# Decarbonisation, situation awareness and better digital tools

***And why the current technology approach isn't getting there***

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# 1 Contents

# 2 Awareness as a pathway to decarbonisation

Decarbonising our organisations could be easier if decision makers had better awareness of how their decisions will cause emissions to go up or down.

Awareness may sound like an oblique, almost technical world. It means understanding where we are. It means that the real world feels straightforward and manageable.

Having awareness is like standing at the top of a mountain and looking down at the world. Everything in the world feels like something we can work with and live in. Not a mess of complex unfriendly detail. Which is what most decarbonisation projects quickly become.

Digital technology could help provide this awareness. But it does not, not much anyway.

Decision makers may have tools which can tell them about one specific emission source, such as from their fuel consumption.

They may have an 'emission management system' they can use to handle data about multiple emission sources, make sure they have provided everything an emission reporting standard demands, and then generate reports.

But this is not really awareness of how your emissions result from your decisions, such as in purchasing, operations, scheduling, investment, across multiple emission types. You want to understand what would make emissions go up or down and by how much, and how the company's costs, productivity, or other factors important to the company are affected.

Such an 'emissions management system' will not do much to help you find the best course to achieve 3 per cent reduction in emissions each year over the next 30 years, as achieving net zero requires.

What about if you are a purchaser, bank lender, regulator, insurer or investor. In other words, a stakeholder in multiple companies. You want digital technology which will

make it easy to get an aggregate picture of all of these companies, or show which companies are improving their carbon picture. The emissions management system probably won't do this either.

We propose a different way of building digital technology which does this, based on models designed to support people's awareness and decision making, built up of multiple smaller models.

This book shows how we might get there - and how you can help your company to get there.

## 2.1 We probably need to reduce emitting while continuing everything else

To decarbonise, we have to stop emitting, while continuing to get nearly all of what we currently get from our lives. That's based on a guess that only about 10 per cent of people are actually willing to reduce their quality of life in order to reduce carbon emissions, unless they are forced to. And they probably won't be forced to, unless the world really is burning.

We have seen that much of the population would rather vote a politician out of power than accept a reduction in quality of life. An alternative politician will always arrive who promises to maintain it.

Besides, wouldn't even environmental activists like to drive, fly, and heat their homes guilt free if they could?

Decarbonisation without reducing quality of life is too hard to happen quickly. The best chance of doing it is a steady few percent improvement a year, achieving net zero in 30 years.

Decarbonisation is unlikely to be about simple choices. We need to know the levers to reduce emissions, whether they are working, and how decarbonisation fits with our other objectives such as making profit or developing a business.

We have to understand the cause and effect of whatever domain we are working in, and develop stories about how it all works, taking carbon into account.

This all calls for much deeper awareness into how decarbonisation fits with the rest of our company's activities, while seeing how we can achieve continuous steady reductions.

## 2.2 Awareness is not data

Technology companies working in decarbonisation need to enable their customers to achieve awareness, not just provide them with data.

Human awareness means much more than data. Data plays a part in awareness, but not the only part, and it is filtered through what we already understand.

To illustrate the comparison, consider the difference between a parent's understanding of their child and what they can see in 'data', such as exam results or the child's food consumption.

The same goes for our relationships, our career, the state of our house, or anything else which is important enough for us to want a deep awareness of what is happening with it.

There may be data involved, but not everything we need is available as data, and there are many steps from data to awareness.

In 2022, digital technology companies are thinking about data, but they are not thinking about awareness.

They may think that, as technology companies, the most they can do to deliver awareness is to provide data.

Yet any other service provider to society you can think of – supermarkets, policing, schools, hospitals – would not judge their contribution purely in operational data.

We know the limits of 'key performance indicator' driven organisations. We have seen the problems when a hospital or police force organised itself about achieving some specific target, but something else went wrong at the same time, because all the attention went on this one thing. The organisation was no longer being managed around common sense and what is clearly the right thing to do.

Another problem which comes from the technology industry's focus on data is that it leads to thinking about the 'user experience' but in a way which does not relate much to what the technology is meant to be delivering. We would not want any other service provider to society to ultimately judge its services based on the 'user experience'. It's like a train company asking us to judge it on how we felt when boarding the train, rather than whether it took us to our destination at reasonable time, cost, and comfort.

## 2.3 Making our decisions about carbon continuously

To actually decarbonise we need to know the carbon impact in the day-to-day decisions that we make.

This cannot be provided by a study which takes months to do. There are plenty of useful studies happening about carbon impacts of different activities or products. Data analysts usually work with static data.
They might estimate the carbon impact of choosing to have a latte instead of an americano. These estimates can be improved as more data becomes available.

But for real life day to day decision making, our needs are far more complex. We might want to know the impact, in carbon, cost and other factors, of having the heating today at 18 degrees or 20 degrees C, buying organic or mass-produced food, driving rather than going by train.

Buying something new or continuing to use something old, travelling to a meeting or zooming, locating our office in the city centre or suburbs, having software cloud based or hosted on premise, or buying something made locally or importing from far away.

We can make these sort of decisions in our personal and home lives, or make them on behalf of large organisations, where our decisions could have massive impacts on cost, carbon, and other factors like employee and customer satisfaction.

We need to know which components of the total emissions are most important and focus our efforts on those. So, it needs human judgement. This is not built into the core of most enterprise computer software systems, because computing has not got that far.

To understand the carbon impact of these decision choices we would need to bring together many different pieces of data. For practicality reasons, it is never possible to gather all the emission data. So, to actually decarbonise we will probably need to consider much more than what might conveniently fit into a database and big data analysis tools.

Another problem with the data analytics driven approach is that the data available for analytics may not be conclusive. To get useful value from the analytics still needs someone who understands the domain to guide it.

## 2.4 Introducing the concept of modelling

The pathway forward proposed in this book is that the best way to decarbonise is to make digital technology which aligns with the models used by the decision makers in their minds.

Software applications also build models about how things work, but the modelling is normally more complex and sophisticated in our minds than it is in software.

A model is a simplified version of reality. Reality itself is too detailed and complex to work with, so we simplify it by modelling the parts we need. All people do this. Dogs and cats do it too.

Modelling is not something you choose to do, or which you learn how to do, it is something you already do. But you

have not needed to label it, because it is so obvious and there has never been any question of not doing it.

You have models in your mind for everything you are responsible for, seeking to achieve, care about or are interested in. Relationships, property, hobbies, career development, how anything works, with people, organisations, and machines.

A geographical map is a form of a model. It takes away detail of the geographical landscape to show what someone might want to know without giving them information they don't need.

Models aren't just for explaining things. Like geographical maps, they are also for finding our way somewhere or explaining it to someone else. They can be about showing how something works or showing how we are going to get somewhere.

A model can be for working out sub-goals which will help us achieve an overarching goal. We could call this 'goal modelling'. An example is the sub-goals pursued in warfare, such as supporting morale and maintaining supply of oil.

