climate change and global warming entered the arena of scientific discussion in the 1960s (O’Brien 1990). Since that time there has been a growing debate for and against the theory of global warming and its relationship to anthropogenic greenhouse gas emissions (Carter and de Freitas 2007; Demeritt 2010; IPCC 2001, 2007; Watson et al. 2001). The general research community (Camilleri et al. 2001; Flohn 1980; Papanek 1995; Schellnhuber et al. 2006; Stern 2006; White 2004), the United

Nations (UNEP 2010) and the World Climate Research Group have documented the likely future effects of unchecked and checked climate change affecting:

- Internally and externally displaced refugees
- Disease
- Food supply
- Water supply
- Species extinctions (flora and fauna)
- Sea level change
- Temperature change
- General change in weather patterns

Internationally in the 1980s, it was agreed that nations should stabilise or reduce their green house gas emissions (Hamilton 2007; Vale and Vale 1991). To assist this process, each nation established past, current and projected greenhouse gas emissions. The benchmarks for each nation provided an awareness of the sources of greenhouse gas emissions and possible directions for greenhouse gas reduction. At that early stage it was accepted that Australia was reasonably efficient at energy generation but very inefficient in its use of energy (O'Brien 1990) and that Australia was a very high contributor to greenhouse emissions on a per capita basis (Fig. 2.6). The Australian government, in response to international pressure, commissioned a range of studies from its federal agencies (Drogemuller et al. 1999; Hamilton 2007; Norton and Williams 1990). The reports were used to inform the government on possible actions, benefits and threats from climate change, as in Fig. 2.7 (AGO 2000b, 2007a; CIE 2007; Energy Partners 2006; Lambeck 2008; O'Brien 1990).

2.3 Greenhouse Gas Reduction

With the acknowledged need to reduce greenhouse gas emissions, it was accepted that limited new efficiencies could be obtained from power generation but much higher gains in end use efficiency were possible (ARUP Research and Development 2005; IEA 2001a, b; Walsh 1988). The greenhouse gas accounting completed by each nation, not only listed where emissions occurred by sector, but also subgroups

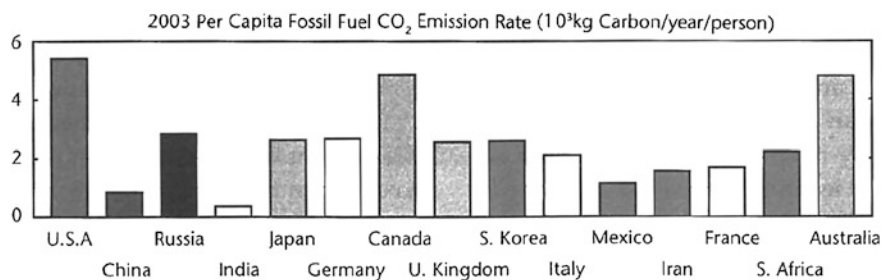


Fig. 2.6 Per capita fossil fuel emissions 2003—10 kg carbon/year/person (Pittock 2009, p. 158)

