The emissions context

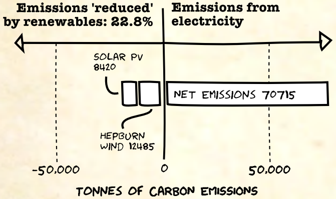
Electricity baseline for Hepburn Shire

znet
HEPBURN SHIRE

Shire Summary

Hepburn's emissions from electricity amounts to 70,715 tonnes of carbon emissions annually. Electricity is used for a range of daily business and household needs such as lighting, heating, hot water,equipment and appliances.

We reduce 22.8% of electricity emissions through local generation of renewable energy from rooftop solar and Hepburn Wind.



Shire facts

Population	15,753
# households	8,648

Electricity supplied by:

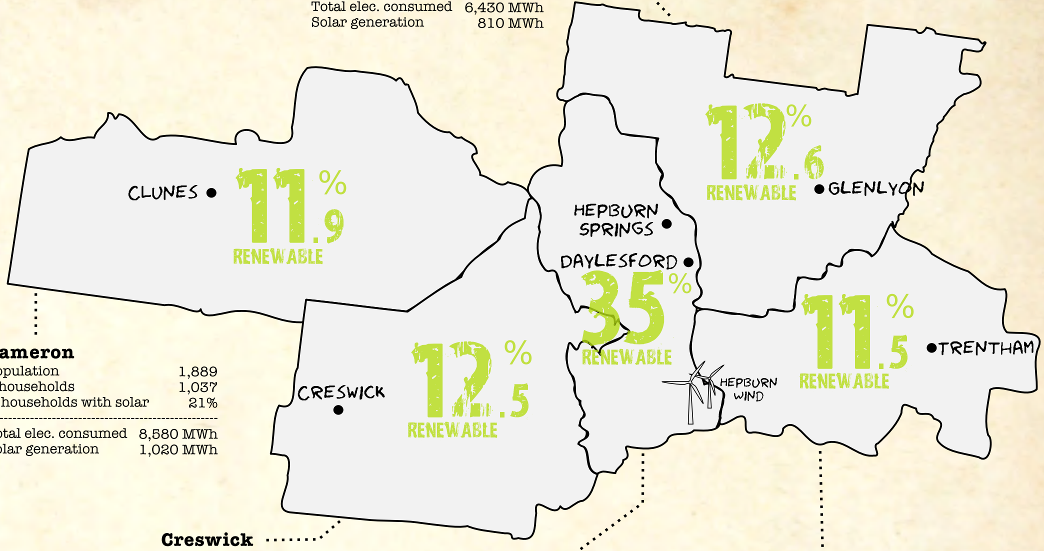
Solar	7,260 MWh
Wind	10,760 MWh
Supplied by grid	60,960 MWh
Total elec. consumed	78,980 MWh
% Renewable electricity	22.8%

Net emissions	70,715 tCO2-e

Data sources

Australian Bureau of Statistics (ABS), Powercor and Hepburn Shire Council (Rates data), openNEM, Clean Energy Regulator

Breakdown by Ward



Holcombe

Population	1,850
# households	943
% households with solar	24%
Total elec. consumed	6,430 MWh
Solar generation	810 MWh

Cameron

Population	1,889
# households	1,037
% households with solar	21%
Total elec. consumed	8,580 MWh
Solar generation	1,020 MWh

Creswick

Population	4,338
# households	2,381
% households with solar	21%
Total elec. consumed	17,880 MWh
Solar generation	2,240MWh

Birch

Population	5,570
# households	3,057
% households with solar	16%
Total elec. consumed	36,810 MWh
Solar generation	2,130 MWh
Wind generation	10,760 MWh

Coliban

Population	2,107
# households	1,157
% households with solar	23%
Total elec. consumed	9,280 MWh
Solar generation	1,070 MWh

About grid electricity

Electricity from the grid that is generated outside Hepburn is also partially supplied by renewable energy. In April 2018, this totaled around 16% of Victoria's electricity generated

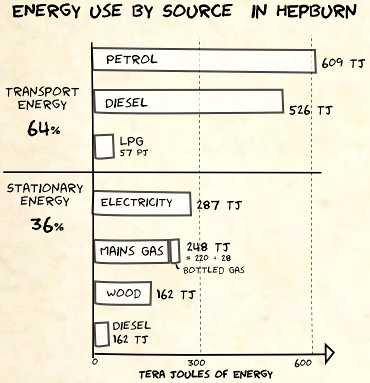
The emissions context

Energy use in Hepburn Shire

znet
HEPBURN SHIRE

What energy is used

Hepburn's energy needs are met by natural gas, electricity, firewood, diesel and transport fuels (petrol, diesel and LPG). We use about 1,870 TeraJoules of energy per year.



The energy 'boundary' for ZNET Hepburn incudes all stationary energy used by local residents and visitors, but only transport energy from the local community.

