

Investigating Science

Depth Study

Year 12 Student Book

STELR Sustainable House Kit

Name:

Teacher/Class:

Contents

Introduction.....	4
What is a Depth Study?.....	4
<i>Requirements for a Depth Study</i>	4
Prior to starting the Depth Study.....	4
How to use this booklet.....	4
Outline of the different sections of the Sustainable House Kit Depth Study Booklet.....	5
Section 1 – Inquiry Questioning.....	6
1.1 Generating questions from experimentation with the Sustainable Housing Kit (SHK).....	6
1.2 Generating questions from the SHK claims.....	7
1.3 Generating questions to claims beyond the SHK.....	10
1.4 Pinning down and deciding on a final Depth Study research question.....	11
1.5 Sign off on Section 1.....	12
Section 2 – Hypothesize and Predict.....	13
2.1 Design an Experimental Aim.....	13
2.2 Hypothesis.....	13
2.3 Experimental Variables.....	13
<i>Variables table</i>	14
2.4 Research and Design of a Model Sustainable House.....	14
2.5 Sustainable House Design.....	15
2.6 Modification of Main Research Question and/or Hypotheses.....	16
2.7 Method.....	17
2.8 Risk Assessment.....	18
2.9 Sign off on Section 2.....	18
Section 3 - Build and test a Model Sustainable House.....	19
3.1 Build Sustainable House Model.....	19
3.2 Design Data table.....	19
3.3 Conduct your research investigation and record the raw data.....	20
3.4 Sign off on Section 3.....	20
Section 4 - Analysis of experimental results.....	21
4.1 Examining the data.....	21

4.2 Examining the experimental procedure	22
4.3 Explaining and applying the Science	23
4.4 Analysis of literature.....	25
4.5 Relevance of findings	26
4.6 Further Questions	27
4.7 Sign off on Section 4.....	27
Section 5 - Communicate findings	28
5.1 Presentation of Investigation	28
<i>What should my presentation look like?</i>	28
<i>Which features should my presentation include?</i>	28
5.2 Sign off on Section 5	29
Appendix 1 - Depth Study Progress Chart.....	30
Appendix 2-Depth Study Hours Log	31

Introduction

The Depth Study is a major component of the Investigating Science course. The ATSE Sustainable Housing Kit provides you with the equipment and background information to carry out a unique inquiry investigation Depth Study into one aspect of sustainable housing.

The aim of this Depth Study booklet is to provide you with a guiding template to:

- design a research question focused on one aspect of sustainable housing
- build your own model sustainable house using the ATSE kit
- investigate and report on the sustainability of your model house

What is a Depth Study?

A depth study is any type of investigation or activity that is an extension of the syllabus.

Requirements for a Depth Study

This booklet has been designed to allow you to meet all the necessary components of your Depth Study while completing an original inquiry investigation with the ATSE Sustainable House Kit. The following requirements have been addressed:

- a minimum of 15 hours of in-class time
- Working Scientifically outcomes of: Questioning and Predicting, and Communicating
- a minimum of two additional Working Scientifically skills outcomes
- development of at least one Knowledge and Understanding outcome – This booklet aligns with Module 3 – Fact or Fallacy?

Prior to starting the Depth Study

To become familiar with both the structure and variables the Sustainable House Kit is capable of testing, - as well as how the collected data can be recorded, stored and presented - a set of introductory activities have been developed. See the *Investigating Science Introductory Sustainable Housing Circuit of Activities* booklet.

How to use this booklet

This booklet acts as a Depth Study guide. Work through each of the five sections of the booklet in order. As each section is completed it can be signed off using the sign off sheet found at Appendix 1.

Keep a log of your hours using a template similar to the one found in Appendix 2.

The following table gives a brief overview of what will be achieved in each of the five sections of the booklet. The time spent working on each section will vary from project to project, so the approximate hours shown in the table are simply a guide.

