



# Post-primary education and energy literacy: an analysis of the potential for geography curricula to contribute to Australian students' energy literacy

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## Abstract

Unparalleled amounts of energy derived from fossil fuels now drive societies and shape people's worldviews. Geography's unique perspectives have significant potential to expand understandings of the effects of production and consumption of energy by drawing on the concept of sustainability using an integrated systems approach. As citizens' energy choices are central to sustainability, the recent introduction of a national geography curriculum in Australia offers potential for developing energy literate young people by providing opportunities to address energy literacy concepts and issues.

The focus of this paper is to examine the extent to which energy literacy concepts are present in the current Australian curriculum for Geography. Using document analysis within a grounded theory approach, this article analyses the Australian Curriculum: Geography, Levels 7, 8, 9 and 10 to assess the extent to which energy literacy concepts and issues could potentially be addressed. Data were open coded allowing categories to emerge, and relationships between categories were identified. The three major domain categories that arose are Energy and Society, Growth and Sustainability, and Energy and Environmental Change. Each takes related concepts that together enable richer means of analysis and understanding.

This study found that though Australia's new geography curriculum has potential for developing energy literate young people, energy literacy is not explicitly articulated or mandated. Hence, the degree to which energy literacy is addressed in the post-primary classroom depends significantly on the teacher's own level of energy literacy and their inclination and capability to teach energy concepts and issues.

## Introduction

Energy literacy is important in a robust geographical education curriculum. Energy literacy requires an understanding of the relationships between people, society and the environment, and the complex ways energy resources and use affect these relationships. Both knowledge and understanding of energy resources and energy resource-related affective and behavioural aspects are necessary (Bodzin, Fu, Peffer, & Kulo, 2013). An individual who is energy literate is:

*one who has a sound conceptual knowledge base as well as a thorough understanding of how energy is used in everyday life, understands the impact that energy production and consumption have on all spheres of our environment and society, is sympathetic to the need of energy conservation and the need to develop alternatives to fossil fuel-based energy resources, is cognizant of the impact that personal energy-related decisions and actions have on the global community, and – most importantly – strives to make choices and exhibit behaviours that reflect these attitudes with respect to energy resource development and energy consumption (DeWaters & Powers, 2011, p. 1700).*

We argue that if educators view energy literacy development as an important post-primary educational goal, then the current geography curriculum already provides much potential for developing energy literate students.

In an Australian context, this study identifies the extent that the post-primary geography curriculum provides opportunities to address energy literacy concepts and issues. This study analyses the Australian Curriculum: Geography, Levels 7, 8, 9 and 10 to assess the extent to which energy literacy concepts and issues could potentially be addressed. This research is a part of a larger study which also

considered the Australian post-primary science curriculum, along with the extent to which the post-primary geography curriculum and the post-primary science curriculum are potentially complementary in improving students' energy literacy. These results will be reported elsewhere.

### **Geography and Energy Literacy**

As the twenty-first century's social and environmental challenges are principally dominated by questions of sustainability, the calls to reclaim geography's significance with a greater emphasis on issues of sustainability are becoming more apparent. Scholars advocating such a shift promote a variety of framings that encapsulate issues of sustainability. They include general calls for a more future-orientated geography (Hicks, 2007), and a greater focus on Sustainable Development (Westaway, 2009). A move toward Education for Sustainability as an approach to both teaching and learning has also been argued to greatly benefit geography students in preparing them to become more capable citizens who are empowered to work towards more sustainable societies (Bardsley, 2004; Kriewaldt, 2004). Education for Sustainability offers an integrated systems approach which incorporates "ecological thinking and the wise use of natural resources – conservation – with the equally important concerns of social, economic and political sustainability" (Fien, 2001, p. 6).

The literature which adopts an integrated systems approach to issues of sustainability (with an emphasis on the interconnections between the ecological, social, economic and political systems) has increasingly recognised energy as being "at the core of our human predicament in the twenty-first century" (Heinberg, 2012). Energy comes in many forms and from many sources, but for the purposes of this study energy will be defined "not in terms of what it is, but what it does – as the ability to do work" (Heinberg, 2012, p. 17). Traditional societies captured most of their useful energy from sunlight, storing it in their food crops or forests. This allowed these societies to use this energy to power work, be it through consuming the food for muscle power or using wood to provide heat. Today, unparalleled amounts of energy are obtained from fossil fuels, non-renewable resources that power almost everything we do via our hydrocarbon-based energy systems. The modern human now has access to vast quantities of energy, the large majority of which is used to power machinery that does work for us, making our modern hyper-complex civilisations possible and seemingly invincible (Heinberg, 2012).

