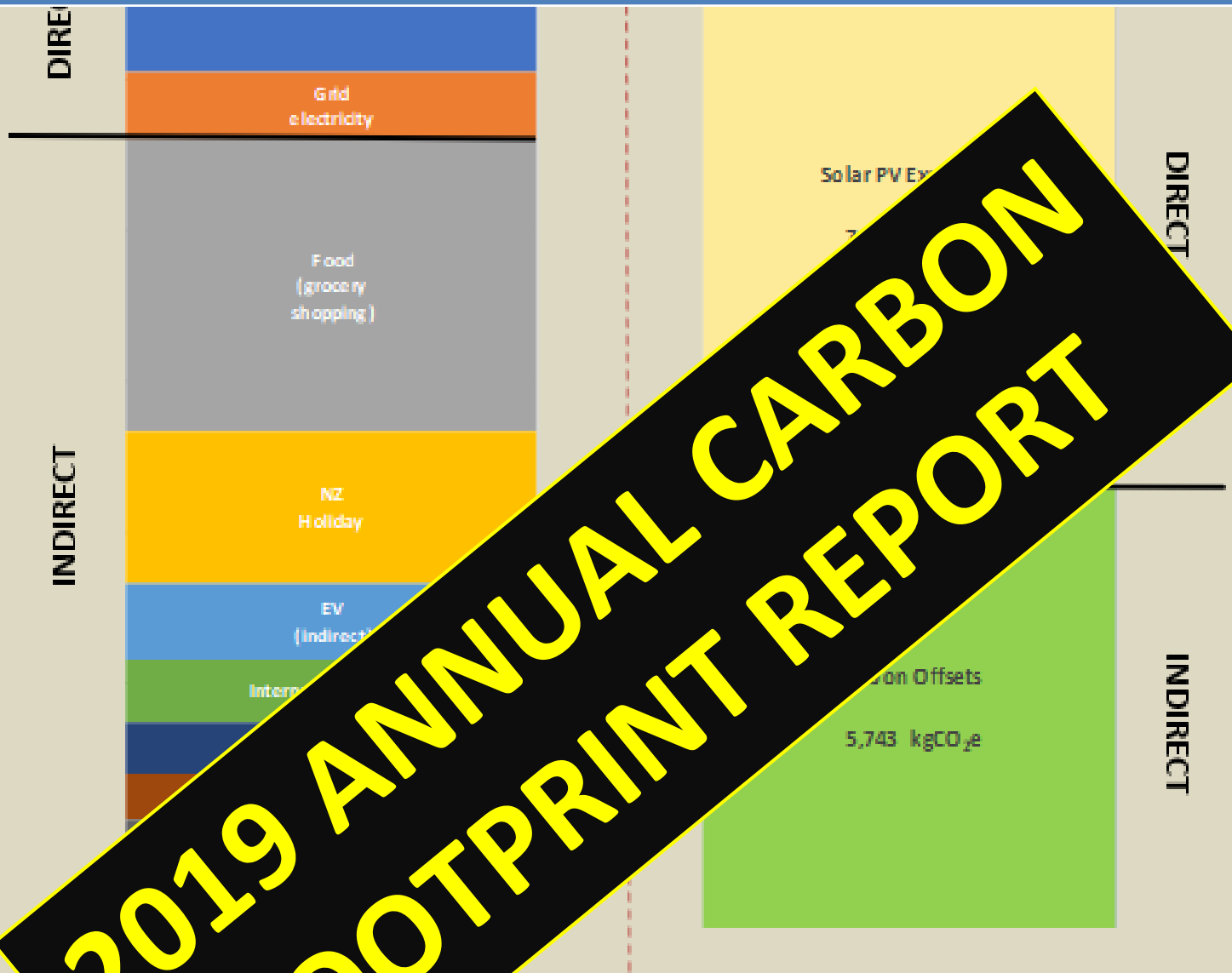


# Net Zero Emissions Household

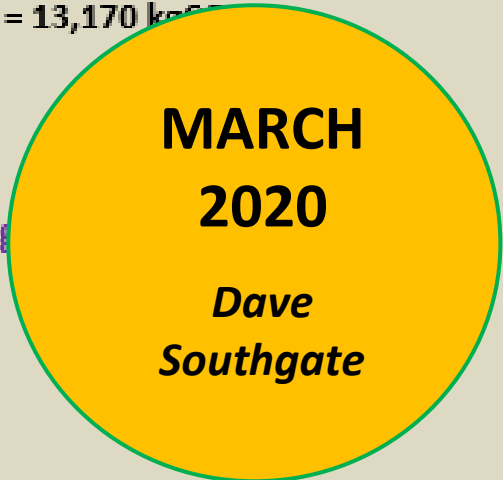
*Becoming a Fossil Fuel Free Family*



TOTAL Carbon Credits  
= 13,170 kgCO<sub>2</sub>e

Net Zero Emissions achieved through purchase of

5,743 kg



# Foreword

The world is in a climate emergency. Unfortunately, many governments around the world are either unwilling, or unable, to take effective action against this existential threat.

I believe that in this policy vacuum individuals can make a useful contribution to reducing global carbon emissions. However, in order to do this effectively we need to have a detailed knowledge of the composition of our individual and household carbon footprints.

My family has spent a number of years reducing our direct carbon footprint and we have dramatically cut, or eliminated, our purchases of grid electricity, gas and petrol. Given the current circumstances I have decided that we now need to work on reducing our indirect carbon footprint – reducing the CO<sub>2</sub> emissions that are embedded in the things we buy and the services we use.

In order to do this we first need to understand the makeup of our indirect footprint. This report is my first attempt at breaking down my family's indirect footprint into its constituent parts. The aim is to reveal the areas where we can take the most effective action to reduce our indirect emissions.

