TASMANIAN CERTIFICATE OF EDUCATION

# Science of Natural Resources
## Senior Secondary 5C

# SYLLABUS SUPPLEMENT

The Syllabus Supplement must be read in conjunction with the syllabus document. It contains advice to assist teachers delivering the syllabus and can be modified from year to year in response to consensus decisions arrived at in TQA Moderation meetings.

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## SYLLABUS SUPPLEMENT TABLE OF CONTENTS

## EXPANDED SYLLABUS OUTLINE

**1. What are the natural resources in Tasmania?**

a) What is a resource?
   i. Discussion and definition

b) What is the time frame of resource formation?
   i. An understanding of a time scale is essential in the formation, use and replacement of resources.
   ii. Timeframes are specific to the context of the resources.

c) Why is the resource valued?
   i. What is valued?
   ii. Who values the resource?
   iii. Have values changed?

d) What accounts for the distribution of these Tasmanian resources?
   i. Where are particular resources found in Tasmania?
   ii. Role of geology and climate in the formation of soil resources
   iii. Role of human impact, topography and weather on erosion of soil
   iv. Role of soils and climate in different types of agricultural production
   v. Role of geology, topography and climate on vegetation distribution

**2. What is the role of research and innovation in the development and management of natural resources?**

a) How do we undertake sustainable resource management?
   i. How do we determine reserves?
   ii. What reserves do we have?
   iii. How quickly are we using it?
   iv. Is the resource renewable?
   v. How is it accessed or harvested?
   vi. What are the criteria for wise use of the resource?
   vii. How do we manage the resource for maximum benefit?
   viii. What drives the use of the resource?

b) What is the role of research institutions in the improvement of management?
   i. University
   ii. Government Departments
   iii. Industry

c) What does it mean to work scientifically in researching resources?

i. Formulate a working hypothesis based on observations of events

ii. Formulate a hypothesis which is testable and includes an independent and a dependent variable

iii. Design experiments to investigate a suitable working hypothesis

iv. Recognise controlled and uncontrolled variables in experimental design

v. Understand the need to minimize the impact of uncontrolled and sometimes unrecognised variables by the use of replicates within an experiment, repeating experiments and the need for experiments to be repeated by different groups of workers

vi. Recognise the sorts of ethical considerations that need to be taken into account in designing experiments

vii. Be able to evaluate the strengths and weaknesses of an experimental design

viii. Be able to design further investigations related to an area of scientific investigation

ix. Be able to state whether the results are consistent or inconsistent with the hypothesis being tested and if needs be state a new hypothesis which is consistent with the results obtained.

d) How do research case studies guide management of natural resources?

i. In sustainable use of resources

ii. In developing new uses of resource

iii. As the basis of innovation

iv. In providing scientific careers

**3. What is the relationship between production and management of a resource?**

a) How has resource use changed through history?

i. As technology changes so does access and use of resource

ii. Origins of the use of the resource

iii. Development of the use of the resource to current uses

b) What impact have principles of ecology had on resource production and management?

i. What is an Ecosystem?

ii. Energy and nutrient flow through the ecosystem

iii. Trophic levels, food chains, food web

iv. Stability of ecosystems

v. Natural versus managed ecosystems

vi. Inputs, processes, outputs, feedback

c) What key aspects describe the science of resource management?

i. Management of physical resources

ii. Management of biological resources

iii. What are the constraints of production?

d) How is sustainable production maximized?

i. Management of biotic and abiotic factors

ii. Environmental impacts

e) What is the nature of advances in technology and to what extent have they led to increased production and changes in management?

i. Increased pressure on the environment

ii. New uses of resources

iii. New styles of management of the resource

**4. What scientific applications are used in the processing in the processing of natural resources in Tasmania?**

a) To what extent has downstream processing impacted on local industries and what are the associated aspects?
   i. Physical processes
   ii. Chemical processes
   iii. Biological processes

b) What is the nature and extent of value-adding with regard to Tasmanian resource industries?

c) What uses have been and can be made of waste products as a resource?