Scholars who use the above definition of energy tend to focus on two interrelated problems centred on questions of how and why modern societies obtain, use and depend on energy. The first problem is that our hydrocarbon-based energy system is becoming increasingly costly in financial and environmental terms, and thus less secure and unacceptably harmful. The rising financial cost is linked to the increasing depletion of easy to access non-renewable hydrocarbon resources (the low-hanging fruit principle), and this poses enormous problems for modern societies which rely on ever increasing energy consumption (75% of which is currently produced from hydrocarbon resources) for their prosperity and stability (Alexander, 2014; Hall, Lambert, & Balogh, 2014). The environmental costs are largely the result of extracting the more difficult to access hydrocarbon resources, along with the interconnected issues associated with aging and new infrastructure, localised pollution and geopolitical conflicts over resource sovereignty (Alexander, 2014; Bradshaw, 2010). The second problem is the possibility of catastrophic climate change fostered by this large hydrocarbon-based energy system (Hicks, 2011, 2013; Hodson, 2010; Sayer, 2009). The energy transition, one which moves individuals and societies away from a reliance on a hydrocarbon-based energy system, we argue is the most pressing issue of the twenty-first century, and underscores the importance of energy literacy.

As a future defined by energy insecurity (expensive and limited hydrocarbon fuel resources), and worsening, unpredictable and increasingly extreme environmental conditions becomes more and more likely, those in the developed world "are faced with defining new directions with respect to energy consumption, energy resources, and a shift towards energy independence" (DeWaters & Powers, 2011, p. 1699). The decisions on moving forward into this uncertain future should therefore not be determined solely by professionals and politicians, but rather every person in society as we all greatly depend on the use of energy. Thus, the type of future the next generations inherit will be contingent on today's citizens and their knowledge and understanding of energy issues (or energy literacy) in their daily lives (Lay, Khoo, Treagust, & Chandrasegaran, 2013, p. 199).

### **Research Methods**

This study employed qualitative data analysis to generate grounded theory to illuminate the extent in which the post-primary geography curriculum can contribute to improving students' energy literacy.

The principles of grounded theory conceptualise theory as emergent from the data analysis and category generation process (Cohen, Manion, & Morrison, 2011). Through systematic methods of data analysis, geography energy literacy domains were developed. In the tradition of constructivist grounded theory (Charmaz & Bryant, 2010), these domain categories represent theoretical categories that highlight the different approaches used, or that could potentially be used, by geography post-primary teachers to teach energy related knowledge and issues.

This study utilised document analysis to solely focus on the Australian Curriculum: Geography, Levels 7, 8, 9 and 10 content descriptions and elaborations (ACARA, 2014).<sup>1</sup> These documents firstly underwent what Bowen (2009) labels a “first-pass document review – in which meaningful and relevant passages of text or other data are identified” (p. 32). Pertinent information identified through this initial process was justified through the use of pre-determined themes, each composed of unique concepts, advocated by Heinberg (2012) as being fundamental to developing one’s energy literacy. The energy literacy themes were utilised to identify the relevant content descriptions and elaborations in the curriculum document, through their potential inclusion and usage of energy literacy concepts.

These energy literacy themes are outlined below, and were chosen for use in this study as they adequately reflect the various elements of DeWaters & Powers’ (2011) definition of energy literacy. As well, they complement the four approaches to teaching energy issues in geography developed by Bridge (2012). These eleven energy literacy themes are adopted as a coding tool in this study. We argue that these themes and their concepts are essential to developing a solid grounding in energy fundamentals and strong energy literacy (Heinberg, 2012).<sup>2</sup>

Following this initial review a process of coding, using the constant comparative method, was employed to guide the data analysis. The constant comparative method involves the

constant clustering or grouping of new data through the checking and rechecking of the working codes and categories (Bowen, 2009; Miles, Huberman, & Saldana, 2014). Memo-writing was utilised. This process explored the potential of these emerging theoretical categories in terms of how well they represent the energy knowledge and issues that are found to be addressed in the curriculum and those that could potentially be addressed. This process enabled systemic comparisons between data, as well as weighing each category’s evidence, while broadly demonstrating the links between the emerging categories and the concepts and themes within the data (Charmaz & Bryant, 2010). All the data were accounted for and accommodated to develop well-defined domain categories through this process of simultaneous coding and analysis, guided by memo-writing (Cohen, Manion, & Morrison, 2011).

These methods resulted in unique domain categories that capture the specific energy literacy concepts addressed by post-primary geography, and the approaches by which they were addressed (or could potentially be addressed). In the next section, the eleven energy literacy themes are introduced. Then these themes are organised into three domain categories. Each geography energy literacy domain category is analysed to outline its potential to be developed in this post-primary curriculum.