Outline of the different sections of the Sustainable House Kit Depth Study Booklet

Section	Time spent* (hours)	Activity
1. Inquiry questioning	~1	Use primary and secondary source data from the Sustainable Housing Kit to generate a set of inquiry questions, one of which can be used for a Depth Study research question.
2. Hypothesize and predict	~2 to 4	Application of thinking in Section 1 to develop a hypothesis and make a prediction. Plan an investigation to respond to the aim and test the hypothesis.
3. Build and test a model sustainable house	~4 to 5	Construction of a model sustainable house to gather data relevant to the research question. Conduct a primary investigation using this model.
4. Analysis of experimental results	~2 to 3	Examination and interpretation of collected data for trends, limitations, relevance, accuracy, reliability and validity. Findings are analysed alongside secondary sources and future trends, and are used to construct new arguments and propose further questions.
5. Communicate findings	~3 to 5	Create a presentation for an audience to communicate research results and their relevance.

*Note: If this is the only Depth Study then the total number of hours needs to add up to at least 15.

Section 1 – Inquiry Questioning

Goal to achieve by the end of Section 1:

Generate a Depth Study research question

1.1 Generating questions from experimentation with the Sustainable Housing Kit (SHK)

Once you have completed at least one Task using the SHK, and are familiar with how the equipment is set up and used to generate experimental primary data, consider the following:

Question 1

Which variable(s) did you investigate when you previously used the SHK? List them here.

Question 2

Which other variables could be tested using the SHK? For example, which variables did your peers investigate? Which variables could some of the other equipment in the SHK investigate? List them here.

Question 3

What other materials, not supplied with the kit (e.g. the insulating properties of curtains) do you think would be interesting to investigate? List some unique variables beyond what the kit contains that you could possibly test with the SHK. Think broadly here.

Question 4

Now think about variables that could be tested in relation to the climate or environment the house might be built in (e.g., the effect of shade trees or prevailing winds on the sustainability of the house). List as many variables you can think of, related to how the house might perform when exposed to various external conditions.

Question 5

If, as an architect, you were asked to build a sustainable house, which variables would you most like to investigate in order to learn more about how you can improve the efficiency of a sustainable house?

Question 6

Use any one of the variables you have listed in Questions 1 to 5 above and turn it into a possible Depth Study research question and write it here:

Possible Depth Study Research Question #1

For example, one variable you might have identified for testing could be the effect of double glazing on the ability of the SHK to retain heat. In this case a relevant research question could be, ‘What effect does double glazed windows have on the ability of the sustainable house to retain heat, compared to single glazed windows?’

1.2 Generating questions from the SHK claims

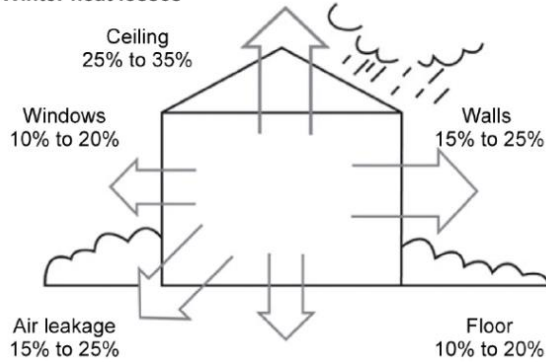
In this section, selected data and secondary sources from the SHK and its resources are examined as a stimulus for question generation.

Question 1

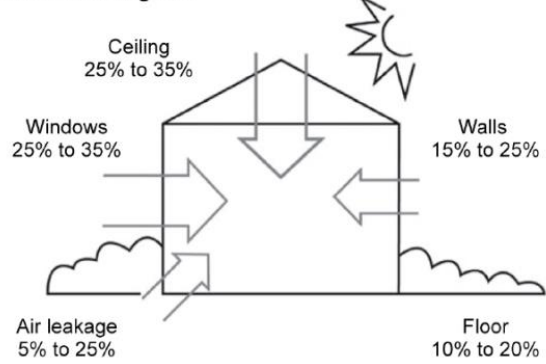
Read the statement below, as well as the information on the following images, that documents the losses and gains in heat during winter (left) and summer (right).