**5. What issues affect resource industries?**

a) What values lie in using Tasmanian resources?
   i. Employment
   ii. Developing infrastructure
   iii. Controlling quality
   iv. Quarantine
   v. Availability

b) What external influences affect natural resource use?
   i. Global markets

c) What are the ethical issues associated with resource management?

d) What are some of the issues that raise public debate in:
   i. Agriculture
   ii. Marine resources/aquaculture
   iii. Energy
   iv. Forestry
   v. Mining

e) What is the nature of government involvement in sustainable resource management?
   i. Controlling use of resources
   ii. Supporting community based approaches influencing sustainable resource management
   iii. Targeted research
   iv. Supporting international marketing and global trade
   v. Policies influencing sustainable resource management

# AGRICULTURAL EXAMPLES

**1. What are the Natural Resources in Tasmania?**

- Diversity of agricultural resources
  - Biotic (eg Animals, microbes, plants, fungi, …)
  - Abiotic (eg Climate, soils, rocks, minerals, water, chemicals, air, …)
  - Human (eg Knowledge, skills, management, research, …)

  *Timeframes are specific to the context of the resources.*
- Annual, perennial and long term crops

**2. What is the role of research and innovation in the development and management of natural resources?**

- The role of research institutions
  - University, TIAR
  - DPIWE research stations and University research farms
  - Serve Ag
- Review of research case studies
  - Rural Tree Decline (eg land degradation)
  - Japanese Ginger Plant (eg effect on photoperiod)
  - Food Safety (eg predictive modelling in microbiology)
  - Pyrethrum Production (eg identification and treatment of fungal diseases)
  - Plant Root competition below ground (eg integrated weed management)

**3. What is the relationship between production and management of a resource?**

- As technology changes so does access and use of resource
  - eg Irrigation, size of machinery, ITC, remote data logging, remote sensing, laser, computer chips in livestock, GPS during harvesting
- New agricultural enterprises
  - New crops see DPIWE website
- The future uses of resources
  - How do the uses of resources change?
  - What are the consequences of changed use?
- Origins of agriculture
  - Hunting and gathering
  - Shifting cultivation
  - Early Tasmanian agriculture eg early land clearing by settlers
- Current systems of agriculture
  - Intensive animal and crop based systems
  - Extensive animal and crop based systems
- The science of management of resources
  - Management of physical resources
    - Improving the quality of soil and water resources
  - Management of biological resources
    - Control of pests, weeds and diseases
  - What are the constraints of production?
  - Resources available for managers
- How is sustainable production maximized?
  - Yield – determined by biotic and abiotic factors
  - Management – eg whole farm planning
  - Environmental impacts – eg EMS, IPM
  - Animal and plant production

**4. What scientific applications are used in the processing in the processing of Natural Resources in Tasmania?**

- Downstream processing in local industries
  - Alkaloid industry
  - Dairy industry
  - Viticulture industry
  - Pyrethrum industry
  - Essential oils
  - Brewing industry
  - Grains industry
  - Meat and livestock industries
  - Vegetable industry
- Value adding by Tasmanian resource industries
- Use of waste products as a resource eg dairy effluent, feedlot waste for worm farms

**5. What issues affect resource industries?**

- External influences
  - Global markets eg EU cattle
- Issues that raise public debate
  - Genetically modified organisms
  - Alternatives to conventional agriculture (eg Organic, permaculture, biodynamics)
  - “Clean green image”
  - Plantation forestry
  - Pesticide use
  - Salinity
  - Social costs
  - Soil erosion
  - Biodiversity
  - Animal welfare
  - Urban sprawl onto productive land
  - Rural Sociology eg community interactions, services available
  - Change from small family farms to large corporate farming enterprises
  - Forestry plantations encroaching on farms
  - Decline of rural communities
- Government involvement in sustainable resource management
  - Controlling use of resources eg water use, land clearing
  - Supporting community based approaches influencing sustainable resource management eg Landcare
  - Targeted research
  - Supporting international marketing and global trade
  - Policies influencing sustainable resource management

# FORESTS / FORESTRY EXAMPLES

**1. What are the Natural Resources in Tasmania?**

- Diversity of Forest resources
  - Biotic (eg vegetation types, species (animals, plants), food chains, food webs, …)
  - Abiotic (eg Climate, soils, rocks, drainage, altitude, aspect, fire history, …)
  - Human (eg Knowledge, skills, management, research, …)

  *Timeframes are specific to the context of the resources.*
- Short term (plantation), long term (native forest eucalypts) and very long term (special species) resources