Stationary energy

About 36% of Hepburn's energy needs come from 'stationary' energy sources that power our homes, businesses and infrastructure. A closer look at our stationary energy mix is provided below

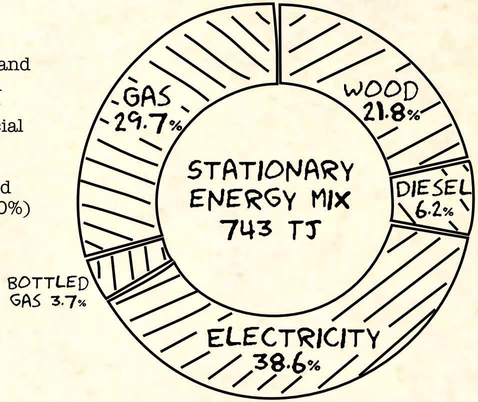
Transport fuels

Transport fuels power the vehicles we use to get around: they account for 64% of energy used by Hepburn's residents and businesses. Petrol is the most used fuel type (51%), followed by diesel (44%) and LPG (5%). All of these fuels produce greenhouse gases and air pollution.

Natural gas: 247 TJ

Natural gas is used by households for cooking and heating both spaces and water. It is also used for industrial and commercial applications.

Most natural gas is piped directly to end users (90%) with the remaining consumed from bottled gas.



Firewood: 162 TJ
from 10kt of wood

Neary 60% of households use firewood for heating sourced, which mostly comes from fallen timber on farming land.

Diesel: 46 TJ
from 1,728 kL of fuel

Diesel is used for farming and agriculture activities (e.g. to power diesel pumps and generators, and for off-road vehicles like tractors).

Electricity: 287 TJ or 80 GWh

Electricity is used for a range of daily business and household needs such as lighting, heating, hot water, equipment and appliances. 23% of electricity comes from local renewable sources: including the households with rooftop solar PV installed (supplying 9.9% of total consumption), and Hepburn Wind (13.5%).

Energy efficiency

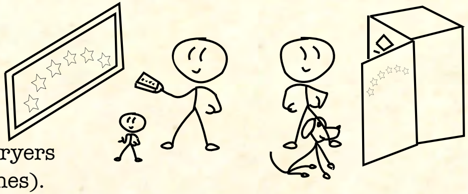
Appliances

UP TO 7% OF ELECTRICITY

Estimated potential contribution to ZNET

The technology

Older appliances (e.g. televisions and fridges) and IT equipment (e.g. computers) can consume a substantial amount of power. Fortunately there has been significant progress in improving both their efficiency and the information available to consumers to assist with better product selection. Many appliances include an energy star rating which makes it easy for consumers to choose a more efficient product. Where on-site solar exists, some whitegoods can be programmed to run during the day to take advantage of solar generation (e.g. dishwashers, dryers and washing machines).



The opportunity

Older electrical appliances can account for the largest proportion of household consumption (up to 35%). Older appliances (such as fridges) generally draw higher operating and standby power and are particularly good targets for upgrades. Measures such as Minimum Energy Performance Standards (MEPS) and Energy Labelling, help to guide improvement in energy efficient appliances.

Best available appliances compared to average:	10% saving in total energy
MEPS program impact (over ten years):	60-80% less energy
Electricity consumption feedback/monitoring:	4 to 12% saving

●●●

Desirability

> MEPS and Energy Labelling are already driving savings.

> Choosing efficient appliances targets the largest source of household energy consumption.

> New (efficient) appliances can have an unpredictable impact on total energy use (e.g. a new appliance might be used more).

●●●

Feasibility

> Informational campaigns about energy labelling is low cost, simple to communicate and effective.

> Trade in programs can also encourage the removal of old appliances from operation.

●●○

Viability

> About a 7% saving can be expected at little to no cost.

> Replacement of old appliances is done when they are due for retirement

Energy efficiency

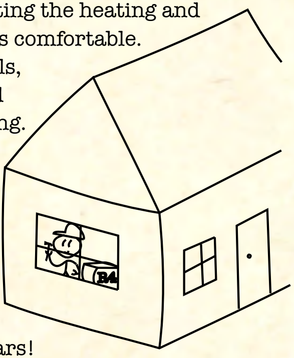
Building fabric upgrades

Estimated potential contribution to ZNET

UP TO 50% OF ELECTRICITY GAS AND WOOD

The technology

Improving the 'thermal fabric' of buildings (the walls, roofs and floors) can be an effective way of limiting the heating and cooling required to keep indoor spaces comfortable. Key measures include: insulating walls, ceilings and floors, double glazing and shading windows, and draught proofing. The key measurement for residential thermal performance is heating and cooling demand, which in Australia is generally measured in a star rating of up to 10 stars (with the minimum for a new dwelling at 6 stars). The average of existing dwellings in Victoria is less than 2 Stars!



The opportunity

Most houses built before the year 2000 have limited or no insulation. Houses without insulation have poor thermal performance. Draughts and large glazed areas are also factors in poor thermal performance. An average house without insulation can be improved by 2 to 3 stars with insulation and some other basic efficiency measures. This equates to a 50% energy saving for space conditioning.

Potential energy savings of upgrades a base (1.4 star) home:

+ Roof insulation to R4 (3.5 star):	50% energy saving
+ Wall and subfloor insulation (5.5 star):	70% energy saving
+ Draught proofing, shading and double glazing (7 star):	80% energy saving

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Desirability

> Low hanging fruit like draught proofing and most insulation achieves large savings at low cost and effort.
> More intrusive measures become cost prohibitive.

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Feasibility

> It is relatively straightforward to insulate ceilings.
> Insulation is more complex for walls and floors, but is still possible (e.g. using spray foam).
> Draught proofing is a 'no brainer'.

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Viability

> Ceiling insulation costs around $5-10 per sqm
> Full retrofit of house from base to 5 star is possible and cost effective, however retrofits beyond 5 star may not be possible (or economic)
> The average cost of double glazed glass is around $15,000 per household.