‘Insulation acts as a barrier to heat flow and is essential for keeping your home warm in winter and cool in summer. A well-insulated and well-designed home provides year-round comfort, cutting cooling and heating bills by up to half. This, in turn, reduces greenhouse gas emissions.’

Winter heat losses



Summer heat gains



How could some of these claims and secondary source data be tested? Write some closed questions that could test any of the claims made:

Closed questions from the text Question that have an answer in the text and/or diagram above	Closed questions beyond the text Questions related to the text and/or diagram but are not found there and need to be researched
e.g. How much heat is lost from windows in the winter?	e.g. Which type of window loses the least amount of heat in the winter?

Question 2

Look at the following data:



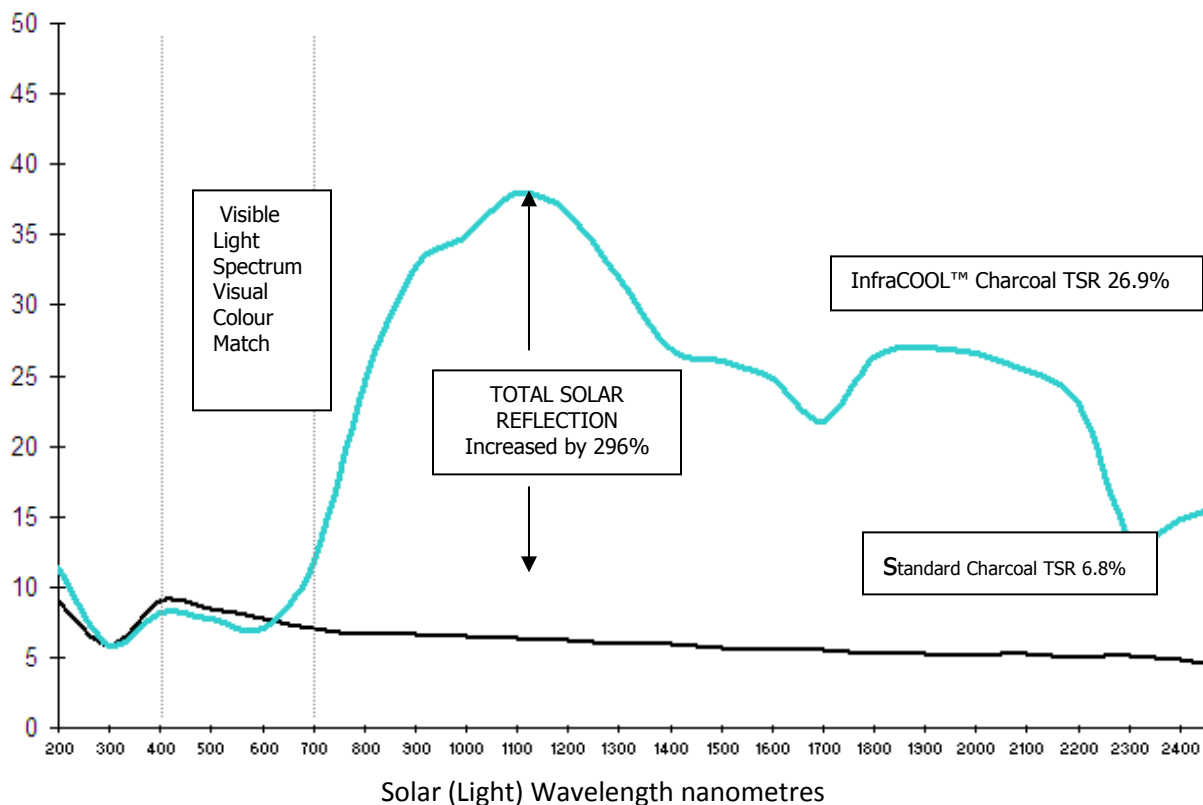
KEY FACTS : HEAT REFLECTIVE COATINGS

- Due to their large surface area and exposure, roof surfaces can capture large amounts of the Sun's energy and thus COOL ROOFS offer potential energy savings.
- Dulux® InfraCOOL® Technology works by maximising the TOTAL SOLAR REFLECTION including the (invisible) infra-red portion of the Sun's energy which accounts for approx. 50% of the suns total light energy.