**2. What is the role of research and innovation in the development and management of natural resources?**

- The role of research institutions
  - University, Co-operative Research centre for Temperate Hardwood Forests
  - WARRA Long Term Ecological Research Site (see Forestry Tasmania web site)
  - Forestry Tasmania, Forest Practices Board, Private Forests Tasmania, private companies, …
- Review of research case studies
  - Alternatives to clearfalling in wet eucalypt forests
  - Control of mammal browsing in plantations
  - Ecological processes involved in the decay of logs on the forest floor

**3. What is the relationship between production and management of a resource?**

- As technology changes so does access and use of resource
  - Eg. Innovation in machinery design (harvesting, transport, processing), GIS information systems, computers, developments in steel technology, laser control systems in processing, developments in glue technology (laminated beams, reconstituted timber products), the values of eucalypt fibre for soft tissue papers, computer paper, high speed printing presses and high quality magazines
- New forestry enterprises
  - Eg. Rotary peeling of lower grade regrowth eucalypt timber
- The future uses of resources
  - How do the uses of resources change?
  - What are the consequences of changed use?
- Origins of forestry in Tasmania
  - Early Tasmanian use of timber, housing, boat building, exports
  - Early methods of accessing and processing timber in Tasmania
  - The ‘forest conservancy’ movement
  - Creation of the Forestry Department and its six initial tasks
  - The development of private forestry in Tasmania
- Current forestry processes
  - Intensive plantation based systems
  - Extensive native forest based systems
  - The CAR reserve system
- The science of management of resources
  - Management of physical resources
    - Maintaining the quality of soil and water resources
    - Ensuring effective regeneration of the resource
  - Management of biological resources
    - Control of pests, weeds and diseases
  - What are the constraints of production?
  - Resources available for managers

- How is sustainable production maximised?
  - Yield – determined by biotic and abiotic factors- forest measurement techniques
  - Management – eg district and whole state planning
  - Environmental impacts – eg EMS
  - Harvesting and regeneration techniques
  - Fire and its use as a management and regeneration tool

**4. What scientific applications are used in the processing of Natural Resources in Tasmania?**

- Downstream processing in local industries
  - The sawmilling industry (large scale and country sawmills)
  - Veneer mills
  - Reconstituted timber products (particle board mill and MDF mill processes)
  - Pulp and paper production
  - Woodchip industry (fibre technology)
- Value adding by Tasmanian resource industries
  - Eg, furniture, craftwood, wooden boat building, pre-stresses laminated beams, etc. …
- Use of waste products as a resource eg sawdust as a fuel and as a growing medium in the mushroom industry

**5. What issues affect resource industries?**

- External influences
  - Global markets
  - Public demand for particular products
- Issues that raise public debate
  - Alternatives to conventional forestry (eg pro-silver,..)
  - Alternatives to the use of timber (eg hemp for fibre, steel, plastics, etc. )
  - “Clean green image”
  - Plantation forestry
  - Non native species (Radiata pine, eucalyptus Nitens)
  - Pesticide use
  - Clearfalling in native forests
  - Oldgrowth logging
  - Export woodchipping
  - 1080 control of browsing mammals
  - Social costs
  - Soil erosion
  - Biodiversity
  - Rural Sociology eg community interactions, services available
  - Forestry plantations encroaching on farms
  - Decline of rural communities
  - Log trucks on public roads
- Government involvement in sustainable resource management
  - Controlling use of resources eg water use, Regional Forest Agreements, etc
  - Supporting community based approaches influencing sustainable resource management eg Landcare
  - Targeted research
  - Supporting international marketing and global trade
  - Policies influencing sustainable resource management

# MINERALS INDUSTRY EXAMPLES

**1. What are the Natural Earth Resources in Tasmania?**

- Materials that are mined, quarried or otherwise extracted from the Earth's crust
  - Groundwater
  - Building materials, eg. stone, clay, soil, sand Metalliferous minerals
  - Metalliferous minerals
  - Carbon and hydrocarbons, eg. coal, oil shale, petroleum, gas

  Timeframes are specific to the context of the resources.
- Resources used in the quarrying, mining, extraction and production of Earth resources, eg. water, air, wood, energy