Generating nearby

Bioenergy

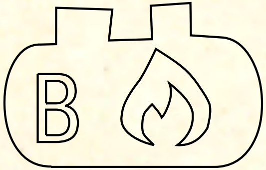
Estimated potential contribution to ZNET

ONLY LIMITED BY BIOMASS AVAILABILITY AND GENERATOR SIZE

The technology

Energy generation from biomass uses the burning of organic matter (e.g. crop waste) to produce heat energy at all scales (e.g. firewood is a type of biomass). At large (commercial) scale biomass is burnt to produce either heat to supply district heating or to produce steam for power generation.

The creation of biogas (from the breaking down of biomass) is undertaken either actively in a biodigester, or passively by capturing 'waste' biogas from landfill sites or from the treatment of sewage.



The opportunity

Productive land in the Hepburn Shire is primarily pasture land for grazing. Crop stubble is minimal. Forestry activity and saw milling occur in neighbouring shires, but not within the Hepburn Shire. Fallen hardwood is available as resource in the area, but this is currently used for space heating (a high percentage of households use wood heating). The Shire's waste is a reasonable source of biogas.

Council is developing a pilot project, with views to expand to a 65kW system which delivers 252 MWh of electricity into the grid per annum and a 257MWh heating load.

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Desirability

> Bioenergy is generally positively perceived.

> Bioenergy is not a well established industry in Australia, however has been well explored in Hepburn Shire

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Feasibility

> Relatively limited bioenergy resource in Hepburn Shire due to the scale of the population.

> Municipal waste may offer the best local source, which is being investigated by Council.

● ● ○

Viability

> Cost varies depending on technology and type of biomass.

> The effective price varies from around 9c per kWh to 20c per kWh.

Fuel switching

Electric Vehicles

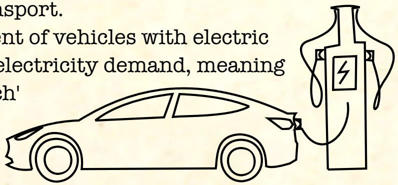
Estimated potential contribution to ZNET

UP TO 100% OF TRANSPORT EMISSIONS

The technology

Electric vehicles (EVs) use electric motors to drive their wheels. Electricity is either stored in batteries in the vehicle (e.g. Li-Ion batteries like in your phone), or generated by a secondary motor powered by petrol or diesel (i.e. a hybrid-electric vehicle). Battery powered EVs and 'plug-in' hybrids can be charged using (high capacity) home charging units or at public charge stations. Similar vehicle electrification trends are happening in commercial and public transport.

Importantly, the replacement of vehicles with electric versions increases overall electricity demand, meaning that EVs are a way to 'switch' from fossil fuels to renewable (electricity).



The opportunity

Australia has been slow to embrace EVs - partly due to model availability, current premium costs and concerns about vehicle range and charging infrastructure - however EV sales are forecast to be over 50% of light vehicles sales within 20 years. Recent modelling suggests that the replacement of all internal combustion engines with battery EVs in Australia would increase total electricity demand by around 26%.

For Hepburn, the electrification of transport is an opportunity to target around 50% of energy demand and 33% of total emissions.

●●●

Desirability

> Consumer sentiment towards electric vehicles is very positive

> People are still concerned about vehicle range. The local charge station infrastructure on Vincent Street helps ensure Daylesford can be a destination for EVs!

●●○

Feasibility

> EV technology is well established and being increasingly adopted by major car manufacturers

> Battery technology is improving (with alternative sources being developed, e.g. hydrogen fuel cells)

> Uptake likely to be linked to autonomous vehicles and car sharing

●○○

Viability

> Electric vehicles are currently sold at a high premium over internal combustion engine vehicles

> Limited options vs current vehicles

> Would benefit from the introduction of policy on stricter vehicle emissions

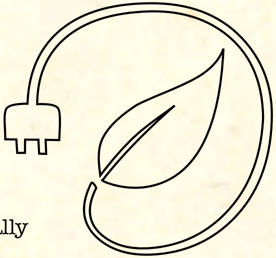
Importing or purchasing

Renewable energy

Estimated potential contribution to ZNET

100%
OF ALL ENERGY

The technology



Many renewable energy sources already exist in Australia. Achieving zero net energy for Hepburn under this option involves the purchase of energy from existing renewable sources. Renewable electricity is usually accredited through the government's GreenPower Program, it can be purchased through a purchase agreement directly with a renewable energy supplier, choosing GreenPower from an energy retailer or using an offset product such as Hepburn Wind's Community Green. Options to purchase renewable bottled gas (e.g. biogas) and sustainably sourced wood are also possible.

The opportunity

The electricity we purchase can be 100% renewable if every business, household and institution in Hepburn chose to purchase 100% GreenPower through their electricity retailer, or through a group purchase of renewable energy through the local electricity supply.

If community members want their electricity to be generated within Hepburn or nearby to Hepburn rather than being sourced from a commercial renewable energy generator with a grid connection to Hepburn. Hepburn Wind has an electricity product available.

Sourcing bottled biogas and sustainable wood would also contribute to Hepburn meeting the zero net energy target.

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Desirability

> Importing renewable energy does not provide local social and economic benefit.
> May be more attractive as an interim option while local generation opportunities are being developed.