- Various internationally accepted verification methods demonstrate the potential benefits of InfraCool® Technology in comparative testing vs comparable std charcoal and/or surface materials.

PERFORMANCE DATA – InfraCOOL® CHARCOAL vs Std Charcoal

This graph shows Total Solar Reflectance (TSR) and Spectral Reflectance of 2 visually equal panels is measured at individual wavelengths from 200-2500 nanometers



Summary of Results represented in the graph:

1. Significantly higher reflectance of InfraCool® across the infrared region (separation of the lines above 700 nm).
2. Matching reflectance (intersecting lines) in the visible light region confirm the colours are close visual matches.
3. TSR (Total Solar Reflectance) increased from 6.8% to 26.9% (296% increase) with InfraCool® Technology.

How could some of these claims and secondary source data be tested? Write some closed questions that could test any of the claims made:

Closed questions from the text Question that have an answer in the text and/or graph above	Closed questions beyond the text Questions related to the text and/or graph but are not found there, and need to be researched
e.g. At which wavelength is Infracool® the most effective?	e.g. Are there products for windows that can help reflect excess radiation?

Question 3

Chose one of the questions from the tables in Question 1 or Question 2 that you might like to investigate to test a claim and re-write it here as a Depth Study research question.

<p>Possible Depth Study Research Question #2</p>

1.3 Generating questions to claims beyond the SHK

Question 1

You may be interested in using the SHK as a model to study a question about a claim related to other aspects of sustainable housing, such as the insulating properties of a particular fabric. Use the following template to tease out some questions related to your own ideas.

Questions linking the personal experience Here questions can be raised that relate to you, your life experience, your future, your ideas. They help form a personal connection to your project.
e.g. Will a particular product make my own home more sustainable in order to reduce my ecological footprint?

Question 2

You may be interested in using the SHK as a model to study a question about sustainability related to us as a society. Use the following template to tease out some bigger-picture questions.

Big Ideas/ Global questions These questions relate to the overarching, big picture ideas that have meaning for humanity, society and/or the future.
e.g. Can the environment and industry really benefit from using geothermal heating?

Question 3

Chose one of the personal or global questions from Question 1 and 2 above that would test a claim that could be investigated using the SHK, and write it here.

Possible Depth Study Research Question #3

1.4 Pinning down and deciding on a final Depth Study research question

Question 1

Evaluate all the variables and possible research questions you have identified so far while working through Section 1. Consider which question has variables that you could test within the classroom and within the time frame you have. Consider the originality of the questions and your level of interest in claim it is testing. Develop one question that you think is most appropriate to use as your central research question and write it here.

Final Depth Study Research Question

Question 2

Write some subsidiary questions that you can research, that will help you respond to your final Depth Study question. These questions help you break the research down into manageable pieces that support the main research question.

Subsidiary Research questions to support the Depth Study Question

1.5 Sign off on Section 1

Show your teacher or supervisor your Final Depth Study Research question so they can give you relevant feedback and sign you off from Section 1 so you can proceed to Section 2.

End of Section 1

Section 2 – Hypothesize and Predict

Goal to achieve by the end of Section 2:

Design a model sustainable house to carry out an investigation to respond to the Depth Study Research Question

2.1 Design an Experimental Aim

Turn your research question from the end of Section 1 into an aim and write it here:

2.2 Hypothesis

In response to your aim in 2.1, formulate a hypothesis and justify your thinking.

2.3 Experimental Variables

Question 1

What is your independent variable, the one you will be changing or manipulating? Do you need to select a range for your independent variable? If so suggest the range in the Variables table below.