## Findings and Analysis

The first-pass document review of the geography curriculum, Levels 7 through 10, revealed that ten of the eleven energy literacy themes were strongly addressed within the content descriptions and the elaborations. The use of the term *strongly* indicates that key concepts within the theme are potentially addressed within the content description and the elaborations, while the term *weakly* indicates that the elaborations offer recommendations where potential exists to address relevant energy literacy concepts.<sup>3</sup> Nine of the eleven energy literacy themes were addressed weakly within the content description elaborations.

Energy Literacy Themes	Post-primary Geography (Years 7–10)	
	Addressed Strongly	Addressed Weakly
A) Net energy	1	2
B) Energy density	1	0
C) Embodied energy	1	0
D) Energy slaves	2	4
E) Energy-fuelled population growth	4	3
F) Energy-fuelled economic growth	4	6
G) Peak Oil and resource depletion	2	3
H) Energy sprawl	1	5
I) Pollution and visual blight	4	9
J) Climate change	2	3
K) Energy conservation–efficiency and curtailment	0	1

Table 1. The total number of geography content descriptions where each energy literacy theme was strongly and weakly addressed.

## Energy Literacy Themes

Below we outline each energy literacy theme, their key concepts, and provide an appropriate content description as an example of how each can be integrated into the current curriculum.

**Net Energy:** This theme refers to how much energy there is available after subtracting the energy costs to extract, process, and deliver an energy resource. This theme is necessary for determining the viability of new and old energy resources – frequently referred to as their Energy Return on Energy Invested (EROEI). A society’s net energy determines its potential for social specialisation (e.g., artists, educators and politicians do not directly extract, process and deliver energy, whereas farmers and coal miners do), thus the greater the net energy for a population the greater opportunity for a complex society.

### Key Concepts: EROEI, Energy Resources, Fossil Fuels.

Within the Changing nations unit, the ACHGK054 content description focuses on urbanisation (ACARA, 2014, p. 25). The Net Energy theme’s concepts provide insight into how urbanisation is an energy intensive way of living and primarily the result of a society becoming increasingly complex.

<p>The causes and consequences of urbanisation, drawing on a study from Indonesia, or another country of the Asia region (ACHGK054)</p> 	<ul style="list-style-type: none"> <li>• discussing urbanisation as a shift in where and how people live</li> <li>• exploring the relationship between urbanisation and the tendency for economic activities to cluster unless tied to the location of resources or customers</li> <li>• examining how urbanisation can affect carbon emissions and water consumption</li> </ul>
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Figure 1. Content Description ACHGK054 (ACARA, 2014, p. 25).

**Energy Density:** This theme emphasises that different fuels contain varying amounts of potential energy per unit of weight or volume. It is useful for appreciating the astounding energy density of most fossil fuels when compared to wood, for example.

Unit 1: Water in the world	Elaborations
<p>The classification of environmental resources and the forms that water takes as a resource (ACHGK037)</p> 	<ul style="list-style-type: none"> <li>• classifying resources into renewable, non-renewable and continuous resources, and investigating examples of each type</li> <li>• describing how water is an available resource when it is groundwater, soil moisture (green water), and surface water in dams, rivers and lakes (blue water), and a potential resource when it exists as salt water, ice or water vapour</li> </ul>

Figure 2. Content Description ACHGK037 (ACARA, 2014, p. 17).

## Key Concepts: Potential Energy.

The Water in the world unit's ACHGK037 content description focuses on the classification of environmental resources, differentiating between renewable, non-renewable and continuous resources (ACARA, 2014, p. 17). These are fundamental skills and knowledge for students beginning to understand the Energy Density theme's concept of potential energy and the inherent unsustainable nature of non-renewable energy resources.

**Embodied Energy:** This theme emphasises that every material object is manufactured, used/maintained, and finally disposed of; and these steps all require a certain amount of energy. It helps us understand that the energy demands of people who are living consumer lifestyles are inherently larger when compared to those living more traditional livelihoods. This is also true for the physical infrastructure on which the consumer lifestyles rely. In most industrial countries, the energy demands of infrastructure are immense when compared to more traditional ways of constructing, buildings for example, which are much less energy intensive throughout their life cycle.

## Key Concepts: Energy Demanding, Energy Intensity.

The Geographies of interconnections content description ACHGK067 focuses on people's interconnections through trade. This content description provides the opportunity to understand trade in terms of its enabling qualities which nurtures a reliance on historically high energy intense goods and services. It also helps to build an appreciation for the important role energy exporting regions play at different scales around the world.