● ● ○

Feasibility

> No technical constraints for electricity.
> The production of biogas is not mature in Australia.

● ● ○

Viability

> The retail price of GreenPower is around 5 - 8c per kWh more than fossil fuel energy.
> Group purchase of 100% renewable energy could be price competitive with existing household contracts.

Energy efficiency

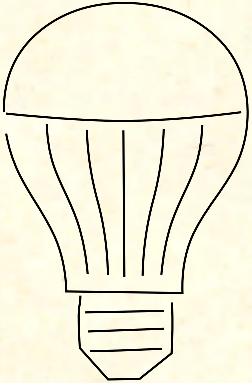
Lighting

Estimated potential contribution to ZNET

UP TO 7% OF ELECTRICITY

The technology

Lighting upgrades can play a significant role in reducing energy use, particularly for non-residential uses. Highly efficient LED lights for example use approximately one-fifth the energy of a halogen downlight.



The opportunity

Lighting makes up around 10% of Australia's energy consumption. The relatively recent use of halogen downlights in some households means that the proportion of energy used for lighting in these homes is even higher. 50% of all lamps are incandescent or halogen types which are obvious targets for replacement. Replacing halogen with high quality efficient LED alternatives can save 80% of the energy used in lighting.

Potential energy saving from replacing halogen with LED:

- Household energy:	7% of total electricity
- Commercial lighting:	30% of total electricity

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Desirability

> Simple and effective energy saving.
> Easy to communicate.
> Often individual household savings are small even though they offer a good return on investment.

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Feasibility

> Bulb replacement programs have been successful in the past.
> The Victorian Energy upgrades supports replacement of lamps.

● ● ○

Viability

> LEDs are now cost competitive with other lamps.
> Paybacks depend on how many hours per day a light is in use.

Generating nearby & storage

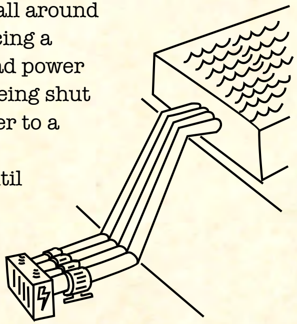
Pumped-storage Hydroelectric

IMPROVES
CASE FOR
RENEWABLE
TECHNOLOGIES

Estimated
potential
contribution
to ZNET

The technology

Pumped-storage Hydroelectric (PSH) has been around since the 1890s and in its current reversible form since the 1930s. It has been widely deployed all around the globe and is currently experiencing a renaissance as a solution to base-load power now that coal fired generators are being shut down. PSH pumps water from a lower to a higher elevation reservoir, it stores the potential energy of the water until there is electrical demand, then discharges it through turbines which produces electricity.



The opportunity

PSH is an important technology for load balancing of the grid as more 'intermittent' renewable energy is added (such as solar and wind). Systems can be developed utilising lakes, reservoirs, disused mines, irrigation systems, sewerage systems and drinking water infrastructure. However economies of scale mean that currently only mid to large scale projects are generally viable, these can be coupled with solar and wind installations.

A recent study looking for pairs of dams with an altitudinal difference of more than 250m identified 22,000 potential PSH sites in Australia. Although the list is not exhaustive, there were no viable sites identified in the Hepburn Shire.

●●○

Desirability

> Positive public perception
> Can add more value to existing infrastructure
> Complements utility scale wind and solar by offering grid balancing services

○○○

Feasibility

> Requires quite specific site and existing infrastructure to be feasible
> Requires more land than chemical and mechanical batteries (i.e. less density')
> Suited to mid-large scale applications

●●○

Viability

> Highly competitive economics for for mid-large scale applications compared with other utility battery technologies
> Established technology

Generating on-site

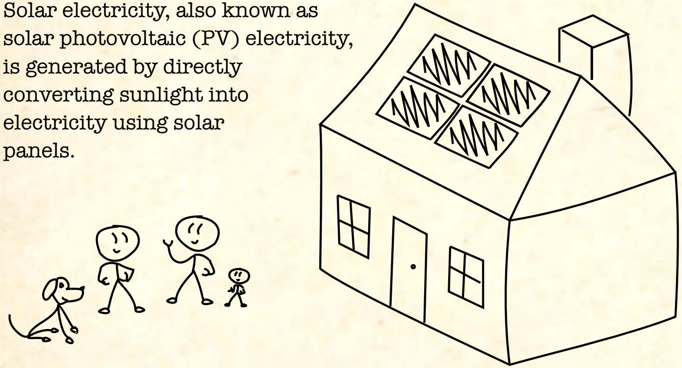
Solar Photovoltaic (PV) Panels

Estimated potential contribution to ZNET

UP TO 40% OF ELECTRICITY

The technology

Solar electricity, also known as solar photovoltaic (PV) electricity, is generated by directly converting sunlight into electricity using solar panels.



The opportunity

Hepburn has excellent climatic conditions for solar. The total rooftop solar capacity in Hepburn is estimated to be nearly 6 MegaWatts (the equivalent of 1,250 large household systems of 4kW each), based on an available rooftop area of 82,000 sqm. Using all of this roof space could meet about 40% of Hepburn's total annual electricity demand.

●●●

Desirability

> The solar PV industry is well established.
> Very positive community perception and acceptance.

●●○

Feasibility

> Rooftop solar, which is "net-metered" is already highly feasible in Australia.
> High penetrations are technically achievable but there may be constraints to electricity networks as more systems are connected.
> Solar energy is only generated during the day.