Question 2

What is your dependent variable, the one you will be measuring? Add it to the Variables table.

Question 3

Do you have a control that you can measure your experimental results against? If so record it in the Variables table below.

Question 4

Which variables will you need to keep constant? List as many variables you think will need to be kept constant so that they don't influence the experimental results.

Variables table

Independent variable	Dependent variable
Control	Variables that will need to be kept constant

2.4 Research and Design of a Model Sustainable House

Before you construct your model sustainable house with the ATSE kit, some research to guide your specific design and help understand the science behind it will be very useful. Consider the following:

Question 1

Has anyone else designed a similar house and/or conducted a similar experiment before? If so, how does their passive design benefit sustainable living? Make some notes here:

Question 2

What do you need to learn or review about passive housing design, energy transfer and transformation, and/or sustainability?

Question 3

How does the design strategy reduce heat flow into or out of a house using scientific explanations?

Question 4

Use your thinking and research from questions 1 to 3 above to write some unique questions specific to your project that will help you understand the science behind the design of your sustainable house. Create a research table similar to the one below to collect the information in response to each question. Add in any relevant subsidiary questions from the end of Section 1.

Suggested research table layout:

Research Questions	Notes/Information	Reference

2.5 Sustainable House Design

Question 1

Here are some more questions to think about before you begin to build your model sustainable house. If you have any questions of your own, add them here, or to your research in Section 2.3.

- How many people will live in the house?
- How many rooms will the house have?
- Where is the house located?
- What is the local climate like?
- What building materials will you use?
- How will you cool the house in hot weather?
- How will you warm the house in cold weather?
- Will your house design be passive?
- What will the key scientific processes taking place be?
- Are there similar examples online that you can learn from?

Question 2

Make a simple preliminary drawing of your sustainable house design. Which aspects of the model house design are most relevant to your investigation? Annotate the image of your model in order to explain what you will be testing and how during your investigation.

2.6 Modification of Main Research Question and/or Hypotheses

Question 1

After conducting research and designing your model sustainable house do you need to modify your working Depth Study question? If so, rewrite it here.

Modified Final Depth Study Research Question
--

Question 2

Refine your hypothesis and/or your justification so that it incorporates the new knowledge you have gained after researching and designing your model sustainable house.

2.7 Method

Write the method you intend to use to investigate your research question and test your hypothesis. Make sure your method includes the following:

Step by step procedure that works

- Describe how to manipulate the independent variable
- Include when and how to make observations and/or measurements of the dependent variable
- Name the equipment used to take the measurements
- Include quantities and units to the appropriate level of accuracy
- Show how to control any variables that may affect the validity of the results
- Provide the opportunity for 3 repetitions in order to test for reliability

2.8 Risk Assessment

Once you have designed your method, write a Risk Assessment. Use the table below to record each possible Hazard, the Consequence of that hazard, and any Precautions required to avoid the hazard.

Hazards	Consequences	Precautions

2.9 Sign off on Section 2

Show your teacher or supervisor your:

- chosen variables,
- Model Sustainable House,
- completed research table,
- method
- risk assessment

Your teacher or supervisor will give you relevant feedback and sign you off from Section 2 so you can proceed to Section 3.

End of Section 2

Section 3 - Build and test a Model Sustainable House

Goal to achieve by the end of Section 3:

Build a Sustainable House Model and use it to investigate your hypothesis

3.1 Build Sustainable House Model

Construct your sustainable house model. Log any modifications you make from your design plan in Section 2.5, or challenges you have along the way. Describe any trouble shooting you did to overcome the challenges.

3.2 Design Data table

Draft a suitable data table you can use to record your data when conducting your investigation.

3.3 Conduct your research investigation and record the raw data

Carry out your investigation with your Sustainable House. Record your data in the data table as you go. Insert the raw data here by either cutting and pasting, or printing and adding it to your report. Include a graph to visually represent your findings.