Consider the complex sub-goals our ancestors pursued in order to survive, including defending their town, growing crops, and religious rituals, which they thought had a big influence on their survival. They would have been continuously considering what works and what doesn't.

Models can be held in people's minds, written down, and programmed into computers. Computer systems can be developed to support the models which people have in their minds.

## 2.5 The concept of modelling for decarbonisation

When it comes to decarbonisation, people will already have models in their minds about how they want to achieve decarbonisation goals, such as from reducing temperatures, speeds, purchases, travel, or achieving efficiencies from maintenance or special investments.

Digital technology would ideally help them see if they are achieving their decarbonisation goals, how choices they might make would help do more or less to achieve them, and how other organisational issues would be affected.

It would help them improve their models by showing the relationship between cause and effect, what change will lead to what output.

## 2.6 Modelling helps use and aligning the strengths of people and technology

Technology is better for storing and crunching large amounts of granular data. People are usually better at making decisions with uncertainty and estimates and working with data sources too diverse to be easily programmed into a computer model. But for the two to work together, the digital technology outputs need to be aligned with the useful human inputs, whatever they are.

In many areas of enterprise digital technology, digital modelling is not that important. For example, in personal financial management, you look at your bank statements to see how much money you have and how fast you are spending it and work out if you will have enough money to last until you get paid next. There is no need for any alignment between the modelling of the online bank and your modelling of your finances.

We don't need digital modelling for our e-mail. We use our e-mails to update our mental models of what is going on, but the digital technology is just moving a message from the sender to the receiver.

But when we are in a complicated situation with different things happening and a challenge keeping track of them all and how they work together, that's when digital modelling gets important.

For the carbon example, if our task is building wind turbines using government funding, then modelling is not that necessary. But if we are trying to work out whether investing in wind turbines is the best option for our environment-focused investors, given the uncertainty over

returns from wind farms, uncertainty over alternatives, and uncertainty over investor appetite for alternative projects, then modelling gets far more important.

## 2.7 From binary choices to complex choices in decarbonisation

Much of the discussions about decarbonisation up to 2022 have been fairly binary, a choice between this and that. As the choices get far more granular and complex, digital technology and modelling gets much more useful.

Binary choices are whether to be vegetarian or not, whether to build wind farms or not, whether to buy an electric or petrol car. Environmental activists generally focus on binary choices, such as whether we should drill for more oil or not.

There are more dimensions to these choices, such as whether to have both an electric and petrol car, or a more efficient petrol car. But the arguments are generally not so nuanced.

If you believe that environmental success can be achieved through advocating for one option in this sort of binary choice, this book will not make sense to you.

Complex choices relating to carbon are about the temperatures we heat to or clean at, the trips we take, the purchases we make, the investments we make, the waste we have and what we do with it, the skills we develop, the speed we go at, if we keep something well maintained. Whether to replace or rebuild, or continue with what we have. If we are to achieve decarbonisation without negative impacts on our lives, we need to take the right option in many complex choices.

An industrial example of a complex choice could be a company operating thousands of motors deciding which ones should be upgraded or provided with regulators. Enormous energy and cost savings are available by changing motors to recent models or adding regulators (known as ‘variable frequency drives’) to control the energy consumption of the motor.

Most motors in today's industrial use are not the most recent models, and are oversized for what is required, because they were installed in a time where energy costs did not matter so much. They also have no means of adjusting their power consumption and output.

But investing in upgrades to equipment is also expensive and will not pay off in all circumstances. The pay-off depends on the cost of the upgrade and the operational energy savings, which is based on expected future life of the existing motor. But if you can work out which motors should be prioritised for this improvement, it would make big dividends in both carbon and cost.

Carbon taxes are another factor which makes environmental decisions less binary. High direct costs on emissions are useful in achieving decarbonisation because it means we have more reasons to reduce emissions than just opinion, which can be limited in its force. But it means there is another factor to consider in how we make our choices. This then makes modelling more worthwhile doing.

## 2.8 Modelling takes us beyond opinion and regulation

Decarbonisation efforts were driven initially by people's opinions or views. People felt personally that something needed to be done and did it themselves or pushed others to do something.

The limits of opinion-driven decarbonisation are clear - not everybody has the same opinion, and in a commercial environment it is hard to continue when you have competitors with lower costs.

People's opinion can be guided by how much connection they have with a certain option. We might see people from a coal mining region being sceptical about the need to stop burning coal.

When we are working solely with opinion, and there are opposing sides, it gets easy for views on both sides to harden, forming a big obstruction to progress.

Perhaps we are in a world where 10 per cent of people want to do everything possible they think is right for the environment, 80 per cent of people are mainly concerned with getting on with their lives, and 10 per cent of people oppose it. So, we may be reaching the limit of how far we can decarbonise purely through opinion.

Regulation comes in as the next step, imposing carbon costs and levies, and stating things we cannot do. The limits of regulation are what we see today. Politicians can only go so far to inflict carbon taxes without being voted out; and regulation needs to apply to everybody the same while every company is different.

Modelling can take us beyond the limits of option and regulation as a driver for decarbonisation. With some basic external incentives to decarbonise, such as from carbon prices, investors, or customers, we can use modelling to find continuous incremental improvement steps.

## 2.9 The unit of awareness – the carbon footprint

The carbon footprint concept gets a lot of criticism. People rightly say, a footprint can never be completely measured. But it is the right concept. When we choose to undertake an activity, we create a mix of emissions, which would otherwise not happen. If we want to reduce emissions, we have to know what activities to stop and how to stop them. So, we need an idea of the carbon footprint.

Just like an actual footprint, it does not need to be completely defined, just understood well enough to see it is there. There is a clear enough difference between leaving a footprint and not leaving a footprint.

We call it a 'footprint' rather than a number about our emissions, because every real-world activity has a wide range of emission sources. Perhaps one large emission source, such as the emission from fuel combustion when driving a car, but lots of smaller emission sources, such as from manufacturing the car and constructing the road. Every carbon footprint has some version of the 80:20 rule - a small number of emission types are responsible for the bulk of the emissions.

It will never be practical to calculate our carbon footprint absolutely because a list of the emission sources related to any product will never end. But at some point, we can draw a line and say we have the most important emissions of our activity, and a manageable list of emission sources.

Ultimately a carbon footprint is provided as data, which is generated through a model using a mixture of calculation, estimates at varying degrees of granularity, setting boundaries, and omission.

Where we share this footprint with others, we would ideally also share the model behind it. If we are sharing it with our stakeholders, so we care about their view about this model, we should be able to discuss it with them. If the discussion leads to both parties agreeing to add extra emission calculations to a model, or improving an element, the digital technology should be extendable to allow this.

## 2.10 Filling the gap between data reporting and operational decision making

Most of the discussions and software around industrial decarbonisation so far have been about reporting.

There are a number of different reporting models being developed by standards organisations, which tell you how data should be collected and calculated.

Carbon reporting is important, such as for regulators to set limits, governments to understand the big picture, and for bank lenders to set conditions.