●●○

Viability

> The generation cost is around 8 c/kWh to 12 c/kWh.
> If the majority of power consumed on-site during the daytime and little or no electricity is exported, solar is already cost effective because any energy generated that is unused on site is usually exported into the electricity system at a lower price.

Energy sharing

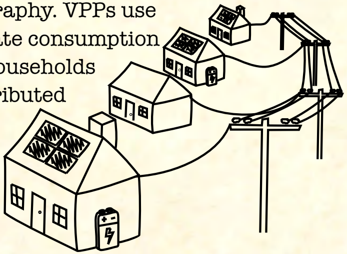
Community Microgrids & VPPs

Estimated
potential
contribution
to ZNET

IMPROVES
CASE FOR
RENEWABLE
TECHNOLOGIES

The technology

Community microgrids utilise local resources to meet local demand. They enable high local penetration and sharing of technologies such as solar, wind, hydro, storage, combined heat and power and demand response. Microgrids also reduce losses in the electricity network. A Virtual Power Plant (VPP) is a similar concept that is less constrained by geography. VPPs use internet technologies to aggregate consumption and production from multiple households and businesses: this allows distributed energy resources (DERs) like solar, batteries and 'flexible' loads to participate in markets for energy generation and grid support services.



The opportunity

Community microgrids and VPPs help participants use distributed energy resources like solar and batteries more effectively. This ability to share resources improves the return on investment and penetration of renewables. In theory, VPPs (and microgrids) that are connected to the wider electricity network generate additional revenue by participating in energy markets and providing grid support. However at present, this technology is in its infancy.

The business case for community microgrids and VPPs relies on participation (i.e combined size of DERs), and is enhanced in areas where the grid is 'constrained' and able to benefit from grid support services. At present, Hepburn's network has reasonable capacity, but grid reliability could be enhanced.

●●○

Desirability

> Allows energy resources like solar and batteries to be shared locally and/or to the wider energy market
> Reduces overall energy cost by providing stability to the grid

●○○

Feasibility

> Requires coordination locally (i.e. community grid operator) or through a technology provider (for a VPP)
> The ability to trade energy locally is still a few years away

●○○

Viability

> VPPs are still emerging and currently only available in limited form
> Microgrids not likely to be a viable long term strategy
> Business case depends on the number of participants and (often) their location (vs capacity of the local network)

Energy sharing

Community Microgrids & VPPs

IMPROVES CASE FOR RENEWABLE TECHNOLOGIES

Estimated potential contribution to ZNET

The technology

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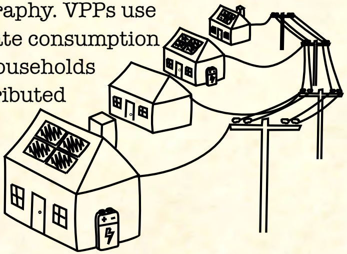

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Generating on-site

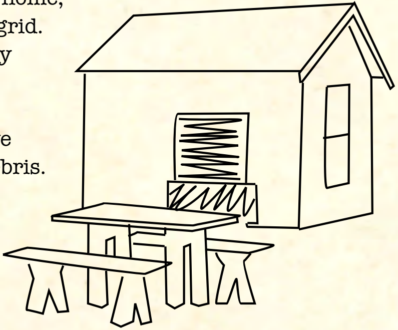
Micro Hydroelectric

Estimated potential contribution to ZNET

LIMITED BY RESOURCE AND SITE AVAILABILTY

The technology

Micro hydro systems are generally around 5-100kW in scale. They can provide power to a home, community or feed into the grid. Micro hydro systems work by diverting the inflow of water from a river, stream or waterfall, the intake will have a grate to protect fish and debris. It will then be tunneled to a powerhouse that has a turbine that turns a generator, creating electricity.



The opportunity

Hepburn Shire doesn't have the natural resources for mid-large scale hydroelecric power (which is an economic source of renewable electricity generation). However Daylesford has a history with one of the oldest micro hydro stations being located at Lake Daylesford that operated early last century, powering lights and buildings around the iconic lake, generating around 12kW. Local groups are currently looking at how to preserve the site and potentially get it up and operating again.

There could be other existing small sites located around the shire. A minimum drop of around 60cm for the pipe, stream or waterfall is necessary to be viable.

●●●

Desirability

> Very positive public perception
> Opportunity to preserve local heritage

●○○

Feasibility

> Established and simple technology (low cost to assess potential sites)
> Relies on suitable sites being available and close to the grid
> Micro hydro is unlikely to impact waterway flows and supported wildlife

●○○

Viability

> Cost of generation expected to be higher than other technologies and larger scale hydroelectric

Generating nearby

Mid to Large-scale Solar PV

Estimated potential contribution to ZNET

MORE THAN 100% OF ELECTRICITY DEMAND

The technology

Solar electricity, also known as solar photovoltaic (PV) electricity, is generated by converting sunlight directly into electricity. Large or "utility" scale solar PV uses the same technology as rooftop solar panels. Utility scale solar PV is suited to country locations with low population density but with close proximity to appropriate grid connections.

The opportunity

Hepburn has a medium solar exposure and plenty of available land for utility scale solar. This availability of land - which account for land uses, elevations, and population data - is what will theortically limit the total solar farm capacity in the Hepburn Shire area.