**2. What is the role of research and innovation in the development and management of natural resources?**

- The role of research institutions
  - CODES, University
  - CSIRO
  - Mineral Resources Tasmania
  - Geoscience Australia
  - Industry scientists
- Innovation and development
  - Technology, products and commodity demand
  - Geological theory, experimentation, debate, models, simulation
  - Theory, technology and exploration
  - Technology and extraction processes
  - Commodity production
  - Health and safety
- Review of research case studies
  - Plate tectonics and ore formation, eg. Hellyer, Rosebery, Mt Lyell or Henty
  - Use of limestone in handling and use of aggregate (gravel) (Boral Quarries)
  - Limestone and cement production (Australian Cement, Railton)
  - Lime production (Mole Creek Lime)
  - Technology and exploration, eg. remote sensing, regional survey
  - Technology and mining, eg. explosives and blasting, underground communication, mine design, mine machines, ventilation
  - Metallurgical breakthroughs, eg. flotation, gold extraction
  - Biological extraction, eg. bacterial gold extraction (Beaconsfield Gold)
  - Smelting, eg. zinc (Pasminco Hobart Smelter), iron alloys (TEMCO Georgetown), aluminium (COMALCO), iron ore pellets (ABM, Port Latta), cement (Australian Cement, Railton), tin (Rallinga, Port Davey), gold (selected mine sites, West Coast)

**3. What is the relationship between production and management of a resource?**

- As technology changes so does the discovery, delineation, access and use of a resource
  - Size of machinery, ITC, remote data logging, remote sensing, laser, computer modeling, design and simulation, GPS
  - Environmental management and access
- New mineral enterprises, eg. nickel (Avesbury and Melba Flats deposits), magnesite, crude oil and natural gas in Tasmania

- The future uses of resources
  - How do the uses of resources change eg. osmiridium, tin, change from white clay to calcite for paper production, magnesite, tantalum, oil shale
  - What are the consequences of changed use?
  - Origins of minerals use, eg.

    Hunting and gathering, eg. weapons, tools

    Decoration, eg. jewellery, painting (ochre)

    Medicinal

    Currency

    Communication

    Cultivation

    Construction

    Mobility, travel

    War
- History of the use of earth resources
  - The Ages of Humans – Stone Age, Copper Age, Bronze Age, Iron Age
  - Pressures of population increase, standards of living and accompanying development of technologies. "Technology breeds technology"
- Need for and discovery of new materials – Discovery leads to new technologies; new technologies lead to discovery.
  - Increased population and improved standards of living equate to increased demand for minerals.
  - Quarrying, mining and hydrocarbon extraction is a temporary use of the land
- The science of management of Earth resources
  - Quarrying, mining and hydrocarbon extraction is a temporary use of the land
  - Management of physical resources
    - How can non-renewable resources be managed? Are they sustainable? What is "sustainable" in the minerals industry?
    - Management of ecological resources, environmental management
  - What are the constraints on production?
    - Rock and sediment deposits, orebodies and hydrocarbon reserves have finite sizes. Quarry, mine and hydrocarbon resource dimensions are limited by economic, engineering and environmental factors. The production of a commodity is limited by world needs.
  - Management of ecological resources, environmental management
    - Minerals industry operations have had, and have the potential to damage the environment. Minerals industry operations are often located in or adjacent to environmentally sensitive areas.
    - Environmental management is an important aspect of a minerals industry operation
    - The government oversees and enforces strict environmental regulation
  - Resources available for managers
- Minerals industry operations are sustainable as long as new resources are found. How can sustainable production be maximised?
  - On-going exploration
  - Discovery
  - Resource and reserve confirmation
  - Environmental impacts – eg EMS, IPM
  - Effective production
  - Closure and rehabilitation

**4. What scientific applications are used in the processing of natural resources in Tasmania?**

- Downstream processing in local industries – mineral extraction, mineral conversion, smelting
  - Iron ore to magnetite (Savage River)
  - Magnetite to pellets (Port Latta)
  - Massive mixed sulphide ore into separate metal sulphide minerals (Rosebery, Mt Lyell, Hellyer, Henty)
  - Metal sulphide minerals to metals (Pasminco Hobart Smelter, Port Pirie (SA))
  - Gold from sulphide ore (Henty, Beaconsfield, Rosebery, Mt Lyell)
  - Gold from vein quartz
  - Tin from mixed mineral ore (Renison, Rallinga)
  - Tin from alluvial sands and gravels
  - Magnetite, tin and tungsten minerals from granite
  - Lime from limestone (Mole Creek Lime, Beams Bros. Flowery Gully))
  - Cement from limestone
  - Aluminium from Bauxite (COMALCO)
  - Iron alloys from haematite, quartzite and coal (TEMCO)
  - Clean coal washing
  - Cutting building stone
- Value adding by Tasmanian resource industries
  - Use of coal in cement making
  - Mag wheels (Southern Aluminium – now closed), aluminium dust.
  - Cut and polished stone