But it is also important to put it in its place. Decarbonisation is not achieved primarily through better reporting. It is achieved through making a series of good decisions and being able to factor carbon emissions into them. Reporting may help provide data to inform these decisions. It may also distract the effort if the focus moves to making reports rather than decarbonising.

Carbon reporting itself can be complex. If we follow a structured reporting scheme, we may find ourselves

calculating emission data which the scheme asks for, but does not have any material impact on our 'footprint'.

It can take a long time to work out which schemes and which elements of them need to be followed and how to get there. We may feel obliged to engage consultants. Anyone receiving our report, such as a bank, may oblige us to get auditors to check what we are doing. As a result, we may be asked to provide more data. Software tools may be useful in compiling data and making the report. But none of this connects directly to actual decarbonisation.

To illustrate the difference between reporting and decision making, consider what makes a supermarket chain successful. Good data collection, management and reporting is important in supermarkets. But what is more important is the ability to make continuous decisions based on this data.

A supermarket chain sees continual changes to supplier prices, customer demand and competitor activity. Its decision makers need to understand how customer demand changes with price, time of year, and other factors. As a result of this understanding, they can make good decisions about what to put on the shop shelves and how to price it. A customer sees it worthwhile to visit and give the supermarket its grocery spending.

Or consider how a family household becomes low carbon. Reporting is unlikely to play a major role. But perhaps this family has found a way of living which does not involve much emission. This may be a family which can be comfortable living in a small home, without a car, without family holidays involving long flights. With moderate heating, without too much food waste, or buying lots of clothing and other manufactured products. In other words, it has found ways to get into a low carbon position. No reporting has been involved.

## 2.11 The human decision maker in the digital chain

Digital technology specialists should not fall into the trap of thinking that technology alone can handle the whole operational chain of gathering emission data, decision

making, and executing decisions. It is generally a human being making decisions in the middle.

There are some industrial operations which have a lot of computer decision making. Amazon's e-commerce operation, Uber's taxi service. Such end-to-end digitalisation requires that a computer understands the whole operation.

But most real-life situations involve much uncertainty, and this is where people can normally make better decisions than computers. Perhaps domestic supply chains (Amazon) and taxis (Uber) are rare real-life situations where uncertainty is low.

In theory we can make AI tools to automate all kinds of decision making. But then it still needs lots of people to make these AI tools.

Where we have a human decision maker in an organisation, it will often be someone with rich mental models about how their domain works, which they originally learned from others and continually update from what they see. As a result of their decisions, the organisation achieves its goals.

People who are effective at what they do are good at understanding the situations they are in, building models about how to get from where they are to where they want to be, pursuing them, and adapting the model as they go.

We may be talking about a work environment where people are co-ordinating scarce resources, making plans, alerting someone appropriately. We may be talking about work environments which relate to human health. Decision makers may be working in a complex unpredictable operation - like shipping. There could be multiple factors to monitor and juggle to achieve a goal - such as monitoring a complex IT operation. And now we ask people to try to decarbonise at the same time.

Technology can support these people by automating the data work. Handling new data from sensors, storing past data, assessing if slow changes are happening, assessing if something is looking different to normal, generating an alert and sending it to the right people.

Most people in organisational roles in 2022 are using plenty of data, such as bank balances, sales, accounts, crime statistics. They have other electronic information such as schedules, task lists and their own spreadsheets. They have conversations and e-mails with others. They read documents and get alerted to things changing.

They build up an awareness of their domain, and the expertise to know what to do to get the result they want, based on this awareness. The quality of the organisation results from all of this decision making.

And so it is, or soon will be, with carbon emission decision making. Human decision makers will gather data, make decisions, and the output will become data in reports. But it is the decision making which is most important.

## 2.12 Building on the dashboard

A technology developer may read this and think, the best way to serve a decision maker with technology and give them awareness is to provide a great digital dashboard. It will give you the most important information on the first screen. Then you can drill deeper to find more detail or see how the initial figures were calculated.

But in terms of delivering actual awareness, this only works if the dashboard is giving someone precisely what they feel they want at that point.

Giving someone a dashboard is like a teacher giving a textbook to a child. It is possible that the child will read the book and immediately understand the subject, but it does not happen very often.

The usual first reaction of a child given a textbook, or any adult given a random nonfiction book, or someone being shown a software dashboard, is that they feel it is not relevant to them.

People have very specific and diverse needs, interests and starting points. Even a classroom of students learning the same thing for the first time.

People working in a company with its own operational methods can have the same reaction, if they are shown a software dashboard, unless it was designed for their specific needs. And the awareness needs of people in two companies doing the same thing can be very different.

Also, the information someone in an operational role needs will not all be the sort of reported data provided from a dashboard. It might also involve what is happening right now in the company, what is required of them, what other people are doing elsewhere in the company that affects them.

For decarbonisation, the ideal digital technology might be able to tell us the decarbonisation 'cost' of any option at the point where we decide, or where we have the biggest ability to reduce emissions right now. Which is our most inefficient equipment, or the best investment opportunity? Where could there be a methane leak, we don't know about, or a gap in our methane testing? While a dashboard may form part of informing us, it only provides part of the answer.

## 2.13 The opposition to these ideas

The ideas in this book, about a modelling driven approach to decarbonisation tools, will not get widespread approval.

There is a lot invested in the status quo of reporting, reporting software, consultants, and auditing.

Many people have strong binary opinions about decarbonisation, such as that decarbonisation could be achieved so long as the stupid x stopped doing y.

The standard software business model is to develop standard products that can be sold to multiple customers, not to develop custom products and services for customers who probably do not even know what they want.

Modelling is not a concept widely understood or liked in digital technology circles. Awareness is not a concept many digital people think about.

There are ways around these obstacles, but they get quite tough. The rest of this book explores what they might be.

# 3 Our solution - the concept of Digital-Awareness-Decision models

## 3.1 Introduction

This book is about how computers can do more to support people's decarbonisation decision making.

It is based around the observation that most decisions today, in organisations or anywhere else, are made by people, not machines.

Today, computers play a role in supporting people making decisions. People may use various data sources, such as their e-mail, planning and scheduling tools, reports, or software tools, to understand what is going on and let their mental models evolve.

Our approach is that digital technology should be developed around understanding the human decision-making models which already exist and helping them to develop. Then making digital tools which support that.

We call it a 'digital-awareness-decision' model, which makes a nice acronym 'D-A-D model'.

The 'model' is not entirely a digital technology product. It is a technology plus people product. The technology provides awareness and supports decision making, and people get awareness and make decisions. They both fit together.

Decarbonisation decision making may not yet be so complex that it needs such decision support software tools. But it is about to become much more so.

The complexity in decarbonisation is growing because of the need to achieve continuous reductions in emissions while the business provides the service levels its customers expect.

## 3.2 An awareness decision model (without the digital)

To ease you into the theme, let's talk about 'awareness decision models' which do not involve digital technology.