A single large scale 60MW solar farm (i.e. the size of the Gannawara solar farm in north west Victoria), would generate about 110 GWh per annum - enough to meet over 140% of the Shire's electricity demand.

● ● ●

Desirability

> Solar PV is a low cost and well established industry.
> High positive perception, however current land use practices must be taken into account. For rich productive land such as in Hepburn, agricultural solar is an option.

● ● ●

Feasibility

> Utility scale solar is highly feasible in Australia with a number of medium sized projects in operation.
> There are potential capacity issues for the local electricity network when connecting utility scale generation.

● ● ○

Viability

> The cost of generation is around 9c per kWh to 16c per kWh.
> Declining cost of solar PV will improve viability over time.

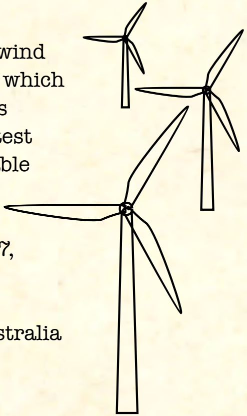
Generating nearby

Wind turbines

Estimated potential contribution to ZNET

MORE THAN 100% OF ELECTRICITY DEMAND

The technology



Wind power captures the energy of the wind by turning the blades of a wind turbine, which drives a generator that in turn produces electricity. Wind power is one of the fastest growing and most cost-effective renewable energy sources, and has grown at an average rate of 16% p.a. in capacity globally over the last decade (2008-2017, Global Wind Energy Council).

There are almost 100 wind farms in Australia to date.

The opportunity

The total wind resource in the region is high. Accounting for appropriate land uses, elevations, and population data, the wind farm capacity in the Hepburn area has been estimated at 1,500MW. Hepburn lies on tablelands with a reasonable to good wind resource and predominantly grazing farmland that is suited for wind turbines. The wind is already being harvested by Hepburn Wind's two community-owned turbines at Leonards Hill, generating enough power for 2000 homes at around 11,000MWh per annum.

Total capacity:	1,500MW
Annual generation:	3,500 GWh

This potential generation is far beyond Hepburn's needs!

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Desirability

> Community acceptance of wind farms can be greatly enhanced if the benefits of the energy generated are distributed locally
> There is 'misinformation' about health effects that have falsely impacted the perception of wind.
> Hepburn Wind is a successful community wind farm!

● ● ○

Feasibility

> Well established technology.
> Integrates easily into grazing farmland with minimal footprint.
> Needs to be located near transmission infrastructure to be able to export energy back into the electricity grid.

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Viability

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Energy efficiency

Heating and Cooling

Estimated potential contribution to ZNET

UP TO 15% OF ELECTRICITY GAS AND WOOD

The technology

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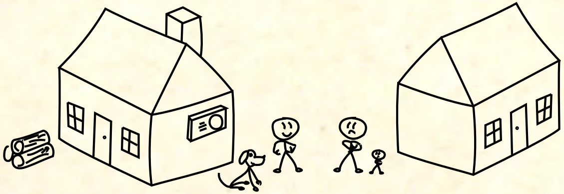

The opportunity

Energy used for space heating throughout most of Victoria, and Hepburn specifically, is high. Of total heating/cooling energy, often somewhere between 80-90% is typically associated with heating. The availability of timber means a high proportion of space heating in Hepburn uses wood (58% of households) with an average 3.5 tonnes burnt annually per home. Many homes will have reverse cycle air conditioning however the use of these for heating is often quite low. The best options for space heating are efficient pelletised wood heaters or reverse cycle (heat pump) air-conditioners.

Heating | replace panel heater or old gas heater with reverse cycle AC:	80% of heating energy
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Desirability

> Traditional wood heaters might be preferred to electric appliances.

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Feasibility

> Minimum Energy Performance Standards (MEPS) are already driving improvements in the efficiency of space conditioning appliances.

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> A new air conditioning system (3kW) for a standard home costs around $1500.

Energy efficiency

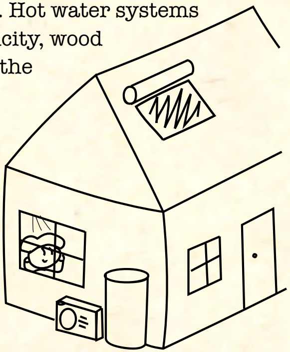
Domestic Hot Water

UP TO 18% OF ELECTRICITY

Estimated potential contribution to ZNET

The technology

Hot water is typically the second largest user for residential energy in Victoria after space heating. Hot water systems can be powered from solar, gas, electricity, wood and now even heat pumps (which use the same technology as reverse cycle air conditioners). Replacing electric, gas and wood systems with more efficient water heaters or running existing electric systems from solar PV during the day can offer significant energy and/or carbon savings.



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Saving from heat pump: 70-80% less energy
Total household saving: 18%

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> Heat pumps are a simple measure to undertake.
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Generating nearby

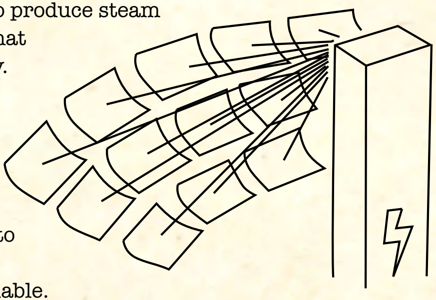
Concentrated Solar Thermal

Estimated potential contribution to ZNET

MORE THAN 100% OF ELECTRICITY DEMAND

The technology

Concentrated solar thermal (CST) technology uses the heat of the sun rather than light, to generate electricity. It uses lenses and reflectors to concentrate sunlight, which then heats water, oil (or another fluid) to produce steam to drive a turbine that produces electricity. CST plants are usually paired with storage technology (e.g. molten salt) which stores heat to allow electricity to be generated when sunlight is not available.