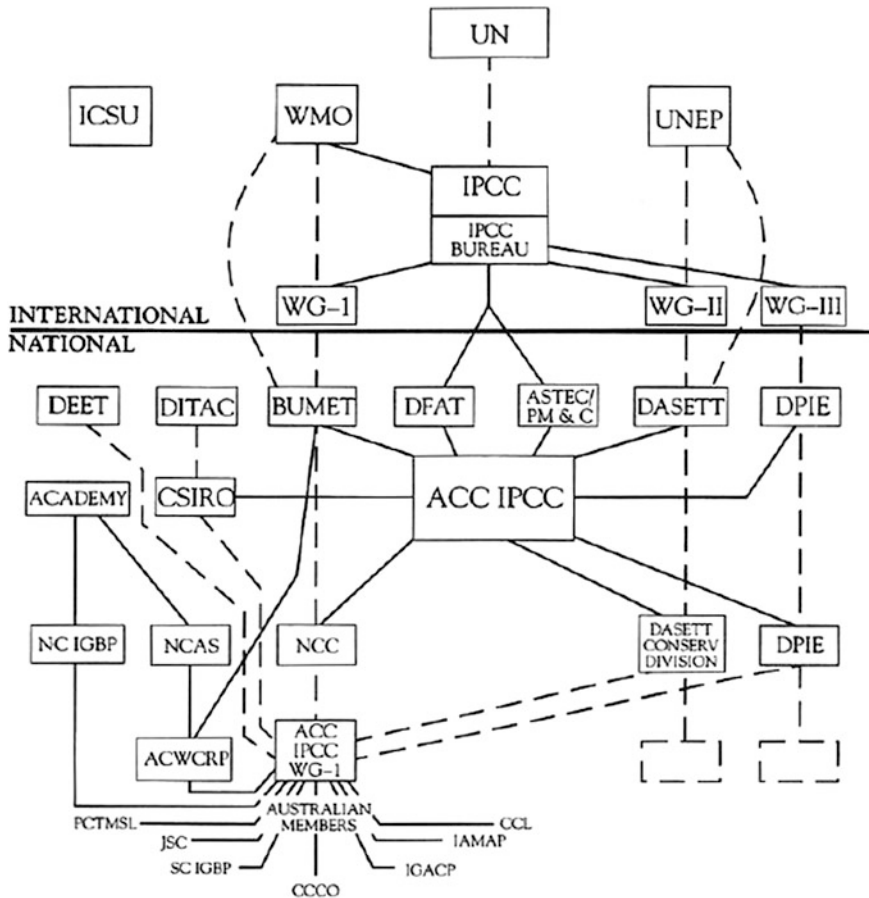


Fig. 2.7 Diagram of communication with the Australian government with respect to climate change—1989 (O'Brien 1990, p. 26)

within each sector (AGO 2002a, 2005, 2007b; DCC 2009; US EPA 2010). In an attempt to reduce immediately the long term effects of global warming or climate change and to meet their Kyoto Agreement (1987) obligations, many nations developed strategies or policies to reduce emissions by focusing on the 'low hanging fruit' first. These were areas where it was accepted that with a minimal effect on economic health, a nation could reduce its greenhouse emissions (CIE 2007; Downey et al. 2008; Green 2006; Gullu et al. 2001). Many reports included in this group the emissions from space conditioning residential and commercial buildings (AGO 2002b, 2004b; Cadima 2007; Carbon Trust 2006; Daly 2007; Do et al. 2007; Eckstein 2006; EU 2003; Harrington and Foster 1999; Isaacs 1999; Jeeninga and Kets 2004; Kavvic et al. 2009; Kim and Moon 2009; Lomas et al. 2010; Parker et al. 2003; SEAV 2004). It was estimated that up to 50 % of

greenhouse gas emissions were caused by the construction, operation and maintenance of buildings (Boardman et al. 2005; Kavgic et al. 2009; Kim and Moon 2009; Konstantinos et al. 2005; NIFES Consulting Group 1993; Sahlin et al. 2003).

The Council of Australian Governments (COAG) endorsed the National Greenhouse Response Strategy in 1992 (Williamson et al. 1995). In the 1997 Prime Ministers' Greenhouse Gas Reduction Statement, the government was seeking realistic, cost-effective reductions of emissions in key sectors (ABCB 2006b; AGO 1999). In November 1998, the Australian governments endorsed the 'National Greenhouse Strategy' (AGO 1998), committing themselves to the first stage of an ongoing national greenhouse response. The strategy explored and documented for the first time in Australia:

- An inventory of greenhouse gases
- An understanding of climate change and its impacts
- Possible methods to reduce greenhouse gas emissions
- Energy efficiency and supply
- Transport and urban planning and
- Carbon storage

The significant quantity of Australian emissions which could be attributed to the built environment was now recognised. It was considered that improving the built fabric of buildings would immediately reduce the energy used to maintain thermal comfort (ABCB 2006b; Bennet 1999; Tucker et al. 2002). Module 4.9 of the strategy "Energy Efficiency Standards for Residential and Commercial Buildings" voiced the first principles to develop minimum energy performance standards for the building sector (AGO 1998). Consequently, the Commonwealth Government announced its intention to pursue a strategy that included two elements:

- the encouragement of voluntary measures by industry, and
- the introduction of minimum mandatory (thermal performance) requirements in the Building Code of Australia (ABCB 2006b).