You already use awareness-decision models, but never saw the need to give them a name.

Already today you made decisions based on some awareness – about what to wear and eat, and what to do. If you have been working you may have made decisions with big consequences based on what you were aware of, such as about investments, hiring and co-ordinating.

These will probably have been routine decisions for you. But you would have made them differently if you had been aware the situation is different. You have a model in your mind about how you decide based on what you are aware of.

Most people in most jobs see the same things over and over again, so have mental models about what specific things to be aware of and how to decide about what to do about them. The result is the world as we see it.

Think about the awareness-decision models used by a police officer. The awareness comes from what is reported, what they are told by colleagues, and what they see with their eyes. The decision model is what the officer uses to decide how to act on the decision. How urgent it is and what sort of response is appropriate.

This is not a digital-awareness-decision model, as we define it. You might have checked the weather forecast with digital technology before deciding what to wear. But there is no link between the models used for weather forecasting and the mental model you use to choose your clothes today.

## 3.3 A digital-awareness-decision model

The value of a digital-awareness-decision model happens in a more complicated situation with multiple things happening, or which could happen. There may be factors influencing other factors; causes and effect you don't necessarily know all about. It leads to difficult decision making.

Our ideas for the digital-awareness-decision model were originally developed in making software for the deep-sea shipping industry.

For operational staff and the crew of a ship, much is happening all at the same time. The ship's cargo needs to be safely moved to its destination, there are shipboard

inspections from regulators and customers, there are maintenance tasks to do. There are spare parts to buy, and external contractors to deploy.

The factors connect together in ways that people don't necessarily know about at the time. Factors can influence other factors. A ship waiting in warm waters for a port berth to be free can see a faster build-up of grime on the hull, which increases resistance when the vessel is moving, and means more fuel and carbon emissions, and unhappy customers who pay for the fuel.

It can be very hard for individuals to keep on top of what is happening and make the right decisions. But Digital-Awareness-Decision model based software can help people keep track of what they need to know and do.

Think of the task of managing cybersecurity for an organisation. There's an enormous amount of relevant digital information available, including about security systems installed on the company's fleet of PCs, possible hacks taking place now, notifications of security controls obstructing people's legitimate work, data about training or staff security awareness.

Well modelled software would use available data to present exactly what someone needed to know at any time and help them make decisions about how to allocate their time.

A similar picture could be drawn for decision makers managing a hospital, managing public health during a pandemic, fighting a war, supporting the settling in of refugees, and rebuilding a country after a war.

Up to now, decarbonisation has not been so complicated as these examples. Companies made choices of which direction to go and pursued it. But from now on, it will get more complicated, as demands to decarbonise get more demanding and harder to achieve, and decarbonisation objectives increasingly clash with other organisational objectives such as profitability.

## 3.4 A digital-awareness- decision model for your home

Think about what a digital-awareness-decision model might look like for your own family household. The daily decisions could be choices of temperature for a washing

machine, whether to take showers rather than baths, temperature of central heating in different rooms of the house, whether to holiday by aeroplane or train. There can be longer term decisions - the size of the house and accessibility by public transport, and whether to put in more insulation.

The factors which matter here will be different for every family, in the same way that the answer of whether to wash clothes at 30 degrees or 50 degrees – and why - is different for anyone you ask. So, off the shelf software is unlikely to help much.

For example, you might buy a digital central heating system which lets you switch on your heating from your smartphone before you arrive home. But actually, your house is small and well insulated enough, and not particularly cold, so it only takes a few minutes to heat up. It is OK to switch the heating on when you get home.

Some decisions will come down to your personal preference rather than because of any data, such as whether to own a car or fly long distance on holiday. In this case you won't want digital technology to help.

But other home decisions are more complex, and higher energy costs, or desire to decarbonise, will make them more so. Can you achieve an adequate comfort level from your heating but use less gas? Can you combine a family holiday with a work trip to reduce your flight emissions? Is it worth spending money on insulation, heat pumps, solar panels, and other methods which need considerable investment but not necessarily much gain?

Can you get the same level of cleanliness on your body with a shorter shower? Can you get adequate cleaning of your clothes at a lower temperature, or does it depend on which stains or which colours? What is the impact of handwashing dishes over a dishwasher? Can we do more to stop teenagers committing carbon crimes, such as putting much more water in the kettle than they need, taking long showers, keeping the door open in winter? If we still want a car, can we use it less?

If we are considering a loft extension, what would that mean to our carbon numbers, with more space to heat, more heat escaping through the roof, and purchases of steel and other materials?

Ultimately, could we develop tools to support decisions to reduce our family emissions by a continuous 3 per cent a year, as industry will need to do?

We probably would not want to pay for sophisticated digital technology to help answer these questions. But there are industrial decisions which are very similar in nature to our household questions but on a much bigger scale.

The bigger scale of industrial challenges, compared to home challenges, means that the savings justify the technology investments. Such as digital tools to calculate the minimum temperature of water and time required to clean a tank which has held a certain chemical, so it can be used to hold another chemical without contaminating it.

## 3.5 What situation awareness and transparency means in decarbonisation

Situation awareness, when decarbonising, at a basic level, means this. Knowing what we are emitting, knowing how to reduce it, and knowing about whether our efforts to reduce emissions are working.

Situation awareness also means knowing if we have sufficient knowledge. Is there a possibility of a methane leak we don't know about, or if our machines could be operating more efficiently than they are now. Do we know enough about whether our people are doing what they should be doing to decarbonise and have the necessary skills.

Most organisations don't know fairly basic things about their carbon emissions, such as how much of their heating bill is spent heating empty rooms, or how much could be saved with a small investment in insulation.

The organisation's external stakeholders demand 'transparency'. This relates to situation awareness, but the word usually refers to the awareness of people outside

the organisation. Transparency doesn't mean making all your data public. It means being able to make awareness available to people with a legal right to see it, such as regulators, or people you choose to make it available to, such as customers.

Perhaps external people can use the same digital technology and models as people within the organisation, although with different access rights.

Someone 'consuming' the data, such as a bank, investor, or regulator, can drill down into the data to see where the numbers come from, which data is estimated, how the forecast is made, and if there are data sources which might be missing. This can go all the way down to the granular data collection or live sensor data.

This could replace the need for auditors. If it is easy for everyone to see and understand the model, and see the data going into the model, we don't need to hire people to check the models for us.

Ultimately there could be smart contracts connected to this data, if people trust it enough to have a charge or benefit directly calculated from it, such as the interest rate on a loan.

As of 2022 carbon data is arguably becoming less transparent. We have software products which do not show how any numbers were calculated, and a maze of reporting schemes which make it hard for anyone to work out if the right emissions data has been included.

## 3.6 What good decision making for decarbonisation could mean

Making good decisions related to decarbonisation requires knowing the carbon implications of any decision we might make. This is different to knowing what the emissions currently are.

Which spending or investment, or other changes, will best reduce emissions, while keeping costs manageable, and while not impacting the quality of services provided? Or if there

is an impact, can we make sure it is a small one, or one people will accept?