<p>The causes and consequences of urbanisation, drawing on a study from Indonesia, or another country of the Asia region (ACHGK054)</p> 	<ul style="list-style-type: none"><li>• discussing urbanisation as a shift in where and how people live</li><li>• exploring the relationship between urbanisation and the tendency for economic activities to cluster unless tied to the location of resources or customers</li><li>• examining how urbanisation can affect carbon emissions and water consumption</li></ul>
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Figure 3. Content Description ACHGK067 (ACARA, 2014, p. 31).

**Energy Slaves:** This theme emphasises that the modern energy economy provides the average person the power equivalent of vast numbers (100s) of human and animal servants at any given time. This theme is useful in demonstrating that modern lifestyles are constantly benefiting from relatively large amounts of cheap and easy energy availability.

## Key Concepts: Modern Energy Economy, Power Equivalents.

The Changing nations unit's content description ACHGK054 focuses on urbanisation and provides the opportunity to discuss the ways in which urbanisation relies on cheap and easy energy availability. Starting points could be understanding the necessity of high energy usage in urban areas in regards to economic activity (e.g., industrial and transportation development) or household energy consumption (e.g., increasing fossil fuel reliance for heating, cooling, cooking and transportation).

<p>The causes and consequences of urbanisation, drawing on a study from Indonesia, or another country of the Asia region (ACHGK054)</p> 	<ul style="list-style-type: none"><li>• discussing urbanisation as a shift in where and how people live</li><li>• exploring the relationship between urbanisation and the tendency for economic activities to cluster unless tied to the location of resources or customers</li><li>• examining how urbanisation can affect carbon emissions and water consumption</li></ul>
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Figure 4. Content Description ACHGK054 (ACARA, 2014, p. 25).

**Energy-Fuelled Population Growth:** This theme emphasises that the energy windfall that fossil fuels presented to humanity is central to the runaway population growth of the past two centuries. It highlights the role fossil fuels has played in numerous agricultural revolutions, especially through the expansion of global (and regional) transportation networks and the establishment of unsustainable chemically (and energy) intensive industrial agriculture.

**Key Concepts: Food Production, Monocultures, Biodiversity, Population Size, Interconnectedness of Countries.**

The Biomes and food security unit's content description ACHGK064 provides the opportunity to address food security in regards to industrial agriculture's dependence on fossil fuels. The most obvious issue to address here would be the inherent problems involved with trying to achieve food security for a population (especially a rapidly growing population) via a method of agriculture that is entirely dependent on non-renewable resources.

<p>The environmental, economic and technological factors that influence crop yields in Australia and across the world (ACHGK062)</p> 	<ul style="list-style-type: none"> <li>describing how environmental factors, for example, climate, soil, landform and water, can support higher crop yields and investigating the environmental constraints on agricultural production in Australia, for example, soil moisture, water resources and soils</li> <li>investigating how high crop yields (for example from wheat, rice and maize) around the world are related to factors such as irrigation, accessibility, labour supply, landforms and agricultural technologies (for</li> </ul>
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Figure 5. Content Description ACHGK064 (ACARA, 2014, p. 30).

**Energy-Fuelled Economic Growth:** This theme emphasises the strong correlation between energy consumption and economic activity, as the two have strengthened each other in a self-reinforcing positive feedback loop since the beginnings of the fossil fuel age. This theme helps to highlight the important interconnections between countries, as well as the problems with assuming such energy fuelled economic growth can continue indefinitely.

**Key Concepts: Energy Consumption, Economic Activity, Economic Growth.**

The Biomes and food security unit's content description ACHGK062 provides the opportunity to address the economic factors that influence food security. An interesting approach might include an investigation of the differences between industrial agriculture and less energy intensive methods (e.g., organic agriculture), within the context of a globalising (quickly growing) economy.

<p>The environmental, economic and technological factors that influence crop yields in Australia and across the world (ACHGK062)</p> 	<ul style="list-style-type: none"> <li>describing how environmental factors, for example, climate, soil, landform and water, can support higher crop yields and investigating the environmental constraints on agricultural production in Australia, for example, soil moisture, water resources and soils</li> <li>investigating how high crop yields (for example from wheat, rice and maize) around the world are related to factors such as irrigation, accessibility, labour supply, landforms and agricultural technologies (for example, high yielding varieties)</li> </ul>
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Figure 6. Content Description ACHGK062 (ACARA, 2014, p. 30).

**Peak Oil and Resource Depletion:** This theme emphasises that every oil-producing country increases its oil extraction to the maximum sustained output, and then eventually sees production decline as the reservoirs are depleted. Importantly, this theme highlights that oil, along with all non-renewable resources, does not simply run out or stop being extracted overnight. Instead production declines after the higher quality, easier and cheaper to produce percentage of that resource, is extracted.