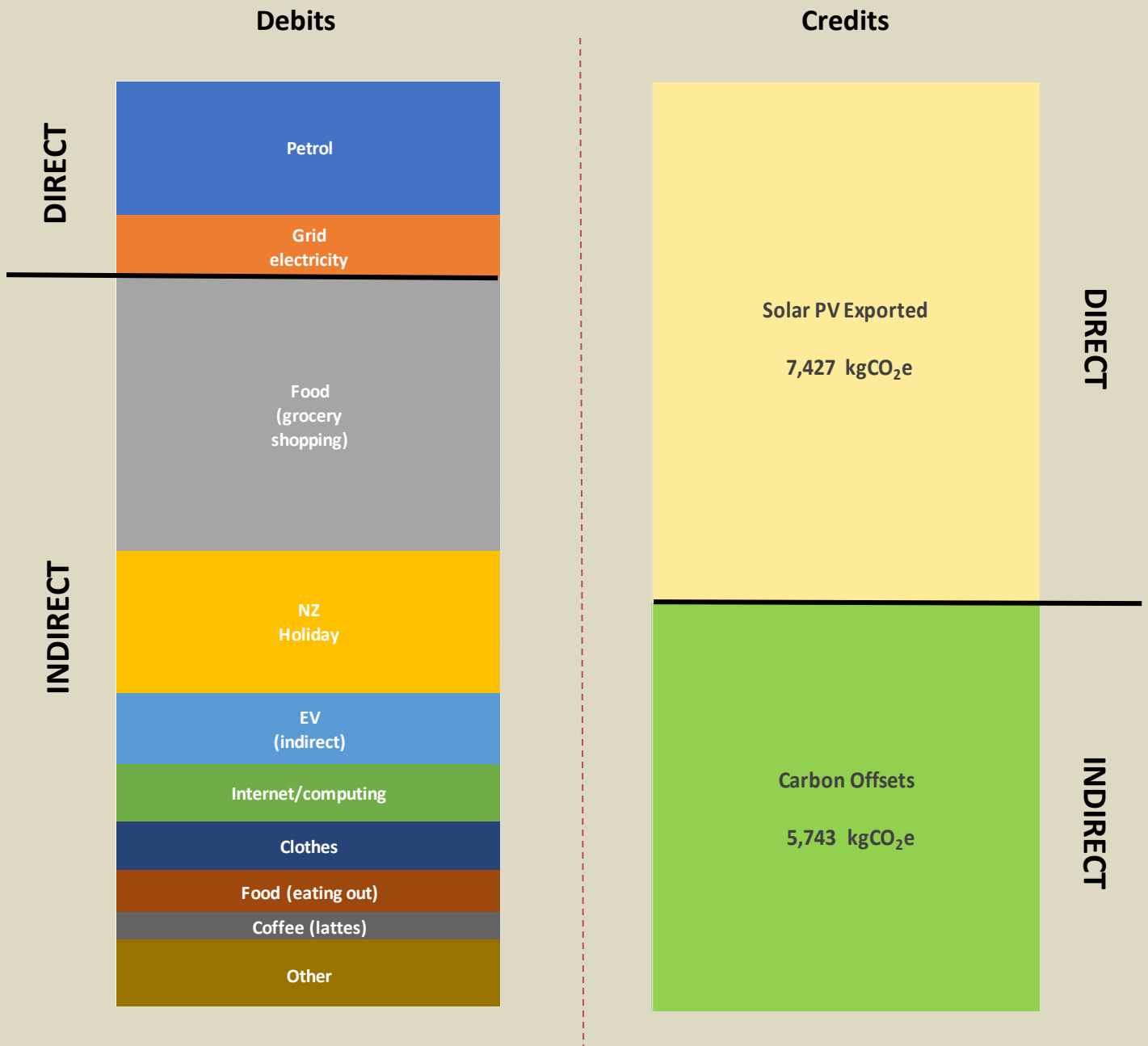
As an initial step I have analysed our total footprint for 2019 and have produced a 'net zero emissions' outcome for the year by buying carbon offsets. In future years I propose to take more concrete action to reduce our total carbon footprint.

Dave Southgate

Canberra

March 2020

# Household Carbon Balance Sheet 2019



**TOTAL Carbon Debits  
= 13,170 kg CO<sub>2</sub>e**

**TOTAL Carbon Credits  
= 13,170 kgCO<sub>2</sub>e**

**Net Zero Emissions achieved  
through purchase of**

**5,743 kgCO<sub>2</sub>e carbon offsets**

# Background

I retired in 2012 after a 31-year career as an environmental bureaucrat. I consider myself privileged to have had the opportunity to spend the last decade of my career working on climate change issues at both the national and international level. However, in the end I became very concerned about the inability of the global governance system to take the steps necessary to control the polluting impacts of carbon dioxide and other greenhouse gases.

Against this background, when I retired I determined that I would tackle the problem from the bottom up and try to minimise, and hopefully eliminate, my family's direct emissions of carbon dioxide. My family began a journey to become fossil fuel free (FFF) by transitioning our household energy use. I wrote about the beginning of this journey in my book [\*Our Household Energy Transition: Becoming a Fossil Fuel Free Family\*](#) which I released in February 2016. I have subsequently produced [four Annual Reports](#) which document, and discuss, the energy and carbon footprint outcomes of our energy transition program.

Our project to be Fossil Fuel Free relates only to our direct carbon footprint. That is, our aim is to no longer directly buy any fossil fuel based energy – gas, petrol or grid electricity. However, I have been fully aware throughout our transition, and other people have often reminded me, that our direct carbon footprint is only part of the problem. What about the carbon emissions embedded in our consumption of goods and services – our indirect carbon footprint?

I initially focussed on our direct footprint because it is the part of our footprint that we directly control. We know very accurately how much energy we are using. I can closely monitor this in real time and adjust our behaviour accordingly. On the other hand, the indirect carbon footprint of our consumption patterns is not clearly defined and it requires a lot of detailed (usually unknown) information to compute its magnitude.

In my transition Annual Report for 2019 I indicated that I had decided to close **Phase 1** of our energy transition project at the end of 2019 and to open **Phase 2** in 2020. In **Phase 2** I intend to expand our aims: while being Fossil Fuel Free (ie no direct purchase of fossil based fuels) will remain our primary (and most difficult to achieve) goal; we will also aim to have 'net zero emissions' (NZE) for our consumption on an ongoing annual basis. This means that from this point on, each year I will attempt to compute, report and manage both our direct and indirect carbon footprints.

This change in direction was largely inspired by the recent surge in public interest in the implicit Paris Agreement goal of the world having to reach 'net zero emissions' by 2050. Ideally the whole world will be 'fossil fuel free' by this stage but I guess that is being overly ambitious. I see aiming to have net zero emissions, which by definition involves the trading of carbon debits and credits, as being a good transition compromise. It certainly beats the climate change inertia that has captured most of the globe over the past few decades.

I have tried to keep discussion in this report to a minimum. My aim is to describe, as simply as possible, the carbon accounting behind our household having net zero emissions for 2019.

In essence, this process involved computing both our direct and indirect carbon footprints (our carbon debits) and then identifying ways in which we could negate those emissions (via carbon credits) to achieve a balanced carbon budget.

# **Direct Carbon Footprint**

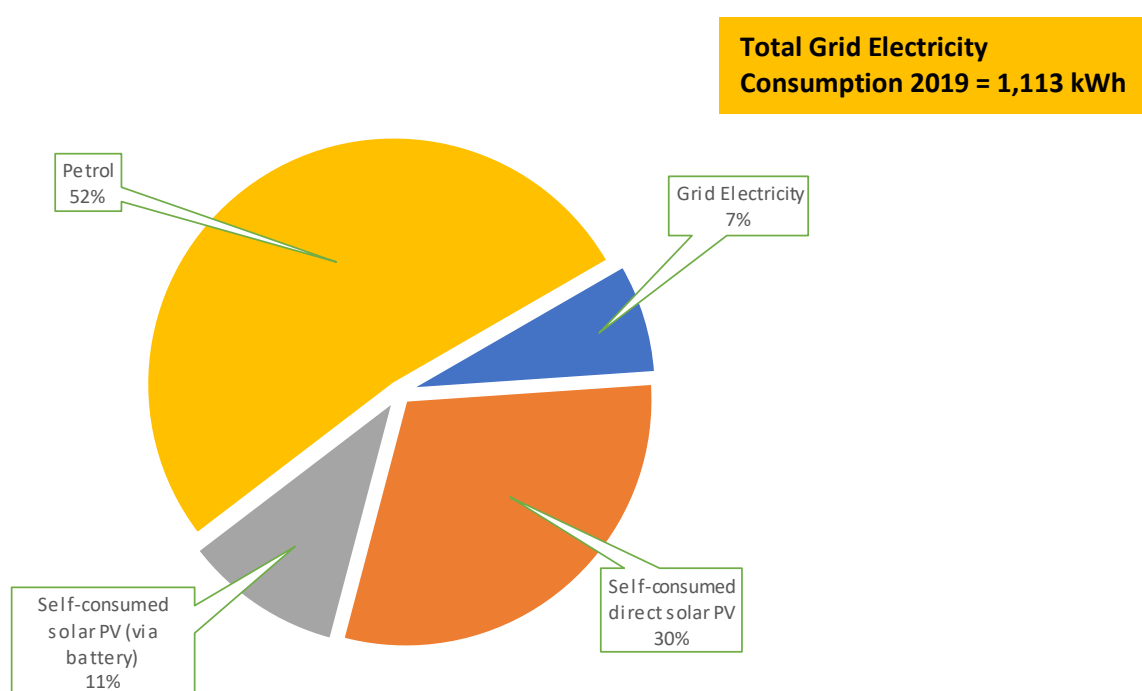
# Chapter 1 Direct Debits & Credits

## Debits

As I've just discussed in the Background, we have been working for a number of years to reduce our direct use of fossil fuel based energy as part of our project to become a Fossil Fuel Free Family.