There may be plenty of suggestions already which need to be assessed for their costs or other impacts. If we have multiple choices of similar projects we can do, such as upgrading equipment, can we assess which projects are the best use of people's time?

The tighter the budgets the harder decision-making is, because that makes it more important that no changes have a big impact on spending or revenues.

Having made a decision, it needs to be implemented. This also involves planning, sharing, communicating, and monitoring. There may be other elements changing at the same time, so you need to monitor if this means a different decision needs to be made.

Here are some more examples of complex decisions involving carbon, which digital modelling might support.

Will you decarbonise all of your operations, plants, or vessels at once, or have one where you invest in 'zero carbon' while the rest continue as usual, and how far will that get you?

What decarbonised fuels can you expect to buy or sell over the next decade, and how far can you predict how markets will evolve?

How high do you project carbon prices to continue rising, how far do you project other climate related legislation to tighten?

If you beat the competitors in your sector on decarbonising, does that give you preferential access to investment, and what is that worth?

Do you plan for new products and services your company can offer or buy, such as zero carbon steel?

Do you have an opportunity to make use of CO2 sequestration and what are the costs and benefits of that?

If you are providing CO2 sequestration services, how are you monitoring CO2 is staying where it is supposed to stay, and you have sufficient time to act if you are concerned it might not be?

## 3.7 How models can help support alignment between different groups

The models-based approach can help achieve alignment between different groups on the way forward, because it makes it easy to understand why a path is being chosen and the play-offs involved.

Everybody can understand a model, so long as the granularity is low enough, so that it does not require much effort to absorb.

Here are some reasons why different people might prefer a different path to decarbonisation. Engineers might be most interested in a problem they can optimise; tech people might be most interested in a tech solution to a problem; environmental enthusiasts may only accept the lowest possible carbon solution and unwilling to accept nuclear power or carbon sequestration. Customers may want decarbonisation with no impact to their quality of service or costs; investors may want to invest in a company they perceive to be good at 'ESG' but probably without affecting investment returns.

Alignment from modelling only works if people are already agreed on the goal. If they are not agreed on the goal, modelling cannot help. But most people are agreed on the need to decarbonise, they just may disagree on the means of getting there.

The model can be a framework for people to discuss the pros and cons of different approaches. Then it can show why a certain approach is the best way to decarbonise given the constraints on the business.

The person who builds the model can also have a role of explaining to people how it works.

If necessary, they can refine the model so it can take different factors into account.

There are often debates about carbon data between a company and its stakeholders. For example, where external users of carbon data accuse a company of providing data which is incomplete, inaccurate, based too much on estimates. They say it shows only a picture of the past rather than the future or say that the assumptions the data is based on are wrong.

We can imagine a world where adults can have a mature debate about what data should be provided and how, whether the data is acceptable, and what the assumptions should be. But that is only possible if everyone understands the model behind the data and is able to discuss it, rather than the model being hidden beneath complex reporting schemes and software.

If someone believes that another emission source is 'material' and ought to be measured rather than estimated, or included rather than not included, it can be added easily, in our ideal scenario. For example, they may want the carbon footprint of a building to include carbon emitted to make steel used in building construction.

The model itself can be shared, so it would get very easy to understand how someone else's data was derived and have trust in it.

The data 'consumers' don't need to read code, but they can see how numbers were calculated, because they can understand the model.

## 3.8 Emissions management software is not evolving like this

Digital software products for emissions management or decarbonisation, as of 2022, is not evolving in a direction like the one described in this book.

Emissions management software is usually designed to support data and reporting, rather than decision making.

When companies are asked to provide carbon data to customers, banks, or regulators, reporting functionality is useful. But reporting is not the same as awareness, which is needed to make good decisions. So, the software does not do so much to support good decision making about decarbonisation.

The software products contain models. But they are models designed by the software company, hidden within the software. We see the forms to collect data and read the result on dashboards and reports, but don't see how the models work.

The software may have been designed to solve a specific 'use case', but it's not your company's use case, unless you commissioned the software to be built just for you. But every company's decarbonisation challenge is different.

To illustrate this, consider how every person and family thinks and decides about activities which drive their energy use and carbon emissions in a different way. Such as decisions relating to power consumption, central heating, commuting, holidays and purchases. Industrial situations are similarly diverse, with different emissions and different reasons why people continue to make them.

The 'one size fits all' software model only works in circumstances where many companies want to do exactly the same thing – such as financial accounting, maintenance management or e-mail communication management.

When the technology industry gets involved in decarbonisation, it seeks to use the tools it already has, to gather, store, analyse and present data.

But this 'data' is not actually decision-making information. It doesn't explain how the world works. In the same way, your bank statement tells you something about your finances, but it does not tell you how your finances work, or how your company works.

The marketing part of the IT industry wants to emphasise its achievements.
While its achievements have been huge, it has not managed to replace people. But the marketing tends to de-emphasise the role of people.

However advanced the technology gets, people will still be needed to annotate machine learning algorithms, write software applications, explain to computers how the world of carbon emissions works, and interpret the data to make decisions.

# 4 What the model would actually look like

## 4.1 A decarbonisation model described with natural language

A digital-awareness-decision model does not necessarily need to include any code itself.

It could be a description of how we will put together existing digital technology products, or work with existing data.

Think of the processes you would follow to find the best temperature setting of an industrial laundry washing machine, if it was worth making the effort to make sure it was absolutely right.

You might want to collect data about how much it cost to run the machine at different temperatures, based on when you run it at that cycle, and the electricity meter readings before and afterwards. You might want to record other possible big draws on the same electricity supply at the same time which would show in the meter reading.

You might want to collect data about perceptions of how clean the fabric was after a wash at a certain temperature, or record that the clothes were particularly dirty or had some difficult stain. Finally, you could use your data to know the minimum temperature which would achieve acceptable results depending on the laundry, what it would cost, and what the cost and benefit implications would be of changing the temperature up or down.

That model can be explained in a few lines and is reasonably obvious. There isn't any value from stating or sharing something people could work out themselves.

But in a complex industrial scenario, there are influences on operations which people don't necessarily know exist, let alone what precise impact they might have on current activities or long-term goals. So, a difficulty getting situation awareness.

Consider that we are making a digital-awareness-decision model for monitoring methane leaks in oil and gas production. We can make a design for which sensors we would

use, how we would handle the data, how we would assess the data for the probability that all leaks have been found, how we would share that with others, what we would do if we do find a new leak, and what financial impact any leak might have, such as impact on bank loan interest.

We might be making a digital-awareness-decision model for deciding how to prioritise upgrade or maintenance of our fleet of motors, taking into account changing costs of equipment, labour and energy.

That could all be described in words, or 'natural language', and be worth sharing.

As part of the natural language model, we could describe any digital technology which would work well, such as off-the-shelf software for storing data from multiple sensors.