A scoping study was completed in 1999 by the CSIRO, for the Australian Greenhouse Office, which explored the minimum energy performance requirements that could be incorporated into the BCA (AGO 2000a; Allan et al. 2003; Drogemuller et al. 1999). The study was completed by the CSIRO Division of Building, Construction and Engineering. The study recommended two forms of compliance for energy efficiency, which fitted within the current BCA methods of prescriptive or alternative solutions to meet a set performance requirement. The study recommended:

- the further development of an accreditation scheme and administrative body within the National House Energy Rating Scheme (NatHERS)
- the further development of the NatHERS and other softwares for the thermal simulation of small to large houses

- the development of insulated fabric systems that could be incorporated within the BCA. These systems would produce a similar star rating to a house that was modelled with a NatHERS accredited software.
- the establishment of suitable climate zones within Australia
- the exploration of other energy improvement measures, that were presently outside the scope of the BCA

Internationally and nationally these types of initiatives were queried by members of the building industry and academics who raised concerns about these recommendations, as they focused primarily on the energy needed to heat or cool a building and the inherent errors that may exist in this process (AGO 2004a; Allan et al. 2003; Ballinger and Cassell 1994; de Souza et al. 2006; Gann et al. 1998; Harris et al. 2008; Hui 2003; Kordjamshidi and King 2009; Kordjamshidi et al. 2005; Productivity Commission 2004; Seo et al. 2005; Soebarto and Williamson 2001; Stein 1997; Williamson 2004; Williamson et al. 2007). Two primary types of energy are used in a building: embodied and operational energy (Birkeland 2002; Blanchard and Reppe 1998; Papamichael 2000). Embodied energy is the energy used to manufacture, transport, install the materials and to construct, maintain and dispose of a building (Crawford and Treloar 2003; Fay et al. 2000). Operational energy is the energy used during a building's service life: in heating, cooling, lighting, fixed and portable appliances, hot water and other energy consuming services, which is greatly affected by occupant behaviour and their perceived level of thermal comfort (Ballinger and Cassell 1994; Brohus et al. 2009; Chappells and Shove 2005; Coldicutt et al. 1978; Delsante 2005c; Fung et al. 2007; Johansson and Bagge 2009; Kalamees et al. 2008; Kane et al. 2006; Kordjamshidi et al. 2005; Stein 1997; Stein and Meier 2000; Stoecklein et al. 1998a, b; Williamson 2004; Williamson et al. 2007). In an attempt to reduce the emissions from these various activities they were broken into subcategories, as shown in Table 2.5 (AGO 2000b). Initially it was hoped that efficiencies would be a market-driven mechanism, but as energy was relatively inexpensive in Australia, energy consumption only increased (ABCB 2006b; Wilkenfield et al. 1995). This led to the gradual development and introduction of a range of legislation to mandate minimum energy efficiency requirements, or labelling systems, to inform purchasers of the relative energy use of houses or appliances (ABCB 2006b; Drogemuller et al. 1999; Millis 2006).

Table 2.5 Action to reduce greenhouse gas emissions

Energy use	Action
Energy for heating and cooling a building	Regulate minimum requirements for building fabric to reduce heat loss or heat gain
Appliances for heating and cooling a building	Provide a star rating system for all forms of heating and cooling appliances
Hot water services	Provide a star rating for hot water systems
Household appliances	Provide a star rating or minimum performance requirements for all appliances
Embodied energy of buildings	To be further investigated and quantified

Table 2.6 Electricity use per year AGO 2008, end use

Energy end use	Tasmania (%)	Australia (%)
Space heating	65	38
Space cooling	0	3
Hot water	14	23
Appliances	18	31

The average household in Tasmania used around 11,000 kWh of electricity per year (DEWHA 2008). The energy end use is broken into the sub-groups of: space heating, space cooling, hot water and appliances, as shown in Table 2.6. The large presence of wood-based space heating in Tasmania, results in use of 56.2 % of electrical energy for space heating (DEWHA 2008). Tasmania provided a representative example of cool temperate energy use within Australia, where any reduction in space heating requirements would have an immediate impact on greenhouse gas emissions.