**Key Concepts: Oil Extraction, Oil Production, Extraction Rates, Conventional Oil, Unconventional Oil, Depletion, Peak Energy, Peak Resources.**

The Water in the world unit's content description CHGK037 provides the opportunity to address the basic knowledge needed to understand Peak Oil along with the general issues associated with resource depletion.

<p>The challenges to food production, including land and water degradation, shortage of fresh water, competing land uses, and climate change, for Australia and other areas of the world (ACHGK063)</p> 	<ul style="list-style-type: none"> <li>exploring environmental challenges to food production from land degradation (soil erosion, salinity, desertification), industrial pollution, water scarcity and climate change</li> <li>identifying the impacts on food production from competing land uses, for example, urban and industrial uses, mining, production of food crops for biofuels, production of food crops for livestock, and recreation (such as, golf courses)</li> </ul>
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Figure 7. Content Description ACHGK037 (ACARA, 2014, p. 17).

**Energy Sprawl:** This theme emphasises the ever increasing area that is devoted to energy production and its environmental impact. It is useful as it highlights the physical footprint of an energy source’s development (e.g., a nuclear power plant) and the related infrastructure that should also be considered (uranium mines, access roads, processing plants, waste disposal sites, and power lines).

**Key Concepts: Energy Development, Energy Production, Energy Sources.**

The Environmental change and management unit’s content description ACHGK070 provides the opportunity to address energy sprawl. For example, having students identify the complex human-induced environmental changes required for different energy developments (the infrastructure associated with energy sprawl), such as a coal power plant or a wind farm.

<p>The challenges to food production, including land and water degradation, shortage of fresh water, competing land uses, and climate change, for Australia and other areas of the world (ACHGK063)</p>	<ul style="list-style-type: none"> <li>• exploring environmental challenges to food production from land degradation (soil erosion, salinity, desertification), industrial pollution, water scarcity and climate change</li> <li>• identifying the impacts on food production from competing land uses, for example, urban and industrial uses, mining, production of food crops for biofuels, production of food crops for livestock, and recreation (such as, golf courses)</li> </ul>
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Figure 8. Content Description ACHGK070 (ACARA, 2014, p. 36).

**Pollution and Visual Blight:** This theme emphasises the everyday harm caused by energy development that damages the beauty and health of the Earth’s ecosystems. The air and water pollution from fossil fuel related use and disasters are the most obvious, but this theme also emphasises energy-related visual blight such as power lines, the aftermath of mountaintop removal, mining, and sprawling wind power developments.

**Key Concepts: Air Pollution, Water Pollution, Land Degradation, Energy Development Visual Blight.**

The Environmental change and management unit’s content description ACHGK071 focuses on the worldviews of people and the effects of these on their environmental management strategies. This content description provides many opportunities to address pollution and visual blight. An example is an investigation of different environmental worldviews and how these influence people’s attitudes towards the effects of different energy developments.

<p>The challenges to food production, including land and water degradation, shortage of fresh water, competing land uses, and climate change, for Australia and other areas of the world (ACHGK063)</p>	<ul style="list-style-type: none"> <li>• exploring environmental challenges to food production from land degradation (soil erosion, salinity, desertification), industrial pollution, water scarcity and climate change</li> <li>• identifying the impacts on food production from competing land uses, for example, urban and industrial uses, mining, production of food crops for biofuels, production of food crops for livestock, and recreation (such as, golf courses)</li> </ul>
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Figure 9. Content Description ACHGK071 (ACARA, 2014, p. 36).

**Climate Change:** This theme emphasises the anthropogenic climatic changes that result from certain gases in Earth’s atmosphere holding additional heat that would otherwise be radiated off the planet’s surface.

**Key Concepts: Anthropogenic Climate Change, Weather Extremes, Greenhouse Gases, Hydrocarbon Based Energy System.**

The Biomes and food security unit’s content description ACHGK063 focuses on the challenges to food production around the world. This content description offers the opportunity to address climate change through exploration of the challenges it provides food production around the world.

<p>The challenges to food production, including land and water degradation, shortage of fresh water, competing land uses, and climate change, for Australia and other areas of the world (ACHGK063)</p> 	<ul style="list-style-type: none"> <li>• exploring environmental challenges to food production from land degradation (soil erosion, salinity, desertification), industrial pollution, water scarcity and climate change</li> <li>• identifying the impacts on food production from competing land uses, for example, urban and industrial uses, mining, production of food crops for biofuels, production of food crops for livestock, and recreation (such as, golf courses)</li> </ul>
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Figure 10. Content Description ACHGK063 (ACARA, 2014, p. 30).