The model can describe how we can display data on dashboards, run simulations of what may happen in future, and see how future emissions may change based on other changes we might make.

In an industrial situation, the natural language model could describe how we build a dashboard to show our past and current emissions. It could suggest a simulation tool which shows us what our fleet emissions would be like over the next 20 years. It can suggest a 'what if' model, which uses this simulation to tell us what our emissions would be like if we invested in a decarbonisation technology.

It could suggest we link these tools to other financial planning tools and so tell us how this changes our estimated future profitability or legal compliance.

The model could describe how the simulation might be done, such as with a spreadsheet, an algorithm, or a Monte Carlo simulation which runs different versions of the future to find the most likely outcome.

If the model is described in sufficient detail in natural language, any required custom coding is comparatively easy, because a detailed plan has already been made. A carbon emitting company could use its own employed or freelance coders to build it fairly quickly. It would be easy for

someone else to understand how the code works and change it, because it matches the model described with natural language.

## 4.2 Carbon data contextualisation model

A model can also show how certain data can be usefully contextualised. That is, showing how data can be brought together with other data so it shows us something useful.

As an example, the data about how much power your house is consuming is not particularly helpful by itself. But if you also know what you were doing at the time, such as running the dishwasher, you are contextualising the data and making it more useful, such as in working out the emissions from running the dishwasher for a cycle.

Here's a data contextualisation model for the decision of what temperature to run a washing machine. You would bring together data about the costs of running on each cycle, how well the machine works at each cycle, and whether your family members are happy with the cleanliness of their clothes if washed at that temperature. A similar industrial example would be for how to contextualise data to make a decision on what temperature water to clean tanks at.

We can imagine carbon contextualisation models being used as a component of a digital-awareness-decision model.

## 4.3 The potential for AI models

AI is a form of modelling but about computers getting insights themselves. When we think of AI based decision making, we are usually thinking of the rare or possible future industry scenarios when computers can make all the decisions.

For most of real life in 2022, we still have people making decisions, because the uncertainty levels are too high for computers. But AI could have a role in a digital-awareness-decision model if it is helping people get a better awareness.

In the decarbonisation domain, there have been ideas for AI tools which could spot something different happening in a

big data set, such as one motor consuming more power than all the others. Or AI could spot that a certain operational task leads to an unexpected increase in emissions people are not aware of.

## 4.4 Trading against emission reductions and blockchain

An idea being discussed in 2022 is that there can be financial incentives or schemes attached to reducing carbon emissions which are automatically triggered under 'smart contracts'.

Company A wishes to spend money on reducing emissions as a kind of offset scheme. Company B invests in reducing emissions. It receives a payment from company A when this is achieved.

Because there is a lot of data manipulation involved in emissions, trust is achieved by making transparent models, where company A can see exactly what data company B is collecting, and how they calculate their emission reduction from it.

This step can be taken further by making smart contracts, with data in a blockchain, so there is no possibility for company B to tamper with the data, and company A automatically pays Company B for 'offset emissions' when data shows the emission reduction is achieved.

It sounds very convoluted, but some people see this as a pathway to a business – it gives both companies something they want, and there is trust between both parties, that the data is correct, and the payments will be made.

This is a form of digital-awareness-decision model, but the decision is programmed to happen automatically based on the digital system having the awareness. In this example there are still people who need awareness, but their role is to provide oversight over the decision rather than making the decision.

## 4.5 Data models are not digital awareness models

Many technology people hear the term 'models' and think it means data models, which is something they are already familiar with. So, it may be useful to show that the

concept of digital-awareness-decision models presented here is not the same.

A data model is purely about the data. How it is managed, quality controlled, stored. How one data field relates to another. A data model can be rigid (such as in a spreadsheet or relational database model) or more fluid (such as a graph database). A data model is essential if two pieces of software are going to work on the same database or connecting through standard APIs.

For the washing machine digital-awareness-decision model described above, the data model might have data for multiple washing machine runs, each with a field for the wash temperature, the wash program, electricity meter reading before and after, and perception of quality of the wash.

This example is simple enough that having a data model is sufficient. But if there are multiple complex factors in the decision, such as with the methane emissions or shipping examples in the next chapter of this book, the data model itself will not be able to describe them and may be too rigid to hold the continuously changing data shape.

## 4.6 Data analytics is not about D-A-D models

There's an important distinction between data analytics and digital awareness decision models. Data analytics is generally a one-off process, while decision making is something which happens continuously.

If we have time to send our data to a data scientist to work out what is going on, then we don't need a D-A-D model. The data scientist is working that part out.

But decarbonisation decisions are, or increasingly will be, continuous. There may be big questions which are suited to sending data to a data analyst, such as whether to electrify a railway line, or why a certain product is seeing problems. But decarbonisation will increasingly be considered as part of every decision we make every day.

There are also cases where the main challenge is to have the right information at the right time, not something a data analyst would typically help with.

For example, in your home, the most useful digital technology for carbon might be one which gives you continual awareness of how much energy you are consuming. This is a tricky digital task but not one which involves analytics.

If you make the same decision all the time but the data changes, then a standard analytics model might help. This can be developed by a data scientist, put into a model and embedded in software.

Data analytics can only work with the data available. As a human decision maker, you can combine data from a digital system with data in your head or data not available in digital form.

For example, you may have sophisticated analytics on your smart meter data, but the analytics would not know that you just bought garden furniture made in China at a large carbon cost of manufacture and transport, which has a big impact on your household carbon footprint.

## 4.7 Why D-A-D models might not get built

From a technology perspective, the main reason why digital-awareness-decision models might not be built is the challenging commercial aspects.

The easiest way for software companies to make money is to make a product they can sell multiple times to multiple people in the same form. They add all the functionality different clients might want. They sell it on the basis of these promises. This is also what technology investors are looking for.

Digital awareness decision model software would need to be built for specific clients, who probably would not know exactly what they wanted at the outset, or what they want to pay for it.

But once they do know what they need, perhaps they find that the technology itself is already available as free or very inexpensive components. Like someone working out that the best way to manage cybersecurity is using the anti-virus software provided free with Windows.

Another problem is that the idea of decarbonisation being made through better operational decision making is not widely accepted. People largely think decarbonisation is achieved through going in one direction rather than another. They think the challenge is creating enough incentive to push people to go the way you want them to.

Lots of people make money from the current way of looking at this, including software companies, consultants, auditors, even environmental campaign groups.

# 5 The challenges of decarbonisation from an emitter's perspective

## 5.1 Introduction

If you work at a company which emits carbon and wants to reduce this, your perspective is different to that of a technology company. Your goal is to reduce emissions, not sell technology. As the buyer of technology, you have power to define the market, so long as you know what you want.

To reach net zero by 2050, you want to aim for continuous steady improvements of a few percent a year in carbon emissions.

Digital-awareness-models can support you in getting there. It may involve collaborating with others. Here are some examples which show more specifically how it can work, and how the concept can help.