**Figure 1** gives a breakdown of our energy use over 2019. This Figure is extracted from my [Annual Report for 2019](#) and the reader is invited to look at this document if you want more detailed information.

It can be seen that in 2019 we sourced about 40% of our household energy use from our solar PV systems.



**Figure 1: Breakdown of our household energy use 2019**

I have converted our fuel consumption data into CO<sub>2</sub>e emissions using the [Government's published greenhouse accounts factors](#). The values for our petrol and grid electricity carbon footprints are shown in **Figure 2** in the next Section.

## Credits

In my 2019 Annual Report I also discuss our solar PV production and export for the year. We exported 9,169 kWh of solar PV electricity in 2019. I have converted this to a carbon credit of **7,427 kgCO<sub>2</sub>e** using the published greenhouse accounts factors and assuming that each kWh of solar PV (carbon zero) electricity that we exported displaced one kWh of grid (mainly coal based) electricity. I discuss this conversion in my Annual Report.

# **Indirect Carbon Footprint**

# Chapter 2

## Introduction

Computing one's **direct carbon footprint** is very straightforward. The energy user knows very accurately, from their energy bills, how much fuel they have used over a period of time. The amount of fuel used can easily be converted into carbon emissions through the application of the published greenhouse accounts factors.

By way of contrast, computing one's **indirect carbon footprint** is not straightforward. It generally involves delving into many layers of data and making many assumptions. For example, if I buy a widget I can normally find out which country it is 'made' in. However, the product may contain many components which have been sourced from all over the world. Indeed, different batches of the same product may have components from quite different origins or be made from different materials. All these unknowns impact on the magnitude of a product's carbon footprint. Unless one is carrying out a detailed examination of a particular product one has to accept that the outcome of indirect carbon footprinting computations is only likely to be a gross estimate.

This paper is a first attempt at computing an estimate of my family's indirect carbon footprint. I hope this will give us an indication of which of our patterns of consumption are the ones needing most attention.

This document is not intended to be a scientific treatise. I have therefore tried to keep the language and concepts simple by avoiding many of the niceties that the specialist carbon accountant would use. I have done this not only to appeal to a wider audience but also because I see little value in getting bogged down in detail when I am only seeking to obtain high level estimates of my family's indirect carbon footprint.

*My Indirect Footprint is your Direct Footprint*

While this may be self-evident to some readers, I think this topic is worth a short discussion.

If I buy a widget from small business manufacturer and distributor Fred, the CO<sub>2</sub> emissions for my widget, which add to my indirect carbon footprint, equal the widget's CO<sub>2</sub> contribution to Fred's direct footprint since he was the person that directly used the energy in the making and transport of the product.

Problems can arise if for some reason Fred and I want to report our combined carbon footprint (including both our direct and indirect footprints). If we simply sum up our individual footprints the carbon footprint for the widget will be counted twice (once in my indirect footprint and once in Fred's direct footprint). Look out for double counting when venturing into the world of indirect carbon footprinting!

What's the value of indirect footprinting then if all CO<sub>2</sub> emissions are reported somewhere in the system as someone's direct footprint? Let's imagine after I bought my widget from Fred I need another one and I become aware of manufacturer/distributor Freda. Unlike Fred who uses grid electricity and a diesel delivery van, Freda uses solar PV electricity to manufacture the widget and delivers it in an EV. Naturally I want to buy my next widget from Freda because of its low embedded CO<sub>2</sub> content (and probably much cheaper price). The outcome? My indirect, and therefore total, carbon footprint is reduced and so is Fred's. Poor Fred is now out of business because his carbon intense business model (coal based electricity and diesel transport fuel) has failed – his direct carbon



footprint is now zero! My knowledge of my indirect carbon footprint has helped me to reduce the size of the world's carbon footprint.

### *Export of carbon footprint*

Another aspect of indirect carbon footprinting which I believe is important relates to the export of pollution. Over the past few decades, the west has outsourced much of its manufacturing to China and other Asian countries. Instead of CO<sub>2</sub> (and other pollutants) arising from the manufacture of goods consumed in the west being registered against the western countries these are recorded against the offshore countries. On a global scale the quantum of emissions may not have changed, but the CO<sub>2</sub> emissions are now registered as direct emissions against say China, rather than against say Australia. A country can reduce its direct CO<sub>2</sub> emissions simply by offshoring polluting industries.

I often find it sad when a commentator is berating China for its growing carbon footprint when at least some (maybe quite a lot?) of that growth is associated with the manufacture of goods that are exported to the west. I think it is doubly sad for Australia when much of an offshore country's direct carbon footprint derives from coal and/or gas which it has imported from Australia.

I think there are strong arguments for countries reporting both their direct and indirect carbon footprints for information and transparency purposes (recognising double counting complexities).

## **Computing the Indirect Footprint**

Unlike our direct footprint which I can monitor and report myself, I was totally reliant on the work of other researchers to compute our indirect footprint for 2019.

To gain a background understanding of indirect footprinting I set out by reading the Mike Berners-Lee book [\*How Bad Are Bananas? The Carbon Footprint of Everything\*](#). While I certainly don't accept everything in the book, I found it gave me an excellent feeling for the task in hand.

Initially, I listed as best I could the main products which my family had bought, and the activities we had been involved in, over 2019. I deliberately did not attempt to evaluate the carbon footprint of products which we bought in earlier years (eg our house). Armed with this list I then attempted to compute our annual carbon footprint for each of the identified products/activities based on factors I could find in the published literature.

When starting my literature search, it very quickly became evident that there is no shortage of material. I was quite surprised at the range of products and/or activities that have been carbon footprinted over the past decade. On some topics, for example food, the range of papers and references is almost overwhelming. Given this, it is not surprising that there are enormous differences between the footprints being reported for the same items.

My approach to picking the 'right' answer was to: firstly look for work directly relating to Australia (the computations in much of the published work relate to either the US or Europe); to give priority to academic papers over those produced by parties with an apparent commercial interest (there is a surprising number of these); and to give priority to the most recent work (carbon footprints can evolve rapidly).

I worked through the list and arrived at the results shown in **Figure 2**. The Table also shows the values for our direct footprint (see **Chapter 1**). I have included a list of references in **Appendix 2** at the end of the document. Not surprisingly, in developing the Table I came across many issues which I could not resolve and therefore there were quite a number of items which I could not carbon footprint. I discuss these briefly in the notes following the Table.