**Energy Conservation – Efficiency and Curtailment:** This theme emphasises two approaches towards using less energy. Efficiency refers to achieving the same or more with less energy, and curtailment refers to actions that end frivolous and wasteful energy use, such as turning off a light when it is not in use.

**Key Concepts: Efficiency, The Law of Diminishing Returns, Jevons Paradox, Curtailment.**

The Place and liveability unit’s content descriptions ACHGK047 provides the opportunity to introduce the basic concepts from the Energy Conservation theme (efficiency and curtailment). One example includes looking at the roles energy efficiency and curtailment can play in enhancing liveability, and discussing if certain actions also act to enhance environmental sustainability.

<p>The strategies used to enhance the liveability of places, especially for young people, including examples from Australia and Europe (ACHGK047)</p> 	<ul style="list-style-type: none"> <li>• researching methods implemented in Australia and Europe to improve the liveability of a place, and evaluating their applicability to their own locality</li> <li>• developing a specific proposal to improve an aspect of the liveability of their place, taking into account the needs of diverse groups in the community, including young people</li> <li>• discussing the impact of housing density on the liveability of places, examining whether liveability and environmental sustainability can be enhanced at the same time</li> </ul>
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Figure 11. Content Description ACHGK047 (ACARA, 2014, p. 19).

**The Geography Domain Categories**

The eleven energy literacy themes were useful in determining where and how in the geography curriculum educators could potentially address important energy literacy concepts. However, to more clearly establish the usefulness of these concepts, and particularly how they could be used effectively with the Australian post-primary geography curriculum, new domain categories are needed. Through the theoretical analysis of the relevant content descriptions, with particular emphasis on their corresponding energy literacy themes and concepts, three substantive domain categories emerged from the geography curriculum (Tables 2, 3 and 4).

These three domain categories reflect how the energy literacy themes were found to be clustered within the geography curriculum, and highlight how particular energy concepts could potentially be approached via geography’s unique perspectives and content. The domain categories demonstrate that certain concepts, when understood and utilised together to highlight geographical content, provide a richer means of analysis and understanding in regards to energy concepts and issues. These domain categories are discussed in the next section.

The domain categories are a result of the geography content descriptions being grouped

with their most relevant energy literacy theme clusters. These clusters represent the energy literacy themes (and their relevant concepts) that were found to be consistently addressed together in the same content descriptions. For example, Energy Sprawl, Pollution and Visual Blight, and Climate Change themes frequently appeared in the same content descriptions. All three themes appeared together once in Figure 8 and, in nine separate content descriptions, two of these three themes appeared together. Each of the three substantive domain categories was developed and defined with consideration to data from the energy literacy themes and their corresponding clusters, their relevant concepts, and the relevant content descriptions and elaborations, along with the corresponding geography concepts and issues they highlight.

**Energy and Society**

This domain category emphasises the different variety of energy sources people currently rely on, and how these energy sources influence their lives and their places. It brings together a variety of concepts highlighted by the Net Energy, Energy Density, Embodied Energy, and Energy Slaves themes (see Table 2). It is helpful to understand this domain category’s focus as the ways in which energy use, particularly the energy produced from fossil fuels, affects people today. This emphasis

Energy and Society		
Energy Literacy Themes	Relevant Concepts	Geography Themes & Concepts
Net Energy	Energy Resources	Environmental and Natural Resources
Energy Density	Fossil Fuels	Liveability of Places
Embodied Energy	Power Equivalents	Development of Place
Energy Slaves	Modern Energy Economy	Human Wellbeing
		Human Settlements and Ways of Living

Table 2. The Energy and Society Domain Category and its Characteristics.

allows students the opportunity to understand and appreciate how the majority of daily activities of those living modern lifestyles requires vast amounts of energy. This focus also provides students the opportunity to investigate the unique characteristics of different energy sources, as well as inquiring about why certain regions or societies rely on particular energy sources.

Table 1 shows that the potential to address this themes' concepts was limited within the geography curriculum, therefore we will demonstrate where these concepts and issues could be addressed using this new domain category's approach. While the Energy and Society domain category offers a valuable perspective that can potentially be employed throughout the post-primary geography curriculum, we have provided a key inquiry question as an example of how this domain category could be utilised to address energy related concepts and issues.