Use of waste products as a resource

  - Ash from coal
  - Inert crushed aggregate from TEMCO slag
  - Hot waste gas recycling through electricity generators at TEMCO, Australian Cement and Pasminco Hobart Smelter
  - Sulphuric acid for production of fertilizers at Pasminco Hobart Smelter

**5. What issues affect resource industries?**

- The resource is owned by the people of that country
- External influences
  - Global markets eg. commodity (metal) prices (supply-demand, cartels, new technologies, fashion)
- Issues that raise public debate
  - Environmental history
  - Alternatives to earth resource use (eg. burning hydrocarbons, unleaded petrol)
  - “Clean green image”
  - Biodiversity
  - Chemical use (eg. mercury or cyanide in gold extraction)
  - Chemical spills
  - Water pollution
  - Ground water contamination (eg. underground operations, in-situ leaching)
  - Health and safety (eg. working hours)
  - Demographic change and social costs (eg. downsizing; fly in-fly out operations; depletion of orebodies and town closure; isolation; young moving away)
  - Company support in “company towns”
  - Rural sociology eg community interactions, services available
  - Decline of rural communities

- Government involvement in sustainable resource management
  - Controlling use of environment eg water use, land clearing
  - Controls in mine safety
  - Use of mineral royalties to improve minerals industry and associated problems, eg. repair of past environmental damage, targeted research and exploration
  - Supporting community based approaches influencing sustainable resource management eg. waterwatch, landcare
  - Supporting international marketing and global trade
  - Policies influencing sustainable resource management

## MARINE/AQUACULTURE

**1. What are the natural resources in Tasmania?**

- Water quality
- Close proximity to southern ocean, fertile fishing grounds, deep harbours, good port facilities
- Wild fishery around Tas – species – abalone, rock lobster, giant crab, scalefish
- Aquaculture species – mussels, oyster, salmon, abalone, scallops, sea horses, sea raised trout

**2. What is the timeframe?**

- Life cycles of aquaculture species – markets
- Development of fishery – research – management – breeding times of species – orange roughy age, Patagonian tooth fish?

**3. Why is the resource valued?**

- Water quality
- No antibiotics in salmon food
- Deep ocean species – high nutrient
- Low pollution?

**4. What accounts for the distribution of these resources?**

- Current flow
- Harbour facilities and close proximity to processing facilities airports and transport infrastructure
- Coastal planning – space – intertidal oyster, depth salmon
- Availability of good fresh and saltwater
- Climate – salmon temp
- Wild fishery – topography of sea floor – OR sea mounts, availability of food
- Human impact
- Turbidity – plant growth – plankton for filter feeders
- Competition from other species

**5. What is the role of research & innovation in the development & management of natural resources**

- Telemetry – abiotic monitoring
- CSIRO – genetics of aquaculture sp; oils; tuna management OR life cycle
- Marine Reserves
- TAFI – new aqua species
- Sea Fisheries – legal fishing limits, places, times, sizes

**6. Examples of working scientifically to research resource**

- OR life cycle
- DPIWE monitoring of water quality & toxic dinoflagellates

**7. Research case studies which guide management of natural resources**

**8. What is the relationship between production and management of a resource**

- How has it changed through history?
- Native Tasmanians – lived off shellfish – middens- manage?
- Early Europeans – came from fishing villages?
- Whaling
- Hobart fishing port
- Scallops in channel
- Nortas
- Mures fish shop – fresh fish caught locally – exported
- Management of abalone fishery
- Cray fishing in SW
- Impact of weather reporting & increased safety regulations – stormy seas
- Tuna fishery – used to be mass production – now top end of Japanese sashimi market
- Seahorses
- Giant crabs
- New species to be farmed – flounder, trumpeter, crays

**9. How is sustainable production maximised?**

- Management of water quality – DPIWE – env impacts
- Limit to farm placement
- Limits to gear, catch and time
- Research into new markets, research into limiting bycatch and new markets for bycatch
- Pollution regulations – bait box straps
- Testing for dinoflagellates

**10. What is the nature of advances in technology & to what extent have they led to increased production & change in management**

- OR life cycle
- Seamount habitat
- GPS, echosounder
- Deep sea technology – cameras, data recorders
- Telemetry tags on fish – better info about fish stocks
- Better water quality management
- Better understanding of human impacts
- Longlining – weighted line, shute

**11. What scientific applications are used in the processing of natural resources in Tasmania?**

- Hatching & growth of smolt
- Helicopters
- Fresh export of fish

**12. Downstream processing in local industries?**

- Algae culture
- Processing technology
- Fish oils
- Fish punts
- Restaurant business
- IMP research
- Stormy seas jackets
- Electronic monitoring
- Tourism – diving, fish farms

**13. Nature and extent of value adding?**

- Seahorses?