2.4 Australian Thermal Performance Regulations

In January 2001 the AGO and the Australian Building Codes Board (ABCB) agreed to develop and include energy efficiency measures for new Australian buildings in the BCA, which is the national code for construction practice and all new buildings in Australia must comply with its requirements (ABCB 2006b). The BCA was developed by the ABCB, which included representatives from: federal and state government, research groups, the manufacturing sector and construction industry groups (ABCB 2006b; Davis 2005). The BCA was given regulatory force by enabling legislation in each state. The process for identifying and applying new inclusions follows the process shown in Fig. 2.8.

The BCA is divided into two volumes: volume one is generally for larger buildings, and includes: residential apartment buildings, commercial, industrial and public buildings; volume two applies to simpler residential stand-alone and attached dwellings (ABCB 2010). As there were no mechanisms to measure the thermal performance of new housing, NatHERS was established in 1993 (Ballinger and Cassell 1994; Delsante 1996; Thwaites 1995). The scheme was administered by the federal government which in co-operation with industry groups and state government members, established standards for:

- star bands for heating and/or cooling energy use relative to climate type
- climate zones for Australia
- building material libraries
- internal heat loads
- occupancy settings
- cooling and heating thermostat settings
- input and output requirements for House Energy Rating softwares

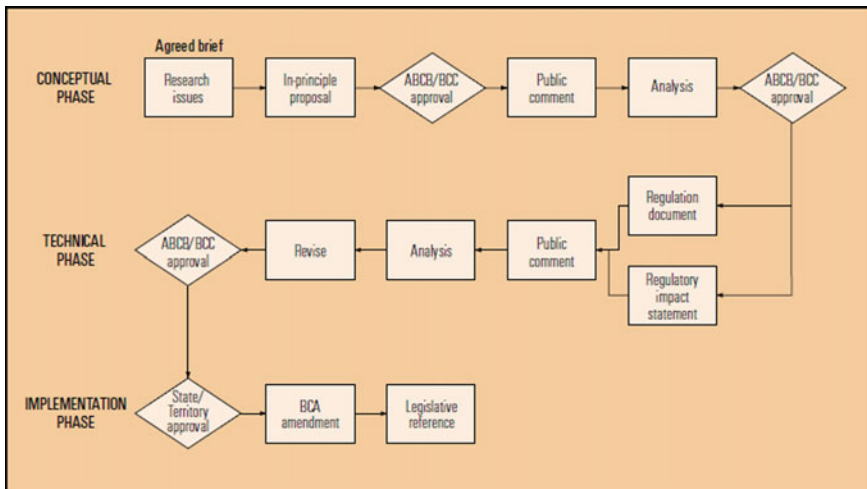


Fig. 2.8 Building codes regulatory process (Drogemuller et al. 1999, p. 9)

The most contentious requirement was the star band system (Davis 2005; Delsante 1996; Rowell 2006–2008). This was debated by stakeholder representatives, who identified problematic issues including changes to building practice and the type of energy that a house might use, as all energy sources have differing amounts of green house gas emissions. The source of household energy might be:

- renewable: Large percentage of hydro power in Tasmania,
- brown coal: Large percentage of Victorian power
- black coal: Large percentage of New South Wales power
- natural gas

Once an acknowledgement of current building practices was obtained, a staged improvement for the building stock in all states of Australia was established. It was agreed that existing construction practices in most states resulted in houses with a star rating between 1 and 3 stars (AGO 1999, 2000a). This was established by completing thermal simulations of 360 house plans of 1990–1999 typical new housing from all jurisdictions (ABCB 2006b; Anderson 2002; Delsante 2005c; Drogemuller et al. 1999). It was agreed that the new national benchmark establish a minimum requirement for all new housing of 3.5 or 4 stars, depending on climate zone (Davis 2005). The star rating bands were a sliding scale that assigned an arbitrary quantity of energy that may be used to heat or cool a house (ABCB 2005b, 2006b). It used a stepped ranking from 0 to 10 stars. A house with a 0 star rating had poor thermal performance, whilst a house with a 10 star rating requires no energy for heating or cooling to maintain thermal comfort (ABCB 2006b; NatHERS 2009a, b). As it was more difficult to maintain a thermally comfortable house in areas that are regularly hot or cold, star rating bands were established for different climate zones. The energy allowed to achieve a 5 star rating in Sydney's