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CST requires direct solar beam radiation. And while the solar resource in Hepburn is very good, it is not as high as areas further north in Australia. This makes Hepburn a less attractive as a 'pilot' site for deploying CST, which would be emerging generation technology in Australia.

Similar to mid-large scale solar PV and wind, the potential capacity for CST is only limited by suitable available land area - which is very good in Hepburn Shire. At present, operational CST plants around the world are sized between 50MW and 400 MW - the smallest of which would generate enough electricity to meet the Shire's current demand.

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Desirability

> Positive public perception.
> Would identify Hepburn as a leader in CST globally.
> Investment in CST would benefit industry in Australia.

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Feasibility

> CST is technically feasible with examples operating in countries like Spain, Germany and the United States, however this would be first of a kind project in Australia.

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> The effective cost of electricity for large systems is around 30 to 40 c per kWh but is expected to drop sharply to (to around 10-20c per kWh) by 2020
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Generating nearby

Bioenergy

Estimated potential contribution to ZNET

ONLY LIMITED BY BIOMASS AVAILABILITY AND GENERATOR SIZE

The technology

Energy generation from biomass uses the burning of organic matter (e.g. crop waste) to produce heat energy at all scales (e.g. firewood is a type of biomass). At large (commercial) scale biomass is burnt to produce either heat to supply district heating or to produce steam for power generation.

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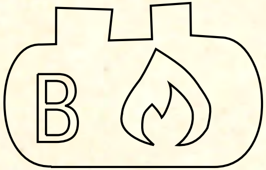

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Council is developing a pilot project, with views to expand to a 65kW system which delivers 252 MWh of electricity into the grid per annum and a 257MWh heating load.

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Desirability

> Bioenergy is generally positively perceived.

> Bioenergy is not a well established industry in Australia, however has been well explored in Hepburn Shire

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Feasibility

> Relatively limited bioenergy resource in Hepburn Shire due to the scale of the population.

> Municipal waste may offer the best local source, which is being investigated by Council.

● ● ○

Viability

> Cost varies depending on technology and type of biomass.

> The effective price varies from around 9c per kWh to 20c per kWh.

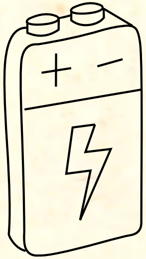
Energy storage

Battery Storage

IMPROVES THE CASE FOR LOCAL SOLAR AND WIND

Estimated potential contribution to ZNET

The technology



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Batteries can also be used at a community and distribution network level to store electricity for managing variable renewables supply, improve reliability and to reduce network upgrade requirements.

The opportunity

Should some form of community micro-grid or virtual power plant be possible in the future, medium scale storage options may be attractive to store and supply power locally. At a household level, storage enables high utilisation (e.g. 80-90%) of on-site solar generation with the grid being used as a back up during low generation periods (e.g. winter).

Substations and power lines around the Hepburn Shire are not currently constrained and should be able to accommodate a reasonable increase in the solar PV across Hepburn. The introduction of battery storage on the low voltage side of the substation reduces the impact of high penetrations of solar PV and may avoid the need for punative solar export limiting or even refusal.

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Desirability

> For some members of the community the ability to become totally self-sufficient from the grid is desirable.

> Strict recycling and disposal practices are required to avoid environmental impacts.

●●○

Feasibility

> Lead acid batteries are already common in off-grid applications and Lithium Ion are becoming more common.

> Australian company Redflow already markets batteries for network level storage.

> Actual feasibility depends on application.

●●○

Viability

> Current costs for battery storage start at ~ $1,000/kWh (fully installed).

> Incremental cost of batteries with solar is still too high in Australia, but costs are coming down quickly

Generating on-site

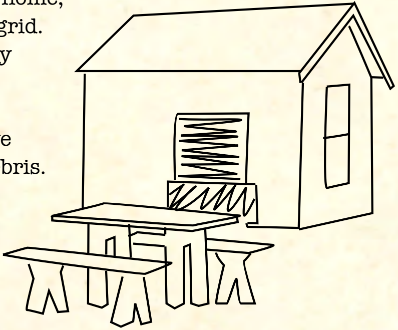
Micro Hydroelectric

Estimated potential contribution to ZNET

LIMITED BY RESOURCE AND SITE AVAILABILTY

The technology

Micro hydro systems are generally around 5-100kW in scale. They can provide power to a home, community or feed into the grid. Micro hydro systems work by diverting the inflow of water from a river, stream or waterfall, the intake will have a grate to protect fish and debris. It will then be tunneled to a powerhouse that has a turbine that turns a generator, creating electricity.



The opportunity

Hepburn Shire doesn't have the natural resources for mid-large scale hydroelecric power (which is an economic source of renewable electricity generation). However Daylesford has a history with one of the oldest micro hydro stations being located at Lake Daylesford that operated early last century, powering lights and buildings around the iconic lake, generating around 12kW. Local groups are currently looking at how to preserve the site and potentially get it up and operating again.