CO <sub>2</sub> Emissions Type	CO <sub>2</sub> e Source	Amount	Wt CO <sub>2</sub> e (kg)	Comments
<b>DIRECT</b>	Petrol	7,990 kWh	1,900	
	Grid Electricity	1,113 kWh	900	
	<b>TOTAL Direct</b>		<b>2,800</b>	
<b>INDIRECT</b>	Food (grocery shopping)		3,855	See Appendix 1
	Flying (fuel)	4 seats SYD-CHC	1,230	NZ Holiday Jan 2019 (includes indirect footprint for fuel)
	New EV (Leaf) (mfr)	1	1,000	10tCO <sub>2</sub> e. Count over 10 years
	Holidays/hotels	1	800	NZ holiday driving 2,000km + 30kgCO <sub>2</sub> e/night for hotels
	Clothes	100 items	700	7 kgCO <sub>2</sub> e/garment
	Food (eating out)		600	5 lunches + 1 family meal/week
	Coffee	750 cups	380	
	Internet	4 persons	320	80 kgCO <sub>2</sub> e/person
	Desk top computing	4 computers	300	60 kgCO <sub>2</sub> e/y + printer
	Mobile phone	4	200	50kg/yr
	Public Transport	5,000 km	200	
	Electricity (indirect for both grid + solar PV)		190	100 kgCO <sub>2</sub> e for grid + 90 kgCO <sub>2</sub> e for solar PV
	Shoes	10 pairs	150	
	Newspapers	300	150	0.5 kgCO <sub>2</sub> e/edition
	Library books	250	125	5 kgCO <sub>2</sub> e/book; book read 10 times
	Petrol (indirect)		100	Scope 3 emission factors
	Washing clothes	200 washes	45	220 gCO <sub>2</sub> e/wash for washing machine
	New bike (mfr)	1	25	250 kgCO <sub>2</sub> e. Count over 10 years
	<b>TOTAL Indirect</b>			<b>10,370</b>
<b>TOTAL CARBON FOOTPRINT</b>			<b>13,170</b>	

**Figure 2: Breakdown of my family's direct and indirect carbon footprints for 2019**

## Notes

1. In arriving at the numbers in the Table, I became acutely aware of the need to avoid 'double counting'. For example, the literature commonly identifies electricity use as one of the key components of the indirect footprint of many domestic activities (eg washing clothes). However, I have already counted our electricity use in our direct footprint and I therefore did not include it again when reporting an indirect footprint.
2. I was not able to arrive at a quantitative value for the indirect footprint for some of the items I had initially identified as being part of our family indirect carbon footprint:

*Aviation:* The figure for 'flying' in the Table for our NZ holiday includes indirect CO<sub>2</sub> emissions for the fuel but it does not include any CO<sub>2</sub> allocation for infrastructure (eg for the manufacture of the aircraft or the construction of the airports). Even if I knew the total CO<sub>2</sub> generated by these activities what would be my family's contribution given there are billions of aviation passengers flying round the world each year?

*Cycling:* Nearly all carbon footprinting of cycling that I found focusses on the amount of extra food eaten by the cyclist. I did not want to compute this as it would be double counting – this is already covered in my 'Food' category in the Table. To be complete one would also need to compute the CO<sub>2</sub> generated by the construction/maintenance of the bike paths and roads which we ride on. This would capture most of the roads/paths in Canberra. Again, even if I had this figure how would it be allocated between car drivers, cyclists, walkers, etc?

*Cleaning:* There is a plethora of articles on the carbon footprint or 'greenness' of cleaning agents. Unfortunately, I was unable to find any data that I could trust. We normally carry out our cleaning using cold water. The electricity used by our cleaning machines (eg vacuum cleaner) is captured by our direct footprint.

*TV; videos:* It is not hard to find references to studies that have been carried out into the carbon footprint of producing TV programs; movies; etc. Clearly the CO<sub>2</sub> emissions from producing a major blockbuster movie are huge. However, the audiences are equally huge. Major events are watched by billions of people. How do I work out my CO<sub>2</sub> contribution if I, along with millions of others, watch one game of soccer on the TV?

*Health:* Clearly a visit to a doctor, dentist, or a hospital has a carbon footprint. The health sector is one of the major sectors in our economy. The challenge is to break down the footprint into digestible parts. How much carbon can be attributed to the training of my doctor or dentist? What about their specialist equipment? If we knew the answer to those questions how much could be allocated to us? Luckily my family has, to date, not troubled the health services too much.

*Electronics:* As a family we always seem to be buying lots of bits and pieces of electronic 'stuff'. How do you carbon footprint little odd gadgets? I must admit my main concern with a lot of these small light items relates more to disposal than to the footprint of manufacture; transport; etc

*Tradies:* We seem to have a lot of visits from trades people (mainly electricians). I imagine that the main contribution to the CO<sub>2</sub> emissions of these visits derives from the vehicles they drive but I have no information on their travel routes (bring on the Tesla Cybertruck!). I did not attempt to quantify this value.

*Heaters; etc* Over the year we bought a few electrical low energy heating/cooling devices as part of our energy transition project. While it is not too hard to find the results of carbon footprinting for this category of household appliances, it almost always focusses on electricity use. As I've stated earlier this is not an issue for this exercise as our electricity use is covered off in our direct carbon footprint. However, I was not able to find any work relating to the carbon footprint of the manufacture/distribution of these types of devices.

3. The data in the Table only includes our family's private carbon footprint. My wife travels for work, sometimes overseas; I have not included the CO<sub>2</sub> from these trips. In my view employers are responsible for managing the carbon footprints of their employees when they are at work.

## Validation

Having a science/engineering background the first question I always ask myself after making some computations is 'are these numbers reasonable?'. This document contains my first attempt at computing our total household footprint therefore I was particularly keen to validate the results shown in **Figure 2**.

I have a great deal of confidence in my computations for our direct carbon footprint – after all, the CO<sub>2</sub> values are simply derived from our electricity bills and petrol dockets using [the Government's published emission factors](#). Very solid energy/CO<sub>2</sub> data!

On the other hand, after working through the literature I was very wary about the robustness of my computations of our indirect carbon footprint. Many of the factors I used appeared to be little more than guesstimates. Clearly there are many products/activities that I wasn't able to include (see a sample of a few of these in the notes under **Figure 2**). If I had included these, and made more detailed examinations of the areas listed in the Table, would the total indirect carbon footprint be materially different?

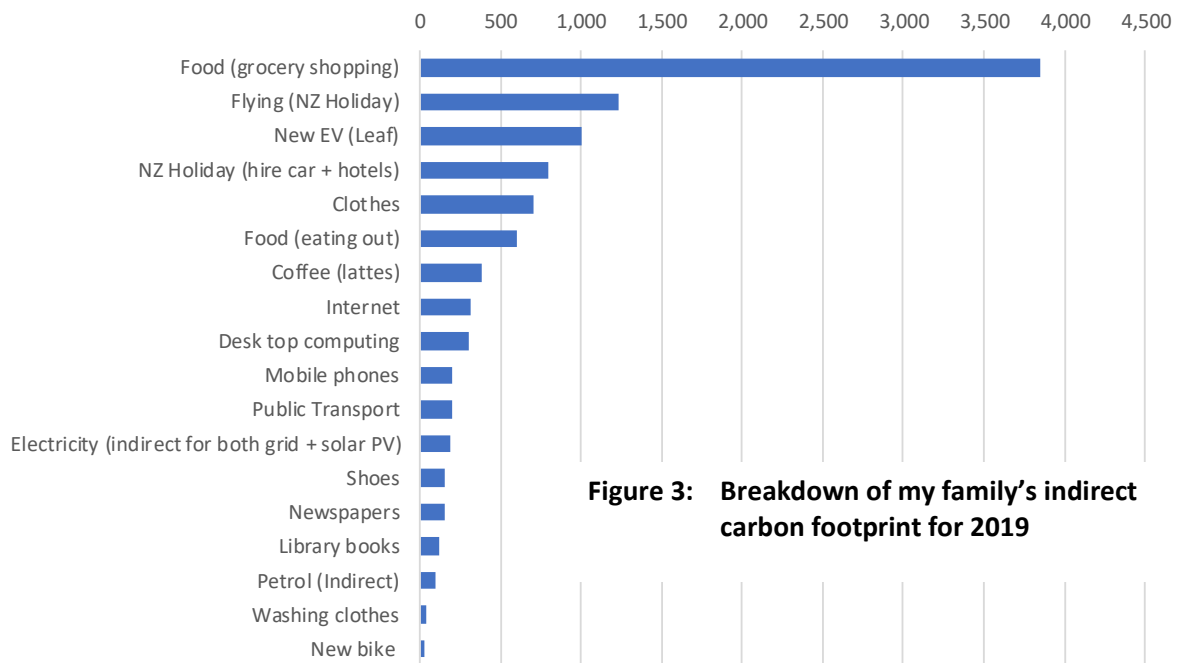
I was initially comforted by the fact that the [ABC reports that in Australia](#) '*an average of 14 tonnes (14,000 KG (sic)) [of CO<sub>2</sub> is emitted] per household each year*'. However, on closer examination it appears that this figure simply relates to a household's direct carbon footprint [I have not been able to find a reliable estimate of the proportion of an Australian home's carbon footprint that is direct, but it appears this is typically around 50%]. A [more comprehensive footprinting source](#) indicates that '*A typical U.S. household has a carbon footprint [including both direct and indirect emissions] of 48 t CO<sub>2</sub>e/yr.*'