## 5.2 Emission decision making model for fuel providers

For a fuel provider, such as an oil and gas producer, let's look at what a digital-awareness-decision model may look like.

From an external perspective (transparency) your customers want to know how much emissions were made in creating the fuel, and how much emission they make themselves in using the fuel. Your investors want to know the emissions which result from the investments they make in your company.

Digital technology could help provide your customers with data about your various fuel products, the emissions in making them and the emissions from using them. It can show how this is changing over time, as you decarbonise your operations in fuel production. There can be a tool to help them calculate their emissions based on how they are using the fuel.

From an internal perspective, you have a company goal to gradually reduce or eliminate emissions from producing and using fuel. Ultimately you want to reach net zero, where

the only products you sell are decarbonised, such as hydrogen, ammonia, or electricity.

Getting there gradually will involve play-offs with costs and volumes. You might provide your customers with a range of options from high carbon to low carbon, at different prices and availability levels.

You need internal awareness of the full emissions involved in making the fuel, including from your own suppliers, such as a drilling company or shipping company. This will involve some estimates, and the digital tool can tell you where these estimates are in your overall data, how big they are, and if you are succeeding in gradually replacing estimates with measured data.

You and your customers can drill down into any number to find out how it was calculated and what the assumptions were. The digital model is fluid and adaptable, so you can add in new data sources as they arrive. You can add in new emission sources, as you get more requests to include them, or discover that they are material.

If as a fuel provider, you are involved in CO2 sequestration projects, either for yourself or for a client, these can be included in the data. The model helps make it clear how they are accounted for.

Technical suggestion: perhaps a fuel provider, also providing CO2 sequestration as a service, could include this in its 'value chain emissions' (Scope 3) as a negative. This could offset positive emissions from customers in its value chain emissions calculation.

## 5.3 Emission decision making model for a shipping company

For a shipping (maritime) company, a first step is to count the most important emission, which is the emission through the ships' exhaust. This can be calculated from the fuel consumption.

Then it gets harder. This is just one of the emissions involved in operating a ship. There's also emissions from power generators onboard, making steel to build the ship, flying the crew to the ship, producing and transporting the fuels to the ship, and melting down the scrap steel at the end of its life for recycling.

You don’t need to count all of these emissions to begin with, but you need a system where you can gradually add in more data as you have it. The granularity required in your emission calculation will continuously increase.

Then you want to better understand the ways that the main emission can be reduced. For example, to know if the ship’s drag through the water is increasing and so the hull needs cleaning.

You may want to assess different possible steps to reduce emission, with simulation and decision-making tools, also showing other side-effects. Reducing speed may reduce emissions but may not reduce the emission as much as you expect, due to reducing efficiency of the engine at lower speeds and may lead to higher costs because of longer voyage times.

You may want tools to help answer questions from customers. What happens if a customer demands that you run a vessel at high speed because they urgently need the delivery, but your emissions go up? Can you see how far they will go up, and will that cause you further implications, such as making the vessel’s emissions for the whole year higher than regulation allows?

You might want a decision-making tool for managing the whole fleet of ships. Perhaps what is most important is the emissions from all your ships, not the individual ships. Perhaps it is more cost efficient to have one high cost zero carbon vessel and run the rest as normal, rather than try to reduce emissions from all of them.

You might have to make decisions about new build ships. How do you weigh up the reduced emissions from operating a more efficient new build ship, plus emissions from building the ship and scrapping the old one, compared to continuing with the old ship you have? And perhaps your customers only care about the emissions from the voyage, not the actual shipbuilding?

You could make investments into the ships themselves, including more efficient power generation onboard, generating power from surplus main engine energy, or doing hull cleaning more often.

Or make a decision to have a larger ship on the basis that the cost per tonne of cargo is lower, but balance this

against increased difficulty finding a customer with a larger volume of cargo to move, and carbon emissions and costs if the ship is idle for longer.

Then there is the day-to-day decision making, about routes, speeds, maintenance, cleaning temperatures. Can you do your normal operations at 20 per cent less energy input? If you go at a slower speed, but the ship takes longer, how does that change your emissions and your revenue? Will customers accept it? Perhaps day to day decision making is more important over the long run than the big decisions.

The day-to-day decision making also maps into many different job roles in the company, including crew, technical management, and people who work with charterers (customers who own the cargo). They all need to see their own version of carbon data, simulation, and decision models, and it all needs to fit together. There needs to be a way people can resolve disagreements – from all looking at the same model and understanding the play-offs from different perspectives.

The shipping industry customers, investors and insurers will want to take this data into their own models. They want to get a sense of the overall emissions associated with ships they are working with, and if they are going up or down. So, shipping companies need to make this data available in a format they can work with.

Many investors, banks and customer groups have their own targets, including a commitment to be 'Paris aligned', such as for their own emissions progressively declining over the next 30 years to zero.

## 5.4 Leading and lagging awareness models

In decarbonisation, we want to know both about our past and our future emissions. Past emissions is what we put in our reports. Future emissions change depending on the decisions we make today, and the operational and investment plans.

Sometimes people use the terms "lagging indicator" for something which happened in the past, and "leading indicator" for something which indicates what may happen in the future.

These terms may be useful in helping us understand the value of different data. "Lagging" data can be based on decisions you made over a year ago. But it should be actual fact, the emissions you actually made.

"Leading" data shows where you are going, what impact you think your emission reduction plans will have. It can be based on simulation models built on the lagging data. The leading information can include notes on how you plan to improve data such as with increased use of measured data rather than estimates. In future, the future simulation models could be come more sophisticated, such as to include data about emissions from new suppliers we plan to switch to, plans for gas flaring, and results of investments.

Investors like lagging data since it should be based on fact rather than simulation or estimates. But they are actually investing in the future, so it should be the leading data which is most important to them.

## 5.5 Why might this not work?

From an emitter's perspective, it is not obvious why a 'digital-awareness-model' would help, or even what it is.

Building these models is very difficult – it may involve gathering perspectives from different decision makers in the organisation, spending time with them to work out what their needs are, and what information they are working with. It may need a project manager.

This person would need to understand how people make decisions and what information they use to make them. This doesn't necessarily mean senior people; decisions are made by people who make schedules and plans or manage a situation.

People are used to buying software, learning how to use it, getting data out of dashboards, and making reports. Not developing a digital awareness decision model.

They may expect technology to sound advanced and use concepts they don't much understand, like blockchain and

AI. But a digital awareness decision model should be something people can easily fully understand.

# 6 How to make the D-A-D business model easier

## 6.1 Introduction

So, the business model of making digital-awareness-decision models is hard.

Investors and emitting companies do not have a direct commercial incentive to create them.

For technology companies, this does not fit with the standard software industry product or services model, where your customers pay to buy your software products, or pay to have digital technology created or managed.

Emitting companies are unlikely to want to pay someone to build a digital-awareness-decision model, since they do not know exactly what they want, and if they did, they would not want to share it easily with others.