Table 2.7 Star bands for Launceston and Sydney ($\text{MJ/m}^2 \cdot \text{annum}$ conditioned floor area)

Star rating	0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Launceston	748	675	549	446	361	291	231	177	123	67	2
Sydney	264	231	176	135	105	84	68	56	43	29	10

generally temperate climate was 84 MJ/m^2 per annum, whereas a house in the colder Launceston climate was allowed to consume 291 MJ/m^2 per annum (Table 2.7).

Amendment 12 of the BCA in 2003 included, for the first time, a performance objective to reduce greenhouse gas emissions by using energy efficiently (ABCB 2003b; Allan et al. 2003; BMW 2009). The first regulations applied to Class 1 buildings, houses, and required the minimum performance rating equivalent to 3.5 Stars or 4 Stars (ABCB 2003a, b; Davis 2005). This requirement was generally accepted with little opposition and adopted (with some state variations) in 2003 and 2004. The 2005 edition of the BCA extended the minimum requirement to most other types of buildings (ABCB 2005a). The requirement for Class 1 buildings was increased to a performance rating of 5 Stars in the 2006 edition (ABCB 2006a). Several states, including Tasmania, New South Wales and Queensland, deferred the adoption of this requirement for new housing. The 2010 edition of the BCA increased the requirement to 6 stars (ABCB 2009b, 2010). Some jurisdictions only adopted the 5 Star requirement in mid 2010 and others have a range of state-based exemptions and guidelines (ABCB 2010).

Since 2004, with each annual review of the energy performance requirements, additional energy saving measures have been included for housing. These have comprised: improvements to infiltration controls, the insulation of hot water plumbing, the use of fixed shading, methods of limiting perforations of built fabric and limits to artificial lighting. It was expected that hot water systems, fixed heating/cooling appliances and embodied energy would come under greater scrutiny between 2010 and 2020 (COAG 2009). Long term, the star rating system will be applied to all energy consuming elements or products included in building operation, in an attempt to have a more comprehensive incentive to reduce energy consumption (Pitt and Sherry 2010). However in 2010 the star rating requirements within the BCA principally affected the energy used for space heating and cooling only (ABCB 2010; Delsante 1996).

2.4.1 BCA Compliance

The BCA provided two methods for buildings to comply with the thermal performance requirements: deemed-to-satisfy provisions and performance-based alternative solutions (ABCB 2010). The deemed-to-satisfy provision provided a relatively simple, but conservative, manual method to determine the external fabric matrix that would deliver the required thermal performance. Developed after

numerous thermal simulations of different house types, they included: detailed descriptions and diagrams of satisfactory building practices and specific requirements for insulation, glazing, shading, building sealing and other factors that affect the heating and cooling of a house (ABCB 2009a).

A house design that did not comply with the deemed-to-satisfy provisions, or which sought to use a less conservative estimation method, required a performance-based alternative solution before it could demonstrate compliance and be approved for construction. This required that the house design obtain a minimum house energy star rating using a NatHERS accredited thermal calculation method (ABCB 2005b; Davis 2005). Within the NatHERS framework three software products were approved for use to undertake the thermal simulation and produce a star rating report. They were: AccuRate, First Rate and BERS (Delsante 2007; Foliente et al. 2004; Major 2006). The AccuRate software had been developed by the CSIRO over more than 40 years. The First-Rate software was a correlation software developed by the state government of Victoria (Kordjamshidi et al. 2005). The BERS software was developed by a private researcher in Queensland, utilised the CHEENATH engine and was principally used in that state (Kordjamshidi et al. 2005; Q-BEARS 2009; Willrath 1998). The only software that was initially suitable for all Australian jurisdictions was the AccuRate house energy rating software.