With this information in mind I used two different carbon calculators (there are many of these on the net) to compute our household carbon footprint. The [first of these](#) gave an answer of **12.9 tonnes of CO<sub>2</sub>/yr**; [the second](#) produced a figure of **9.9 tonnes of CO<sub>2</sub>/yr**.

Given the above, I'm happy that my indirect carbon footprint calculations are in the right ballpark. These will of course need to be refined in the carbon footprint reports for future years.

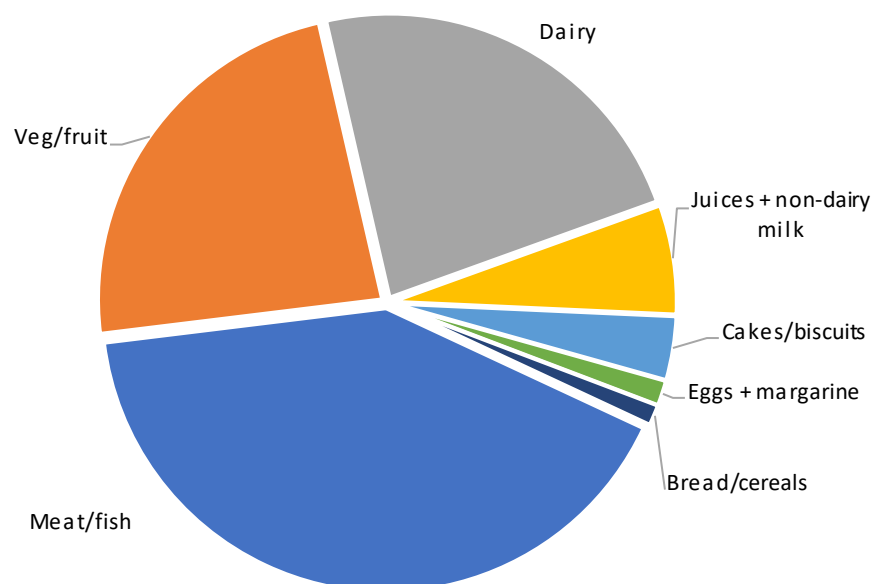
## Discussion

I have translated the indirect carbon data in **Figure 2** into the visualisation in **Figure 3**. Food immediately jumps out as the overwhelming contributor to our household indirect carbon footprint. It makes up about 40% of this footprint. Given the importance of this component I have given a [detailed breakdown of food's contribution to our family footprint in Appendix 1](#).



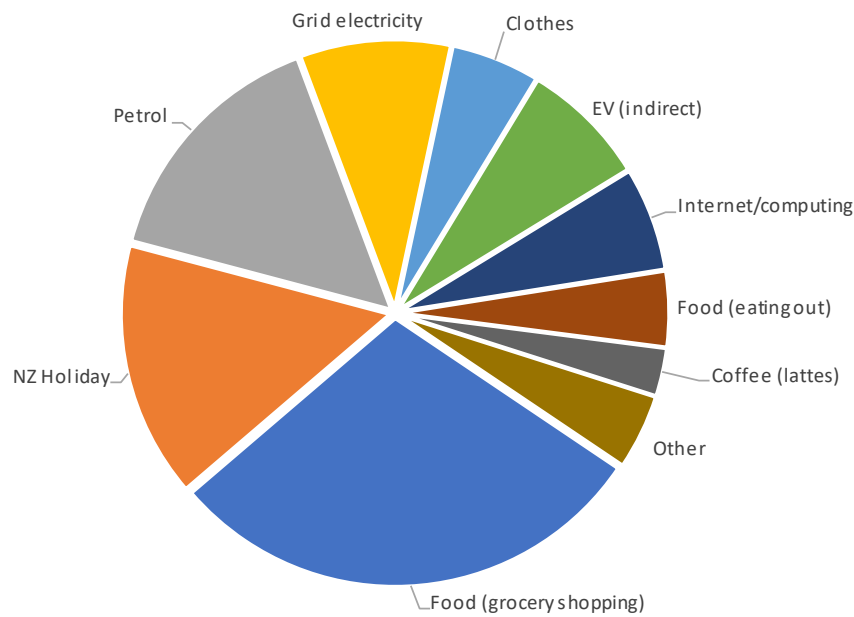
**Figure 3: Breakdown of my family's indirect carbon footprint for 2019**

If the food carbon footprint is broken down into broad food groups an interesting picture emerges (**Figure 4**). Almost 90% of our food carbon footprint falls into only three groups: meat/fish; veg/fruit; and dairy. I'm not sure what a dietician would say about this. Anyway, it is easy to see why a vegan diet is being promoted as a good way to reduce your carbon footprint!



**Figure 4: Broad breakdown of my family's food carbon footprint for 2019**

It is also interesting to breakdown our total (direct + indirect) footprint into broad categories. This picture is shown in **Figure 5**.



**Figure 5: Our total 2019 carbon footprint shown in broad categories**

Amongst other things, this shows the significant contribution that is made by a short overseas holiday taken relatively close to home. It is also interesting to note that apart from 'clothes' and 'EV (indirect)' all the categories in the Figure involve products that are, to all intents and purposes, immediate consumables. Sadly, these days even 'clothes' are often little more than short term consumables. I see our New Nissan Leaf, which we bought in August 2019, as a long-term product and it can be seen that its indirect footprint makes quite a sizeable contribution to our total footprint. It is estimated that 10 tonnes of CO<sub>2</sub> are generated in the manufacture of a Leaf. I intend to allocate 1t CO<sub>2</sub>/yr to our carbon debits for 10 years to pay off this carbon debt.

## Chapter 3

# Managing Our Carbon Footprint

As indicated earlier, the key aims of our energy transition project is now to have net zero emissions, computed on an annual basis, from this year going forward. In simple terms I will compute our direct and indirect carbon footprints at the end of each year to work out our annual 'carbon debt'. At the same time, I will compute the carbon footprint of our total solar PV export to give us our annual 'carbon credit' [see discussion below]. If our credit exceeds our debt, I will take no action. If our debt exceeds our credit, I will buy some form of external carbon credits to provide us with a balanced annual carbon budget.

## Direct Footprint

We, as a family, have spent the last 6 years working to reduce our direct carbon footprint. As mentioned in the Background to this document, you can find [the reports I have written](#) on this work on my website. I have given some brief details of the magnitude and composition of our direct footprint for 2019 in **Chapter 1**.

At the time of writing we are in the process of installing an additional 6kW of solar PV on the roof of our house. The aim is to both reduce our use of grid electricity (which mainly occurs during three months over winter) and to generate carbon credits which I intend to use to balance our carbon account. Time will tell how successful this will be, but I anticipate that this additional solar PV will go a very long way to wiping out our annual carbon deficit.