**14. Uses of waste products?**

- Bycatch
- OR fertiliser
- Oyster & mussel shells?
- Skin?
- Fishmeal?

**15. What issues affect resource industries?**

- Longlining
- Employment
- Safety
- Pollution – visual, chemical, rubbish
- Locking up of coastline
- depletion of fish stocks
- bycatch
- escape of introduced farmed animals – salmon, oysters
- toxic phytoplankton
- farming top prodators – food is depleting wild fishery

**16. External influences**

- Global markets
- Northern hemisphere fish stocks
- Fishing pirates
- SARS – crays
- Climate changes

**17. Ethical issues associated with resource management**

- Impact to seafloor
- Impact on wild fish stocks & associated effect on food web
- Plunder the sea?

**18. Issues that raise public debate**

- Coastline
- Visual pollution
- Depletion of fish stocks – bycatch, turtles, dolphins, albatross
- Eating genetically engineered products
- Source of freshwater for salmon farms
- Escapes
- Effluent from processing
- Seal numbers

**19. What is the nature of govt involvement in sustainable resource management?**

- Money for research
- Regulation of fishery – time, place, size – both recreational & commercial
- Safety regulations
- Education of community – benefits of ?
- Monitoring of water quality, stock quality
- Support for innovative products and finding new markets

# ENERGY

**1. What are the Natural Resources in Tasmania?**

- Water
- Wind
- Natural gas
- Sun
- Waves
- Tide
- Animal, plant and human waste
- Coal (minimal)
- Hot rocks?

**2. What is the role of research and innovation in the development and management of natural resources**

Wind

- turbine technology, getting bigger, quieter, more efficient
- modelling for site selection: macro and micro
- climate modelling
- modelling bird migration patterns, researching mitigation options
- battery technology (also with mini hydro)
- wind mapping
- improved forecasting of wind flow
- hydrogen generation, storage, distribution

Hydro

- mini hydro turbine technology, eg in pipe systems for sewerage
- development of sophisticated 'fish passage' structures to attract and move fish past dams
- minimisation of the footprint of a hydro-electric system
- optimisation of hydro operations to maximise energy production
- cloud seeding to enhance rainfall
- climate change and the impact on weather systems

Coal and natural gas

- exploration technology
- carbon geo-sequestration, greater efficiency

Solar

- photovoltaics technology
- building and materials design for efficiency and good solar properties

Biomass

- experimenting with different crops
- fermentation to produce ethanol, blend with fuel for cars
- increasing energy efficiency of producing ethanol

Natural gas

- exploration technology eg seismic surveys

End use efficiency eg appliances, star ratings

Research bodies

- electricity Supply Association of Australia
- Australian Cooperative Research Centre for Renewable Energy (ACRE)
- CSIRO
- centre for sustainable energy systems at ANU
- national and state government research centres eg Energy Research and development corporation
- Australian Greenhouse Office

**3. What is the relationship between production and management of a resource?**

All forms of energy need to be stored and distributed to homes, factories, other users. Usually powelines or pipelines provides distribution. Potential for hydrogen generation using wind at remote sites.

Access to energy sources often requires new roads to remote places, can disturb wilderness values. Changing land use big factor in management issues.