3.4 Sign off on Section 3

Show your teacher or supervisor the data collected from your investigation so they can give you relevant feedback and sign you off from Section 3 so you can proceed to Section 4.

End of Section 3

Section 4 - Analysis of experimental results

Goal to achieve by the end of Section 4:
Deep thinking about the experiment process

4.1 Examining the data

Question 1

Look at your graph and describe how the dependent variable changed as the independent variable was manipulated.

Question 2

Describe your results as a whole. Include an outline of any obvious or possible trends.

Question 3

Were your predictions and hypothesis supported? Does your hypothesis need to be modified? Explain.

Question 4

Write your conclusion as a statement that may be used as a claim.

4.2 Examining the experimental procedure

Question 1

Assess the **accuracy** of your data by considering the following:

- i. What degree of accuracy were you working to?
- ii. How did you try to keep your measurements and observations accurate?
- iii. Were there any measurements it was difficult to take accurately? Why?

Question 2

Assess the **reliability** of your data by responding to the following questions:

- i. Look at the repeats of your experiments. Which repeats were similar? Give examples.
- ii. Which results are not very similar?
- iii. Overall are your results reliable or not? Justify your thinking.

Question 3

Did you conduct a fair test? That is, was your investigation valid? Assess the validity of your investigation by considering the following:

- i. Which variables were hard to keep the same? Why?
- ii. Were there any variables you couldn't keep the same even though you wanted to? Why not? Did this affect your results?
- iii. Did your method allow you to respond to the research question?
- iv. Overall was your experiment valid (a fair test)? Justify your thinking.

Question 4

Does your sample size have an impact on your results? Why or why not.

Question 5

Read back over any challenges related to accuracy, reliability and validity (Questions 1 to 3). Identify any sources of random and/or systematic error in your investigation. What improvements would you recommend?

4.3 Explaining and applying the Science

Question 1

Using your research findings, explain the key scientific processes in terms of energy transfer and transformation that is involved in the operation of your Sustainable House design strategy. Include a visual representation of the energy flow. For example use an energy flow diagram, or Sankey diagram.

Energy flow or Sankey Diagram:

Question 2

How might the data you collected or the science behind your investigation be used to promote a commercial sustainable housing product? Explain using an example.

Question 3

Do you think there is a possibility your data could be misinterpreted by someone wanting to use it to sell a product? Do you think your data could be open to bias at all? Explain using an example.

Question 4

What might be the effect of the use of emotive language used to help support evidence based scientific claims, such as products that support sustainable housing? Would there be any effect on the reliability, validity or accuracy of the actual data? Should emotive language even be used to support scientific claims? Explain your thinking.

Question 5

Think beyond the commercial world to identify any factors that could affect the way your data is interpreted, analysed or understood? For example: How did you use a control? Which social aspects or preconceived beliefs might affect what people think of your investigation and the data derived? Explain using an example.

Question 6

If your data refuted a claim, how do you think the proposers of that claim could react? What might be the consequence of any negative actions, and how could you counteract them? If your data didn't refute a claim, respond to this question hypothetically (as if it did refute the claim).

4.4 Analysis of literature

Question 1

When gathering information from secondary data on sustainable housing, how much of it was peer reviewed science, how much was un-reviewed science and how much was advertising claiming authority from science? How could you tell the difference between them? Comment on the sources you came across, as well as the ones you used.

Question 2

In the information you gathered, was there any evidence of a conflict of interest? For example did you read any reports that appeared to be based in science but were really promoting a sustainable housing product? Describe any examples.

Question 3

Did you come across any scientific debates or a conflict of information related to sustainable housing? If so, why do you think this might be? If not, can you think of a situation where this could happen?

Question 4

How do you think the media’s communication of science related to sustainable housing, such as during house renovation television shows or DIY vlogs, influence the general public’s view and understanding of science? Would the halo effect have an influence over the validity of the scientific data or theory? Discuss your ideas.

4.5 Relevance of findings

Question 1

Provide a description about how a modern building might actually use your design and what benefits there are for the occupants.