The main source of our annual direct carbon footprint over recent years has been petrol used in our Hyundai i30. We have been slowly using this car less and our acquisition of the Gen 2 Nissan Leaf in 2019, with its larger battery compared to our previous 2012 Nissan Leaf, has enabled us to take more of our family drives without using petrol. Nevertheless, I imagine that we will be using the i30 for a few years yet – hopefully a suitable EV or PHEV will present itself soon.

## Indirect Footprint

Having just computed our indirect carbon footprint for the first time, I have yet to get my mind around how we may reduce our indirect footprint.

The most obvious target for reducing our indirect carbon debts is the 'food' basket. I can't envisage us suddenly going vegan or vegetarian, but I will try to eat less beef and increase my consumption of chicken. Maybe when it's my turn to cook I'll try to slip in a vegetarian meal or two. I would hope that we can manage some carbon reductions in the meat segment of our indirect carbon pie.

One carbon segment that goes up and down from year to year is 'holidays'. Sometimes we take holidays in Australia; other times we go on long-haul trips. I originate from the UK and my wife is from Malaysia and therefore family visits are important for us.

Overall I can't see us making any great inroads into our indirect carbon footprint in the near term. Having said that, I can think of ideas that would help us. For example, we (and I imagine many other people) have no real idea about the size of the carbon footprint of an item we are buying – this value is dependent on many variables – so it would be helpful if some form of carbon footprint labelling scheme were introduced. A [labelling scheme was going to introduced about a decade ago](#), but I

have no idea what happened. I'm certainly not aware of it being taken up. Nevertheless, [articles promoting the concept](#) do still appear from time to time.

On a related theme, the issue of 'food miles' never seems to go away. There certainly seems to be a perception that it is best to buy products that are made as close as possible to where you live. This thinking is based on the not unreasonable assumption that transport makes up a significant proportion of the indirect carbon footprint of most products and therefore 'buying local' will reduce the size of the footprint. Unfortunately, as far as I can tell, this is often not the case and I have read quite a few articles that suggest ['food miles' is a misleading concept](#). Bring on some verifiable footprinting labels!

## Carbon Credits

This is where things start to get messy. When you move into the world of 'net' carbon footprinting you are, by definition, moving into an area where there is some form of trading between positive and negative footprints. To achieve 'net zero emissions' some form of carbon credit will usually be used to balance a carbon debit. This can be done in a number of ways, but it is often a contested space which leaves many people feeling that any carbon reductions are 'notional' rather than 'actual'.

### Carbon credits under your direct control

I am most comfortable with using credits which I can physically generate and monitor myself. For example, I can add a large solar PV system to the roof of my house and claim any exported (carbon free) exports as credits.

I think this is fine, but some people would cry foul if I had sold my [STC credits](#) to my solar installer when the system was installed – they would say that I had already sold my solar PV credits and therefore I could not validly count them again to compute my net zero emissions status (back to double counting). This could get into a long and tortuous debate but my current position (I'm happy to be corrected) is that the annual Carbon Accounts contained in this document relate solely to a private 'carbon bubble' that I have created for our household. I have done this solely to help us understand, and take steps to reduce, our family carbon footprint. I am not trying to claim any broader validity from this work (eg to get some form of monetary payment from a third party). In these circumstances I have no problem with using our solar PV production as a credit in my informal 'net zero emissions' calculations.

Some may see planting and looking after trees as a form of 'concrete' carbon credit. They can physically monitor the status of their credits. Some years ago I bought some [biochar](#), with a view to adding it to the soil in my garden, just to put my toe into the 'sinks' side of reducing the level of CO<sub>2</sub> in the atmosphere. I found this extremely expensive (on a \$/kg of CO<sub>2</sub> basis), and not as satisfying as installing solar PV but I think biochar is a technology that could play an important role in reducing carbon impacts.

### Buying offsets

This is an area that worries many people. You pay money and then it disappears! You simply have to trust that your money will be used to take steps that will reduce atmospheric CO<sub>2</sub> (eg build a wind farm or create a plantation forest).

Putting the trust/transparency issue to one side, many environmentalists believe that buying offsets is a cheap way to avoid taking necessary direct action to reduce your own carbon impacts. At one level this is true, but if I have say \$10,000 to spend is it better to spend this in my own backyard to



achieve a carbon reduction of xkt of CO<sub>2</sub> or to spend it offshore and achieve a carbon reduction of 10xkt of CO<sub>2</sub>? Again putting aside any trust/transparency issues, clearly the latter option gives the best carbon outcome for the planet.

This is a fraught topic, but I must admit that I can see merit in, and indeed do buy, carbon offsets. I recently bought offsets for the flights we took on a short family holiday in January this year. I believe the key to buying offsets is to make sure that they are being sold by a body with good standing (with a reputation to lose if dodgy dealings are revealed) and they are backed by some form of certified scheme (preferably government). For example, I am very comfortable buying offsets from Qantas.

In the end I guess much of this debate goes to personal values. Some people will not buy offsets but will do everything within their power to reduce their indirect carbon footprint by lifestyle change: go vegan; no longer fly; only buy clothes from op shops; etc. I think this is terrific, but one key point for me is that throughout our household energy transition project I have been trying to demonstrate that one can both enjoy a 'normal' lifestyle and have a minimal carbon footprint. Offsets are likely to play some part in this latter scenario if you want to have a net zero emissions impact.

## Managing our Carbon Footprint going forward

You can see from the carbon balance sheet at the front of this document that I have arrived at zero net emissions for our household for 2019 by purchasing CO<sub>2</sub> offsets (see also **Appendix 3**). I did this simply to establish a baseline for our total carbon footprint. Where do we go from here?

We will continue to work hard on our direct carbon footprint. The biggest target now is our indirect carbon footprint. As I said a little earlier, I guess the most obvious response is to examine the breakdown of our indirect footprint and start to tackle the major sources of CO<sub>2</sub>. Beef and cheese clearly stand out as areas where we could make big carbon gains – I think we can probably cut down on our consumption of these foods but I don't think elimination is an option for us at the moment.

Having said that, I am much more attracted to looking at ways to increase our 'footprint credits' rather than decrease our 'footprint debits'. In my experience, when trying to bring about change it is always much easier to offer someone something new than it is to tell them to stop doing something they enjoy. An indirect carbon footprint captures the essence of a person's lifestyle.

If buying offsets is going to be part of the 'something new' then I think there are hurdles. When I was going through the simple process of buying offsets to give us 'net zero emissions' for 2019, I was very disappointed in the offset offerings for individual Australians. While there appear to be quite a number of Australian companies offering corporate offsets, I was not able to find an Australian site that provides a good service for individuals. In the end I bought my offsets from a [US site which appears to be credible](#) (although the user interface certainly has some limitations (eg it only accepts weights in pounds)). The price of the offsets (at approximately \$10USD/kgCO<sub>2</sub>) appears worryingly low – I paid approximately \$110AUD to purchase my offsets (I bought a little bit more than necessary to provide a small buffer). I also only have the broadest description of the types of projects my money will be spent on – I find this particularly unsatisfactory.

As noted earlier, at the time of writing we are in the process of adding an additional 6kW of solar PV to the roof of our house – this will take us to a total solar PV capacity of about 16kW. I'm hoping that in a full year this should largely remove the need for us to buy any indirect carbon credits to become 'net zero carbon'.

If we do need to buy credits in the future, I plan on looking for a much more concrete offerings than the usual ill-defined carbon offsets. For example, I would look to buy a share in a solar or wind farm

where I can be allocated a set proportion of the farm's total annual output and receive notification of, or at least be able to compute, the amount of renewable energy (carbon credits) that I have generated each year. There are many community energy projects up and running in Australia (see for example [SolarShare](#) which is a community solar company based in Canberra).