On the other hand, a big and obvious benefit is that digital-awareness-decision models can help decision makers at emitting companies to be able to make continual improvements. They can help investors and customers to choose them, in an environment where the choices of what to do are more complex than A or B.

We can focus on building models only when they are most useful – such as where there are lots of pieces of obscure data, things are changing, there are complex goals, and it is too hard to track them all in someone's head, or in a spreadsheet, but which shouldn't be hidden behind a complex software product.

Here are some ideas how we can make it easier to get going.

Note that most of all, it comes down to you, the reader, to drive this stuff in your own domain. There are millions of different domains of carbon emissions, and they all need their own models. If we are waiting for existing business models to work with this, we will wait forever. We need to do it ourselves.

## 6.2 Funding from emitting companies

A starting point is if companies which emit carbon see it is worthwhile to pay for the development of this. Either through money to software companies, or their employees' time. They get the most potential immediate benefit, if it gives them a stronger story to tell customers, investors, and lenders.

They could pay their employees to be part of collaborative groups to design models, with the members being the actual decision makers on decarbonisation options. This is the normal development process for industry technical standards.

Having a model, and employees who understand it, can be a source of commercial advantage, if it helps a company sell something, or gain investment or lending, they otherwise will not have.

## 6.3 Making it easier to pay for coding

If these models do not involve any new digital technology, for example if they can be described using natural language only, then there is no problem working out how to pay coders. A natural language model may benefit from employing professional writers.

There can be an aim to describe the technology in enough granularity that it can be passed to IT staff or coders, so they have everything they need to buy the technology products or write the code. If there is coding required, then it is less expensive if it can be done quickly and works the first time.

Coding can be easier and more valuable if it is based on established data storage and exchange standards, such as developed by the Open Footprint Group. Coding can be seen as less expensive if the coders are already employed by the emitter company, which has an operational incentive to want the code to be written.

Another way forward is if members of a group of emitting companies together define what the code should do so it

serves all their interests, and then together cover the costs of developing it.

We could imagine software companies and software users collaborating together to work out what a digital-awareness-decision model should look like, and then a software company can get business making a version of it and selling to the participants.

Coded models could be built initially to order for clients who pay for it, but then made available subsequently at a lower cost to others.

Or a digital technology company can provide a small model free and use that as a basis for selling services to set the model up to work in a client company.

## 6.4 Shared model development

From a carbon and technical perspective, the ideal is that models should be developed collaboratively, or good models are then shared with others, because it takes a long time to get a good one.

Sharing a written (natural language) model is the digital equivalent of any professional sharing knowledge about how they work and make decisions. Some things are kept private, but a lot is shared. Like police officers at a conference discussing techniques about how they find the best way to deal with an emerging problem.

The natural language model will appear like a magazine article, conference report or a book, where people describe how they do things, how they understand what is happening and make decisions. The description can include how a digital model would work, without any actual coding.

If the model is written in code, then one approach is for a company to pay another company which has already written a coded model which solves the same problem.

But the company which invested in developing it probably does not want a competitor to be able to use it without any investment at all.

## 6.5 Breaking models into smaller models – then sharing them

A full 'digital-awareness-decision' model can be broken down into multiple components which we could call 'small models'. For example, there could be small models for gathering data, working with data, analysing it, moving it to the right place, presenting it, simulating it, or anything else. Each of these components could be made available separately as a small model.

Small models could be used to process certain types of data, make a certain data presentation, do a certain analysis, or work with data from a certain machine.

The small models can be put together like Lego bricks making a house, a person dressing themselves with different pieces of clothing to make an overall look, or a DJ mixing together elements of music.

These small models can be so simple that they can be shared freely, whilst the user companies pay digital technology developers to do the work of connecting small models together to make a big model which does what they want.

For an example how small models could be brought together to make a big model, consider all the decisions we make in our family life which involve emissions. They add up to a complex picture, but individually they are quite straightforward.

We could have a small model about deciding on the time we switch on central heating and the temperature, the maximum cost of a flight which we would pay to go somewhere, and when we decide something needs replacing. There could also be small models to do simple calculations for us.

A model to answer a complex but fairly common decision, such as whether to tear down a house and build a new one, can be built from small models such as for working out emissions from new steel and concrete, emissions from demolition costs, how the energy efficiency of the new home compares to the old one, and how it all adds up.

Consider a decision tool about the best temperature to use to run a tank wash. The full model would be very complex, but it could be built from small models, such as one to work out the emissions from washing the tank at a certain water temperature.

Technically there are plenty of challenges for a small decision-making model developed by one company to be used by another. You would need to have data gathered and stored in the same way as the person who made the small model for their own use. But there are ways to overcome this problem, such as from using data storage and exchange standards like Open Footprint.

## 6.6 A models / small models classification system

In a world with many different small models, we would need better ways to find out about the models available to us. We can imagine a classification system for small models which would help us find the most useful one quickly.

Models can be classified according to the domain, but also to the point in the digital-awareness-decision process that they serve.

We could classify models by whether they support immediate term, medium term, or long-term decision making for a particular domain. Immediate term could be about the heating settings, medium term about investing in equipment, long term about big asset investments.

If we are making models to simulate the future, short term means to work out what impact we might have today, long term means whether we are going to hit net zero by 2050.

There can be short, medium and long-term 'data prediction models', where short term looks at today, and long term is our predictions for what our emissions will be in 10 years' time based on the data we currently have.

We can have a category of 'operational models', which can be used to support operational decisions we are making today, taking carbon, financial, and any other relevant factors into account at the same time.

## 6.7 Why it might not work

If a company has built a software tool to support a certain decision-making process, they will be reluctant to share it freely. They will want to add to it, build promises around it, and sell it as a 'solution' which can provide a range of different services to a client easily.

By comparison, the businesses of making software products, carbon consulting and audit have clear commercial models. People know what they are making and buying. It serves a perceived need.

Nearly all of the people working in the field of data and emissions are engaged in an organisation with a business model like this. They will not be too keen to change.

There are not many advocates for 'awareness' as a goal.

# 7 Whatever happens, we do need to understand our emissions

But the only way for decarbonisation to be achieved in our world is if people can understand emissions and be able to make decisions which lead to them being reduced.

People need to be able to build models and stories in their minds about what affects what, and how an activity can end up with less carbon emissions at the end, while delivering what is expected.

If we can't understand and improve our emissions, we can't fix the carbon problem. We may just end up moving emissions to someone who is doing less thorough measuring.

The pathway forward described in this book offers more than making digital models. It supports learning and skill development and can lead to interesting employment. Ultimately this approach will beat the current digital technology model, even if it takes a while.

This may be something you want to do yourself. If you can see how this can all work, you can be part of getting there. And maybe you are not so bothered or tied to the status quo.

You can start by picking a domain for model building that you know about or are interested in, where you see situation awareness is lacking or confused, or relying too much on old digital technology business models to solve. Make models, describe how they work and share them. Get building and help companies to find better ways to continually decarbonise.

This book gives you the direction and space to see how you might be able to do it.