2.4.2 House Energy Star Rating

To determine the house energy star rating using the alternative solution, the house's thermal performance was simulated, based on information from the architectural drawings and specifications of a new house. If the resultant star rating met the standard requirement, then the plans were certified appropriately and (subject to other code requirements), the building permit was issued (ABCB 2005a). If the house did not meet the minimum required star rating, improvements were made to the external fabric elements until the minimum requirement was met. To conduct a thermal simulation, the house energy rating software required adequate input data for: external fabric, internal fabric, room usage and volume, local climatic information, and building orientation.

From these inputs, the software performed a thermal simulation and produced a calculated room temperature for each room of the house. From the calculated temperature, an energy calculation model within the software converted the heating and cooling requirement into an annual quantity of energy for the whole house (Kordjamshidi and King 2009). As there is no method to input specific heater capabilities (Delsante 1996), which would consider the relative efficiencies of different forms of heating equipment, the heating model is based on a coefficient of performance of 1.0 (Delsante 2005–2010). The annual energy quantity was then divided by the conditioned floor area to obtain a $\text{MJ/m}^2 \cdot \text{annum}$ (Fig. 2.9).

	AccuRate Regulatory Version Oct 2005 (expires 31 Dec 2005)			
Nationwide House Energy Rating Scheme				
Project Details				
Project Name: 5 Star house timber floor		Postcode: 7000		
File Name: C:\AccuRate\Projects\2005-12-12 - 5 star timber.PRO		Climate Zone: 26		
Design Option: Des 8 Timb no foil				
Description: a. External Wall - Kool wall / Air Space with non reflective foil vapour barrier / R1.5 Batt / Breathable Vapour Barrier / 10 Plasterboard, (b) Windows - 3/12/3 Timb, (c) Floor 1 - Carpet & Underlay - Tile - parq/ Particle board or Cem Sheet deck / 120 air / Reflective Foil, (d)				
CALCULATED ENERGY REQUIREMENTS*				
Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
214.9	12.4	1.5	228.8	MJ/m ² .annum
* These energy requirements have been calculated using a standard set of occupant behaviours and so do not necessarily represent the usage pattern or lifestyle of the intended occupants. They should be used solely for the purposes of rating the building. They should not be used to infer actual energy consumption or running costs. The settings used for the simulation are shown in the building data report.				
AREA-ADJUSTED ENERGY REQUIREMENTS				
Heating	Cooling (sensible)	Cooling (latent)	Total Energy	Units
178.2	10.3	1.2	189.7	MJ/m ² .annum
Conditioned floor area		102.7 m ²		
Star Rating				
			5 STARS	

Fig. 2.9 HER star rating report produced by the AccuRate software

2.5 Industry Reaction

The Australian domestic building sector provides a key indicator of Australian economic growth. The sector includes: manufacturing, transport, wholesale and retail services, builders and associated trades, the building design profession, engineers, private and public sector researchers and government regulators. When the thermal performance provisions were suggested for inclusion in the BCA, a protracted negotiation commenced between the regulators and representatives from the many construction sector stakeholders listed above. The need for this was apparent due to the fact that any change in the type of materials or how they are used could have a significant impact on the requirements of designers, builders and manufacturers (Dewsbury et al. 2007a; Iskra 2004; Murphy et al. 2005; Nolan and Dewsbury 2007). Further, the changes could significantly affect the affordability of the house and the training required for architectural, engineering and construction practices (ABCB 2006b; Arreaza et al. 2007; Building Control Branch 2009; Energy Partners 2006; Henderson 2005; HIA 2004; Marceau et al. 1999; MBA 2008; Productivity Commission 2004; Tucker et al. 2002; Williamson et al. 2007).

Depending on the type of change, it could dramatically affect the economic viability of some businesses.