Finally, just to emphasise what I implied earlier in the paper, I don't see 'net zero emissions' as being the end of the game. The world needs to ultimately reach a state of being 'Fossil Fuel Free'. I envisage that once we, as a family, have a good handle of what we need to do to become 'net zero carbon' we will push on and aim to develop an excess of credits so that we are able to make a positive (ie negative) contribution to [the world's carbon budget](#).

# **Appendices**

# Appendix 1 Food

It can be seen from the information I have provided in **Chapter 2** that for my family food dominates our indirect carbon footprint. I imagine this is the same for most families. In fact for us, after years of working on our direct carbon footprint, food also dominates our total carbon footprint.

Given this, I had little choice but do a more detailed assessment of the footprint contributions of the all the different things in our grocery shopping basket. As with my analysis in **Chapter 2**, I relied on searching the internet to find CO<sub>2</sub> emission factors for each of the food types I needed to cover. I have shown the outcomes of this work in **Figure A1**.

It is important to note that there are very diverse values in the literature for the carbon footprint of any given food type. I tried to use the same priority as I mentioned before when selecting my references: ideally Australia based; preferably academic research; and give preference to the most recent work. In many cases in the end I just picked a value for the carbon footprint which was somewhere in middle of the range of published values. Therefore I believe all of the CO<sub>2</sub> values I have computed need to be treated with some caution.

**Figure A1: Itemised family food carbon footprint for 2019**

Description	Weight (kg/wk)	Carbon Intensity (kg CO <sub>2</sub> e/kg)	Total CO <sub>2</sub> e (kg/year)
<b>Meat: beef; lamb; chicken</b>			
Beef	1	23	1,100
Lamb/pork/other	0.5	12	300
Chicken	0.5	3.7	100
<b>Fish</b>	0.5	3.4	85
<b>Vegies</b>	3	1	150
<b>Fruit</b>	5	1	250
<b>Dairy: yoghurt; milk; cheese</b>			
Milk	5	1.3	325
Cheese	0.5	20	500
Yoghurt	1	1.3	65

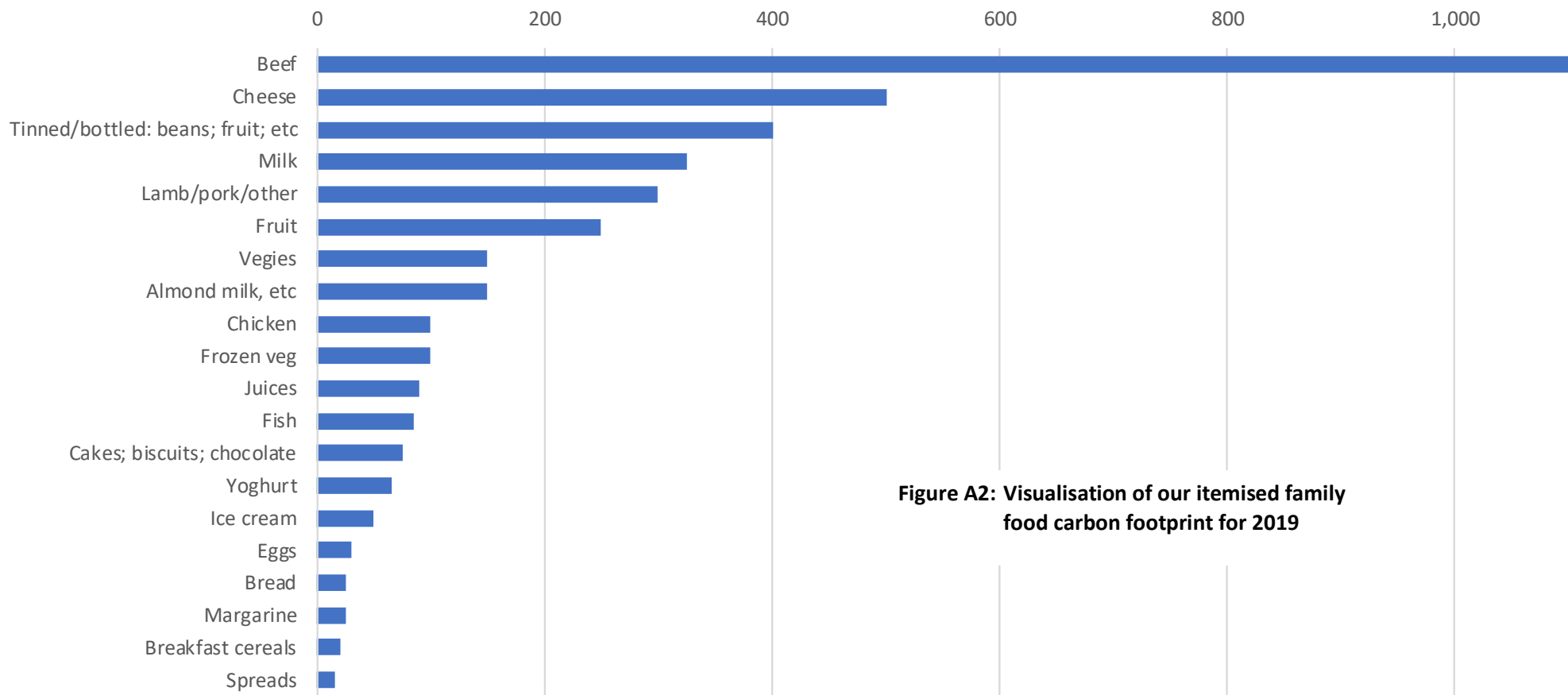
Description	Weight (kg/wk)	Carbon Intensity (kg CO <sub>2</sub> e/kg)	Total CO <sub>2</sub> e (kg/year)
<b>Non-dairy: milk; margarine</b>			
Almond milk, etc	5	0.6	150
Margarine	0.5	1	25
<b>Coffee (in cafes)</b>	15 cups	0.5kgCO <sub>2</sub> e/cup	380
<b>Juices</b>	3	0.6	90
<b>Breakfast cereals</b>	0.3	1.2	20
<b>Cakes; biscuits; chocolate</b>	1	1.5	75
<b>Eggs</b>	6 eggs	1.5	30
<b>Bread</b>	0.5	1	25
<b>Spreads</b>	0.1	2.9	15
<b>Frozen: veg; ice cream</b>			
Veg	1	2	100
Ice cream	0.5	2	50
<b>Tinned/bottled: beans; fruit; etc</b>	4	2	400
<b>TOTAL</b>			<b>4,235</b>

In order to get a better visualisation of the importance of the individual food types shown in the Table, I have produced the bar graph shown in **Figure A2**.

The information in the Figure has been categorised into groups to provide the picture shown in **Figure 4**.

When computing our food carbon footprint, I only tried to capture the foods which make up our normal weekly shop. There are of course many other items which we use often in the kitchen but only need to buy from time to time – eg herbs, spices, sauces, etc.

When transferring this data across to **Figure 2** as 'Food (grocery shopping)', I separated 'Coffee (in cafes)' from the other items.



**Figure A2: Visualisation of our itemised family food carbon footprint for 2019**

# Appendix 2      References

When trying to ascertain the carbon emission factors I simply Googled for the activity/product groups listed in **Figure 2** and the food types listed in **Figure A1**. I did not do this in a particularly rigorous way: I always selected at least three separate sites to ascertain the range of the claimed emission factors; if the first few sites gave a similar answer I did not go further and I picked what I thought was a good round number for the average value; if there was no apparent agreement I opted for the figure that was shown on what I judged to be the most credible site. This process was crude and involved lots of judgement – the figures in the Tables should therefore be considered to be purely indicative.