Hydro

- need to manage reservoir and releases to minimise effect on downstream conditions and reservoir ecology eg lake levels, algal blooms, water quality, timing and size of releases of water to generate
- integration with other sources of power eg wind allows hydro to be used as peak load. Has implications for aquatic environmental management
- managing storage and use of chemicals and oils in power stations on rivers

Wind

- power provided when wind blows, storage through batteries, flywheels, or integration with other sources
- managing interactions with animals eg migratory birds, local water birds
- windy sites often remote, spectacular coastal scenery, can be visual impact
- access to transmission lines v important
- farming activities can still continue on land around turbines

Solar – photovoltaic cells production, cost, storage

Coal – mining, environmental impacts, emissions, mine rehabilitation, tailings, waste water, greenhouse gases non- renewable long term sustainability, infrastructure

Gas – rig, pipeline, under sea and land impacts revegetation, distribution, environmental costs non-renewable, long term sustainability

Oil – non-renewable, sustainability issues, environmental impact, cost, political and social costs

Nuclear – uranium mining, health and safety issues, half life of radioactive waste, safe storage of waste environmental impacts, social political issues

Hydrogen power – new technologies, volatile

**4. What scientific applications are used in the processing of Natural Resources in Tasmania?**

Nearly all disciplines required to investigate, evaluate, select, design, build and operate energy generation systems.

Hydrology modelling, meteorology, geology, geomorphology, botany, zoology, ecology, physics, chemistry, engineering, mathematics, technology.

Determining structure and stability of landforms, vegetation and fauna surveying, environmental impact assessments, monitoring water quality and quantity.

Dam construction structural aspects eg loads and stresses and capacity. GIS, computer modelling, social sciences.

**5. What issues affect resource industries?**

- Initial cost of production
- Supply and demand
- Resource security and ongoing availability. Resource is not 'owned' especially wind solar, water
- Resource sharing required eg environment, farmers, drinking water
- Infrastructure and maintenance costs
- Environmental impacts
- Changing social demands
- Economic viability
- Changing technology
- Government regulations and legislation
- Health and safety
- Market competitors – eg gas and hydro, wind
- Global market – export and import of expertise, technological innovation

## TEACHING RESOURCES AVAILABLE

### AGRICULTURAL EXAMPLES

CD-ROM *"Chemistry and Physics in Tasmanian Agriculture"* available from School of Agriculture, University of Tasmania (ph 62 262620 or David.Russell@utas.edu.au)

CD-ROM *"Aspects of Experimental Design: Case Studies in Agricultural Research"* available from School of Agriculture, University of Tasmania (ph 62 262620 or David.Russell@utas.edu.au)

### FORESTS / FORESTRY EXAMPLES

*"Project Forest: learning about our forests"* resource package available through the Forest Education Foundation. Web site: www.forest-education.com links to a wide range of other related sites are available here. (Contact David Hamilton on 0419 554 013 or dhamilt5@bigpond.net.au Darcy Vickers on 0417 532 058 or dvickers@netspace.net.au

Forestry Tasmania publications available through District offices and information on their web site at www.forestrytas.com.au which includes information relating to forest research

Tasmanian Forest Practices Board publications (manuals, technical bulletins and forest research

### MINERALS INDUSTRY

Resources – Working for the Right Balance" Education Kit with CD-ROM, videotape and booklets. SA Dept Mines & Energy

"Elemental" Education Kit with CD-ROM and teachers guide. Board of Studies, NSW

"Geology of Australia" Geoscience Australia

"Discovery" CD-ROM with Teacher/Student Guide. Australian Institute of Petroleum

"Minerals Downunder" Resource book with Teachers Guide Minerals Council of Australia

'Minerals Education Resource Guide" Tasmanian Minerals Council

National Mines Atlas. Geolscience Australia

Website: www.nationalminesatlas.gov.au

Tasmanian Minerals Council Website: www.tasminerals.com.au

Minerals Council of Australia www.minerals.org.au

Geological Society of Australia www.gsa.org.au

Geological Index www.geologylink.com

Mineral Resources Tasmania www.mrt.tas.gov.au

### ENERGY

www.eia.doe.gov/kids/kidscorner.html

US Department of energy site, good spread of great links. Many facts are focuses on US states, but clear selection of renewables and non-renewables, 'energy ant' character, good resource links for teachers, lots of online resources

www.greenhouse.gov.au

Australian site for teachers, has info on energy ratings systems etc

www.energyquest.ca.gov

California energy commission page – great for kids and teachers. US focus again but good games and facts

www.anzes.org

Australian - New Zealand Solar Energy Society. Not designed for kids but has good info on current solar developments in Australia

www.auswea.com.au

Australian wind energy association, represents wind farm developers in Australia. Good fact sheets for teachers and advanced students

www.csiro.gov.au

Hydro Tasmania "The Power of Nature: Tasmania's Renewable Energy from Water and Wind" (2003), (ABN 48 072 377 158) approx. $3.00 per copy via Energy Discovery Centre, Hobart