The key inquiry question from the Year 7 unit of study is, *What effect does the uneven distribution of resources and services have on the lives of people?* (ACARA, 2014, p. 59). This question provides the opportunity for students to investigate how the different energy sources people rely on (e.g., energy dense natural gas for electricity generation) greatly influence the liveability of their places (e.g., affordable and reliable electricity to power lights, supermarkets, urban development). Transportation is an ideal example to demonstrate the differences in people's lives that access to affordable and reliable energy makes, especially when compared to populations who use less energy intensive means of transportation and how these differences affect the development and liveability of their place.

Generally, the Energy and Society domain category is most applicable to the geography content descriptions which address the topics of environmental/natural resources, services and facilities that affect the liveability of place as well as broad wellbeing and development issues, and the causes and consequences of different ways of living.

## Growth and Sustainability

This domain category links the impact of energy on population growth through agricultural yield, city sprawl development, trade in goods, along with the limitations to growth in most places due to the dependency on non-renewable energy resources. It brings together many of the concepts and issues highlighted by the Energy-Fuelled Population Growth, Energy-Fuelled Economic Growth, and Peak Oil and Resource Depletion themes, while building on many concepts and issues from the Energy and Society domain category.<sup>4</sup> It is useful to understand this domain category's focus as the ways in which energy production and consumption have fluctuated over time, with a particular focus on the dramatic increases during the fossil fuel age. With a historical emphasis, this domain category allows students the opportunity to understand and appreciate the fundamental role energy plays in growth. It also provides the opportunity for students to inquire about the likelihood of further growth in many different areas, while investigating the effects of growth and how these effects could be managed.

Again, we have provided a key inquiry question as an example of how this domain category could be utilised to address energy related concepts and issues within the post-primary geography curriculum.

The key inquiry question from the Year 8 unit of study is, *What are the consequences of changes to places and environments and how can these changes be managed?* (ACARA, 2014, p. 59). This question provides the opportunity for students to investigate the ways projected population growth in Australian cities and towns could be managed. The Growth and Sustainability domain category provides a foundation of concepts that might result in students looking at the ways future energy insecurity could be a major emphasis for the management of projected population growth. These approaches might focus on such areas as slowing population growth (investigating ways of encouraging smaller families), energy security (researching ways of increasing locally produced renewable energy), and food security (inquiring about the ways of increasing locally produced food).

Growth and Sustainability		
Energy Literacy Themes	Relevant Concepts	Geography Concepts and Themes
Energy-Fuelled Population Growth Energy-Fuelled Economic Growth Peak Oil and Resource Depletion	Energy Resources Economic Growth Food Production Population Size Interconnectedness of Countries Oil Extraction Oil Production Conventional Oil Unconventional Oil Depletion Peak Energy Peak Resources	Production and Consumption Urbanisation Migration Changes to Human Wellbeing The Liveability of Place Planning and Managing Development Planning and Managing for Change Food Security Interconnections of Places and People

Table 3. The Growth and Sustainability Domain Category and its Characteristics.

Generally, the Growth and Sustainability domain category is most applicable to the geography content descriptions which address topics associated with economic activities and the effects associated with the different ways of living, managing and planning economic development and food production, and the interconnections between people and places.

### Energy and Environmental Change

This domain category emphasises the role energy (and energy development) plays in environmental quality (e.g., pollution, land degradation, and loss of biodiversity) and climate change. It brings together many of the concepts and issues highlighted by the Energy Sprawl, Pollution and Visual Blight, and Climate Change themes. It is helpful to understand this domain category's focus as the environmental costs of energy use, with particular emphasis on the energy production methods of developed and less developed nations. In relation to the previous domain category, this

focus allows students the opportunity to inquire about the desirability of growth in terms of energy production. It also provides students with the opportunity to understand and appreciate the inherent environmental costs of all our potential energy development options.

The key inquiry question from the Year 9 unit of study is, *Why are interconnections and interdependencies important for the future of places and environments?* (ACARA, 2014, p. 61). This question provides the opportunity for students to investigate how climate change and/or industrial pollution are creating new challenges to food production in Australia and in other areas of the world. This inquiry could lead students to a better understanding of the interconnections between food security, environmental quality, and the broader effects of climate change. Students could also investigate the spread of knowledge that helps people improve the resilience of places and environments in the face of increasingly unpredictable weather patterns.

Energy and Environmental Change		
Energy Literacy Themes	Relevant Concepts	Geography Concepts and Themes
Energy Sprawl Pollution and Visual Blight Climate Change	Energy Production Energy Sources Energy Development Air Pollution Water Pollution Land Degradation Energy Development Visual Blight Anthropogenic Climate Change Weather Extremes Greenhouse Gases Hydrocarbon Based Energy System	Environmental Quality Landscape Degradation Environmental Impact Assessments Environmental Worldviews

Table 4. The Energy and Environmental Change Domain Category and its Characteristics.