Generally, the representatives of the construction industry were supportive of the energy efficiency requirements but were concerned about possible problems in the methods employed to measure building designs (Anderson 2002; Delsante 2007; Henderson 2005; HIA 2004; Kordjamshidi and King 2006; Nolan 2005; Williamson et al. 1995). Primarily, they were concerned with the method of obtaining a star rating and the capacity of the house energy rating softwares to accurately calculate room temperatures and subsequent energy requirements, and in turn deliver a reduction in greenhouse gas emissions (ABCB 2009a; AGO 2004a; Delsante 2005c; Williamson and Delsante 2006). The adoption of the 4 Star requirements in 2003 appeared to have a relatively minor effect on the material and construction practices for new houses. However the move to the 5 Star requirements in 2006 and the 6 Star requirements in 2010 introduced far-reaching changes to what had been relatively unchanged construction practices for many years (Dewsbury et al. 2009; Williamson and Beauchamp 2005).

In response to this, various industry groups and building researchers raised concerns about the energy efficiency requirements, including: industry educational and training needs, material availability, technical support, HER software capacity, how the proposed reduction in greenhouse gas emissions was to be measured and how Australian housing compared to that of other nations (ABCB 2000, 2006b; AGO 2000a, 2004b; Bassett and Stoecklein 1998; BCB 2009; Campbell et al. 2006; Delsante 2007; Energy Partners 2006; Horne and Hayles 2008; Marceau et al. 1999; Millis 2006; Nolan and Dewsbury 2007; Williamson and Beauchamp 2005). The size of Australian houses continued to grow (ABCB 2006b; AGO 2000a, b; Bromberek et al. 2003; Delsante 2005a; Martin 2009) and some concerns were raised as to the checking mechanism that would sit behind the legislative requirement to reduce greenhouse gas emissions (Kordjamshidi et al. 2005; Productivity Commission 2004; Williamson 2004; Williamson et al. 2007).

The concerns regarding the HER softwares were primarily focused on their capacity to predict a room temperature and whether or not one building type performed better than another, due to assumptions within the software (Macdonald et al. 2005; Williamson 2004). The industry became more concerned when it was decided that the 2nd generation of the NatHERS protocol would require that all HER softwares incorporate the CSIRO developed thermal simulation software (NatHERS 2007). The CSIRO developed HER software was generally accepted as the most tested and most thorough within Australia. A software developer could develop their own form of front and back end user interfaces, but the principal simulation engine would be identical for all softwares. The second generation requirements were introduced along with the 5 Star Requirements in 2006. As a part of this process, several improvements were made to the CSIRO software. As the software had never been validated empirically, there were concerns that any imperfections in the software could disproportionately advantage or prejudice one building type over another (Dewsbury et al. 2007a; Henderson 2005; Iskra 2004).

There are three principal types of construction typologies within the Australian residential sector:

- unenclosed-perimeter platform-floored buildings
- enclosed-perimeter platform-floored buildings
- concrete slab-on-ground floored buildings.

Each of these building types is lightweight by most international standards and has differing insulation, infiltration and thermal capacitance properties, dependent on structural, cladding and lining systems (Dewsbury et al. 2008). If the software's capacity to model the three building types in significantly different climates differs, it would not reflect the true thermal performance of a building type and misinform the building industry in matters concerning building thermal performance and preferred forms of building practice (Thomas 2010). Such errors would potentially have a corresponding economic impact on material manufacturers (ABCB 2006b; Building Control Branch 2009; Campbell et al. 2006; Dewsbury et al. 2007b; Kordjamshidi et al. 2005).

When the 5 Star requirements occurred in 2006, four of Australia's eight jurisdictions refused to adopt the increased requirements in the BCA (ABCB 2006a). When the 6 Star requirements occurred in 2010, five of Australia's eight jurisdictions refused to adopt the increased requirements (ABCB 2010).

In consultation with representatives of manufacturers, industry representative bodies, state government regulators, the CSIRO and federal government agencies in 2005, it was acknowledged that the AccuRate software should be validated at this early stage of energy efficiency regulation within Australia (Delsante 2005b; Dewsbury et al. 2007a, b, 2008). The validation would inform industry and government of the capacity of the software to calculate room temperature and guide software developers to areas of the software that may require improvement. This study would require an adequate understanding of available validation methods, and which method was appropriate for validating the AccuRate software. This information is discussed in detail in Chap. 3.

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