Question 2

What are the current trends in the sustainable housing industry?

Question 3

Identify possible benefits of sustainable housing to the Australian economy now, and in the future.

Question 4

In what way might your findings drive technological change in the sustainable housing industry?

4.6 Further Questions

If you were given the opportunity, what further investigations would you carry out in order to build on what you have learned from this Depth Study? Include further research questions that would continue to elicit knowledge about energy efficient sustainable housing.

4.7 Sign off on Section 4

Show your teacher or supervisor your analysis of your investigation so they can give you relevant feedback and sign you off from Section 4 so you can proceed to Section 5.

End of Section 4

Section 5 - Communicate findings

Goal to achieve by the end of Section 5:
Communication your results to an audience

5.1 Presentation of Investigation

When your investigation is complete, communicate your findings to an audience. This audience may be your classroom peers, parents, science fair attendees or your classroom teacher.

What should my presentation look like?

Traditionally a scientific investigation requires a full scientific report or scientific poster. For your Depth Study, you can also consider the following:

- A documentary or media report on sustainable housing
- Develop an evidence-based argument for sustainable housing
- Write a journal article or essay including your research findings
- Develop an environmental sustainable housing management plan with reference to your research
- Analyse a work of fiction or film for scientific relevance and accuracy related to the science behind sustainable housing
- Investigate emerging sustainable house technologies
- Create a portfolio of your investigation

Which features should my presentation include?

Question 1

Your presentation will require at least one of the following tools. Which tool(s) will you use?

Presentation tool	Use?	Description of use
Digital tools		
Visual aids		
Written material		
Oral communication		

Tick which tools you intend to use, and suggest or describe how you will use them.

Question 2

Your presentation will require scientific language and terminology. How will you make sure that you have used scientific language and terms appropriately throughout your presentation?

Question 3

Your presentation needs an audience. Will you present your findings to your class or write an article for the school magazine? Identify your intended audience.

Question 4

You will need to present your research findings as a claim, conclusion or argument that is backed up by your findings. Summarize your findings here and justify them using evidence from your investigation.

Question 5

You are required to engage with feedback from your peers in order to evaluate your claim, argument or the conclusion you made. How will you go about that? Possibilities include using discussion, questioning or debating. How will you incorporate ideas from your peers into your thinking?

5.2 Sign off on Section 5

Before the final presentation of the findings of your investigation, show your teacher or supervisor your work so they can provide you with relevant feedback.

End of Section 5

Appendix 1 - Depth Study Progress Chart

This Depth Study booklet contains five separate sections to be completed in order. Sign off on each section before you progress to the next.

Section	Activity	Progress
		Supervising teacher to sign off and comment on each section as it is completed
1. Inquiry questioning	Analysis of secondary source data to generate an inquiry research question that aims to improve knowledge and understanding about sustainable housing.	Supervisor's Guiding Comment:
		Completion date & Supervisor's initials:
2. Hypothesize and predict	Application of thinking in Section 1 to develop a hypothesis and make a prediction. Plan an investigation to respond to the aim and test the hypothesis.	Supervisor's Guiding Comment:
		Completion date & Supervisor's initials:
3. Build and test a model sustainable house	Construction of a sustainable house to gather data relevant to the research question. Primary investigation using this model.	Supervisor's Guiding Comment:
		Completion date & Supervisor's initials:
4. Analysis of experimental results	Examination and interpretation of collected data for trends, limitations, relevance, accuracy, reliability and validity. Findings are analysed alongside secondary sources and future trends, and are used to construct new arguments and propose further questions.	Supervisor's Guiding Comment:
		Completion date & Supervisor's initials:
5. Communicate findings	Create a presentation for an audience to communicate your research results and their relevance.	Supervisor's Guiding Comment:
		Completion date & Supervisor's initials:

Appendix 2–Depth Study Hours Log

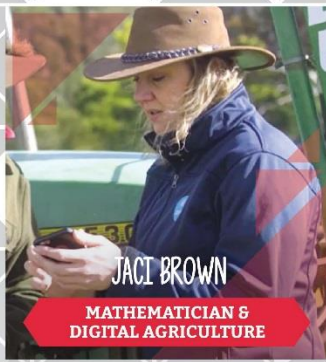
Make a record of the time spent on each aspect of your Depth Study in a table similar to this one.