Generally, the Energy and Environmental Change domain category is most applicable to the geography content descriptions which address the topics of atmospheric and hydrological hazards and climate change, environmental quality and the causes and effects of land, water and air degradation/pollution, and protecting landscapes and environments.

The domain categories have helped to highlight a number of post-primary geography's strengths in addressing energy concepts and issues. However, several limitations are notable. These limitations within the current curriculum resulted in few opportunities for the Energy and Society domain category's perspective to be utilised to emphasise a number of valuable concepts which are vital to understanding certain energy literacy themes. Unsurprisingly it was found that, although there were clear opportunities to address issues associated with energy resources and use, opportunities to address the more technical concepts from the Energy Density and Embodies Energy themes were absent. Therefore, the themes of this domain category's highlighted valuable energy knowledge and issues. However, the geography curriculum failed to provide a clear opportunity to teach much of such foundational knowledge as the EROEI, Potential Energy, Energy Demanding, and Energy Intensity concepts.

The concepts underlining the Growth and Sustainability domain category were found to be much better represented within the curriculum. Throughout, the opportunities to address how energy has, and currently is, driving growth along with the limitations to such growth were abundant when compared to the preceding domain category. The same can be said for the final domain category, Energy and Environmental Change. Again, there were many opportunities to address the role energy plays in environmental quality issues and climate change. Although the concept of energy was rarely explicitly mentioned within the curriculum, the geography themes and concepts were found to closely relate to the concepts highlighted by these two domain categories.

There was one energy literacy theme that was underrepresented in the curriculum. The Energy Conservation—efficiency and curtailment theme was weakly addressed once in regard to improving the liveability of place. The general absence of this theme's concepts, particularly efficiency and curtailment, is surprising. This theme's concepts provide the knowledge for some of the more practical behaviour changes which students can employ.

## Conclusions

*The manner in which energy is captured and transformed lies at the heart of society's relationship with the natural*

*world; and, at the same time, the availability and accessibility of energy strongly influences the relationships among different societies, and between places (Bridge, 2010, P. 4).*

Education for Sustainability employs an integrated systems approach which highlights the interdependence between the environmental, ecological, socioeconomic and political elements of sustainability issues (Kriewaldt, 2004, p. 28). Such holistic approaches to understanding and problem solving illuminates the reason why the post-primary geography curriculum's energy literacy potential is high, and an integrated systems approach is the key to improving the energy literacy outcomes of Australian students.

The above findings and analysis have demonstrated that the current post-primary geography curriculum provides many opportunities for the teaching of different energy literacy components. Although there are significant opportunities to teach about energy concepts and issues, these opportunities were found to usually focus on certain components within an energy literacy theme. As the domain categories demonstrate, understanding and utilising several energy literacy themes and their concepts provides a richer understanding of energy literacy issues, and this method represents a more integrated systems inspired approach to improving energy literacy. Further still, utilising more than one domain category, where appropriate, adds significantly more detail and context to many energy issues. For example, the Geography Growth and Sustainability domain category (with its focus on the limits to growth) would be enhanced with the inclusion of several concepts and themes found to underpin the Geography Energy and Environmental Change domain category. With an emphasis on these two domain categories for example, geography teachers could emphasise the ways that climate change is affecting different elements of growth in different places (e.g., increasing extreme weather disaster clean-up costs and decreasing crop yields).

This study has sought to emphasise the importance of energy literacy to the broader geographical purpose of developing capable citizens who can think critically about sustainability issues and act in ways that contribute to more sustainable patterns of living. This was achieved through highlighting the growing importance of the concept of energy to the field of geography in general and post-primary geography in particular. Through an analysis of the post-primary geography curriculum, it was found that many opportunities exist to address energy concepts and issues from a geographical perspective, but the degree to which energy literacy is deliberately taught in the post-primary classroom depends significantly on the teacher,

his or her own level of energy literacy, and each teacher's willingness and capacity to teach energy concepts and issues. We argue that geography teachers should take up this challenge to integrate energy literacy into their curriculum design and delivery.

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## Endnotes

1. Content descriptions outline the learning objectives and elaborations provide suggestions to guide teachers to meet these objectives.
2. These themes are further elaborated on in Heinberg's (2012, pp. 5–21) introductory chapter.
3. For educators, it is mandatory that they teach the content description. The accompanying elaborations, however, are suggested examples of how certain aspects of the content description can be taught.
4. This is important to acknowledge, as the interrelationships between certain Energy Literacy themes (such as the Energy Density of fossil fuels and the past few centuries of a relatively high rate of Energy-Fuelled Economic Growth) provide a more elaborate understanding of our current energy related issues.