When I was going through this process I noted down values and/or captured the links of particular sites which I've listed below essentially unedited. These may, or may not, have been the sites which I used to obtain the final emissions factor values which appear in the Tables. While my Googling appears to be haphazard [I deliberately did not want to get too bogged down in this 'first cut' of going through the research], I would draw the readers' attention to the 'Validation' section in Chapter 2. I was very happy with the outcomes of the validation – if this had not looked good, I would have revisited my Googling and taken a much more painstaking approach. [Having said that, I think it is self-evident that very carefully working through masses of poor and inaccurate data is not likely to give you any more reliable results.]

My informal notes/web site links are listed below, this only represents a small sample of the sites that I looked at:

Beef 50-60 kgCO<sub>2</sub>e/kg (at best): <https://www.theland.com.au/story/6527876/beef-must-stop-ignoring-its-large-co2-footprint/>

Beef 75 kgCO<sub>2</sub>e/kg beef (derived from figure in article):  
<http://www.fao.org/news/story/en/item/197623/icode/>

Beef massive variation in published figures most common figure about 25 kgCO<sub>2</sub>e/kg (most of these studies not Australian). CSIRO similar figure: <https://www.publish.csiro.au/an/an11030>

Fruit and vegies (US): <http://www.circularecology.com/news/wonky-fruit-and-veg-the-carbon-footprint-of-food#.XIYJMWgzZhE>

Food Australia (RMIT): <https://www.rmit.edu.au/news/all-news/2016/november/new-study-provides-carbon-footprint-league-table-for-food>

Australian cheese: <https://milkmaidmarian.com/2018/06/07/the-aussie-dairy-carbon-hoofprint/>

Milk – major differences in different publications (could be global differences)

Margarine: <https://www.bettermeetsreality.com/the-impact-footprint-of-producing-eating-butter-margarine/>

Coffee: <https://www.ecowatch.com/coffees-invisible-carbon-footprint-1882175408.html>

Food miles debate: <https://www.theguardian.com/environment/2008/mar/23/food.ethicalliving>

Eggs: <https://www.australianeggs.org.au/dmsdocument/521-environmental-assessment-of-an-egg-production-supply-chain-using-life-cycle-assessment>

Bread: <https://blog.csiro.au/how-green-is-your-bread/>

Cakes etc detailed study: <https://www.sciencedirect.com/science/article/pii/S2352550918303087>

Sandwich: <https://www.theguardian.com/lifeandstyle/2018/jan/25/scientists-calculate-carbon-emissions-of-your-sandwich>

Juices: <https://stanfordmag.org/contents/getting-the-most-sustainable-squeeze-from-your-oi-essential-answer>

Peanut butter: <https://www.farmprogress.com/peanut/peanut-s-environmental-footprint-stretches-beyond-farm>

Frozen veggies: [https://stud.epsilon.slu.se/6377/7/gottfridsson | 140304.pdf](https://stud.epsilon.slu.se/6377/7/gottfridsson%20140304.pdf)

Ice cream: <https://www.benjerry.com/values/issues-we-care-about/climate-justice/life-cycle-analysis>

Nissan Leaf indirect: <https://www.carbonbrief.org/factcheck-how-electric-vehicles-help-to-tackle-climate-change>

Latte 340g CO2: <https://www.ecowatch.com/coffees-invisible-carbon-footprint-1882175408.html>

List of footprints for food: <https://www.greeneatz.com/foods-carbon-footprint.html>

Australian study food list: <http://www.australasianscience.com.au/article/issue-december-2016/study-provides-carbon-footprint-table-food.html>

Family footprint/year: <http://shrinkthatfootprint.com/food-carbon-footprint-diet>

Wooden furniture: <https://www.panelsfurnitureasia.com/en/news-archive/un-wooden-furniture-reduces-more-carbon-emissions-than-other-materials/462>

Newspaper: <https://www.theguardian.com/environment/green-living-blog/2010/nov/04/carbon-footprint-newspaper>

Bicycle: <https://www.theguardian.com/environment/bike-blog/2012/mar/15/lifecycle-carbon-footprint-bike-blog>

Books: [https://www.csbsju.edu/Documents/CSB%20Sustainability/SHM%20e-readers%20vs.%20books%20poster\(0\).pdf](https://www.csbsju.edu/Documents/CSB%20Sustainability/SHM%20e-readers%20vs.%20books%20poster(0).pdf)

Shoes: <http://news.mit.edu/2013/footwear-carbon-footprint-0522>

Clothes: [https://www.systain.com/wp-content/uploads/2015/09/Systain\\_Studie\\_Carbon\\_Footprint\\_English.pdf](https://www.systain.com/wp-content/uploads/2015/09/Systain_Studie_Carbon_Footprint_English.pdf)

Internet shopping: [https://ctl.mit.edu/sites/default/files/library/public/Dimitri-Weideli-Environmental-Analysis-of-US-Online-Shopping\\_0.pdf](https://ctl.mit.edu/sites/default/files/library/public/Dimitri-Weideli-Environmental-Analysis-of-US-Online-Shopping_0.pdf)

Use of internet:

[https://www.researchgate.net/publication/238634031\\_Carbon\\_footprint\\_of\\_the\\_Internet](https://www.researchgate.net/publication/238634031_Carbon_footprint_of_the_Internet)



Mobile phone: <https://www.theguardian.com/environment/green-living-blog/2010/jun/09/carbon-footprint-mobile-phone>

Desktop computers:

[https://h22235.www2.hp.com/hpinfo/globalcitizenship/environment/productdata/Countries/\\_MultiCountry/productcarbonfootprint\\_deskto\\_2017104233915185.pdf](https://h22235.www2.hp.com/hpinfo/globalcitizenship/environment/productdata/Countries/_MultiCountry/productcarbonfootprint_deskto_2017104233915185.pdf)

Washing clothes: <https://www.theguardian.com/environment/green-living-blog/2010/nov/25/carbon-footprint-load-laundry>

Hotel room: <https://considerategroup.com/carbon-emissions/>

Buses efficiency: <https://the-riotact.com/the-efficiency-of-buses/57534>

Electrical appliances: <https://pubs.acs.org/doi/abs/10.1021/es201459c>

## **Appendix 3**

# **Carbon Offset Certificate**

**THIS CERTIFICATE OF SUSTAINABILITY IS PROUDLY PRESENTED TO**

**Dave Southgate**

**14,000 lbs of Carbon Offsets from the  
Personal Carbon Offset Package**



**K8YUKXAW-33086**

*Certificate Number*

**March 8, 2020**

*Date*

# About the Author

Dave Southgate retired from the Australian Government Public Service in July 2012 after a 31-year career as an 'environmental bureaucrat'. After working for 8 years in government environmental agencies at both the State and Federal levels he joined the Australian Government Transport Department in late 1989 and stayed there until he retired. Throughout his time in Transport he specialised in aircraft noise; in the latter years he also became involved in aviation climate change issues and developed a particular interest in carbon footprinting.

From 2004 to 2012 Dave was the Australian Government representative on the United Nations International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP). He pursued his interest in carbon footprinting while on CAEP and was a member of the group that oversaw the development of [the ICAO Carbon Calculator](#).

Not long after his retirement Dave began a process aimed at transforming the energy use patterns in his 100% fossil fuelled house. This project is aimed at his family becoming 'Fossil Fuel Free' (in essence the goal is for his household to no longer directly buy any fossil based fuels, namely grid electricity, gas or petrol). Dave has written numerous reports and articles about this project. [These can be viewed and/or downloaded from his website.](#)

Dave has a science/engineering background and has degrees from the Universities of Liverpool, London (Imperial College) and Tasmania.

**You can find consolidated information on our household energy transition project at my website:**  
<https://netzeroemissions.net/>