Date	Time spent	Work Achieved



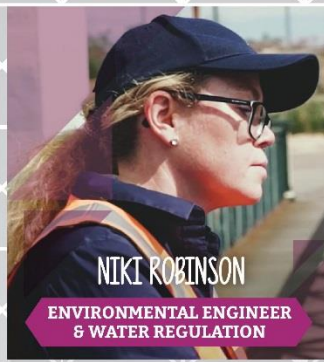
ELLA GROSS

WATER DESIGN ENGINEER



JACQ BROWN

MATHEMATICIAN &
DIGITAL AGRICULTURE



NIKI ROBINSON

ENVIRONMENTAL ENGINEER
& WATER REGULATION



SARAH LAST

BIOLOGIST, INVENTOR
& ENTREPRENEUR



SHEENA ONG

RENEWABLES ENGINEER



SONJA BASSON

ELECTRICAL &
ELECTRONIC ENGINEER



VANESSA RAULAND

SUSTAINABILITY &
RENEWABLES ADVOCATE



ANJALI JAIPRAKASH

ROBOBIOLOGIST



BELINDA GREALY

CHEMICAL ENGINEER



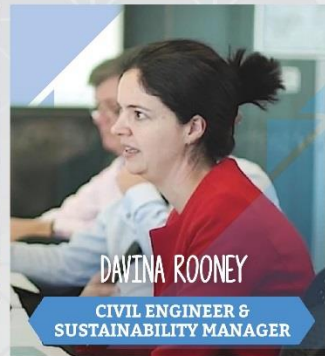
CASS HUNTER

QUANTITATIVE
MARINE SCIENTIST



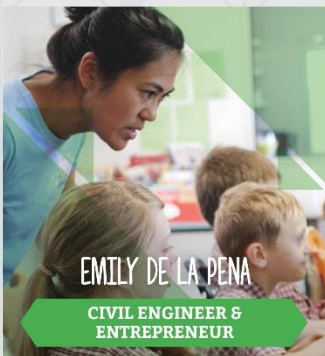
CATHERINE BALL

ENVIRONMENTAL SCIENTIST
& ENTREPRENEUR



DAVINA ROONEY

CIVIL ENGINEER &
SUSTAINABILITY MANAGER



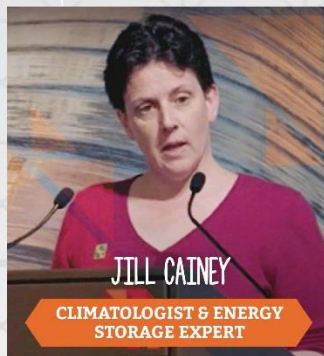
EMILY DE LA PENA

CIVIL ENGINEER &
ENTREPRENEUR



IVANA POPOVAC

SYSTEMS ENGINEER



JILL CAINEY

CLIMATOLOGIST & ENERGY
STORAGE EXPERT



JULIE SHUTTLEWORTH

METALLURGIST



LIZ WILLIAMS

CHEMIST & ENTREPRENEUR



KATE LOMAS

BIOPHYSICIST, INVENTOR
& ENTREPRENEUR



MARIANNE FOLEY

FIRE SAFETY ENGINEER



PIA WINBERG

MARINE ECOLOGIST
& ENTREPRENEUR

VIDEO PROFILES OF WOMEN IN STEM CAREERS AND ENTREPRENEURSHIP

View them all at www.stelr.org.au/WomenInSTEM

#WomenInSTEM #BeAChangemaker #DoSTEMMakeChange

This project received grant funding from the Australian Government.

ATSE
STELR
PROJECT