There could be other existing small sites located around the shire. A minimum drop of around 60cm for the pipe, stream or waterfall is necessary to be viable.

● ● ●

Desirability

> Very positive public perception
> Opportunity to preserve local heritage

● ○ ○

Feasibility

> Established and simple technology (low cost to assess potential sites)
> Relies on suitable sites being available and close to the grid
> Micro hydro is unlikely to impact waterway flows and supported wildlife

● ○ ○

Viability

> Cost of generation expected to be higher than other technologies and larger scale hydroelectric

Generating nearby

Mid to Large-scale Solar PV

Estimated
potential
contribution
to ZNET

MORE THAN 100%
OF ELECTRICITY
DEMAND

The technology

Solar electricity, also known as solar photovoltaic (PV) electricity, is generated by converting sunlight directly into electricity.
Large or "utility" scale solar PV uses the same technology as rooftop solar panels. Utility scale solar PV is suited to country locations with low population density but with close proximity to appropriate grid connections.

The opportunity

Hepburn has a medium solar exposure and plenty of available land for utility scale solar. This availability of land - which account for land uses, elevations, and population data - is what will theortically limit the total solar farm capacity in the Hepburn Shire area.

A single large scale 60MW solar farm (i.e. the size of the Gannawara solar farm in north west Victoria), would generate about 110 GWh per annum - enough to meet over 140% of the Shire's electricity demand.

● ● ●

Desirability

> Solar PV is a low cost and well established industry.
> High positive perception, however current land use practices must be taken into account. For rich productive land such as in Hepburn, agricultural solar is an option.

● ● ●

Feasibility

> Utility scale solar is highly feasible in Australia with a number of medium sized projects in operation.
> There are potential capacity issues for the local electricity network when connecting utility scale generation.

● ● ○

Viability

> The cost of generation is around 9c per kWh to 16c per kWh.
> Declining cost of solar PV will improve viability over time.

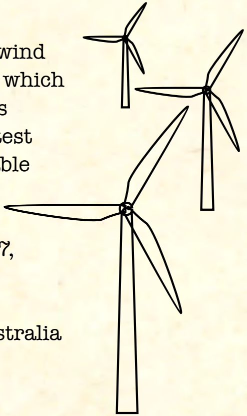
Generating nearby

Wind turbines

Estimated potential contribution to ZNET

MORE THAN 100% OF ELECTRICITY DEMAND

The technology



Wind power captures the energy of the wind by turning the blades of a wind turbine, which drives a generator that in turn produces electricity. Wind power is one of the fastest growing and most cost-effective renewable energy sources, and has grown at an average rate of 16% p.a. in capacity globally over the last decade (2008-2017, Global Wind Energy Council).

There are almost 100 wind farms in Australia to date.

The opportunity

The total wind resource in the region is high. Accounting for appropriate land uses, elevations, and population data, the wind farm capacity in the Hepburn area has been estimated at 1,500MW. Hepburn lies on tablelands with a reasonable to good wind resource and predominantly grazing farmland that is suited for wind turbines. The wind is already being harvested by Hepburn Wind's two community-owned turbines at Leonards Hill, generating enough power for 2000 homes at around 11,000MWh per annum.

Total capacity:	1,500MW
Annual generation:	3,500 GWh

This potential generation is far beyond Hepburn's needs!

● ● ○

Desirability

> Community acceptance of wind farms can be greatly enhanced if the benefits of the energy generated are distributed locally
> There is 'misinformation' about health effects that have falsely impacted the perception of wind.
> Hepburn Wind is a successful community wind farm!

● ● ○

Feasibility

> Well established technology.
> Integrates easily into grazing farmland with minimal footprint.
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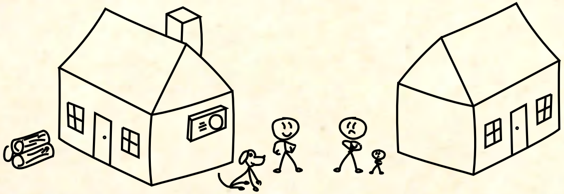

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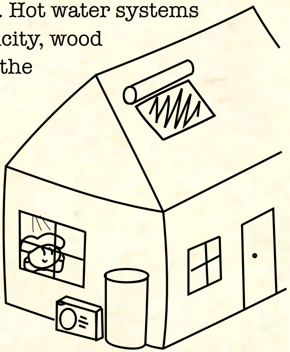

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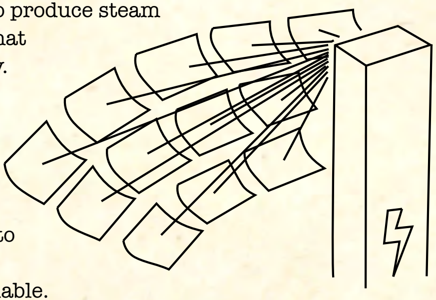

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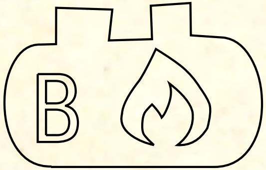

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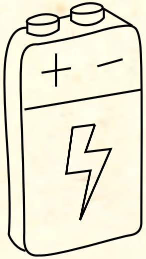
Energy storage

Battery Storage

Estimated
potential
contribution
to ZNET

IMPROVES THE CASE FOR LOCAL SOLAR AND WIND

The technology



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