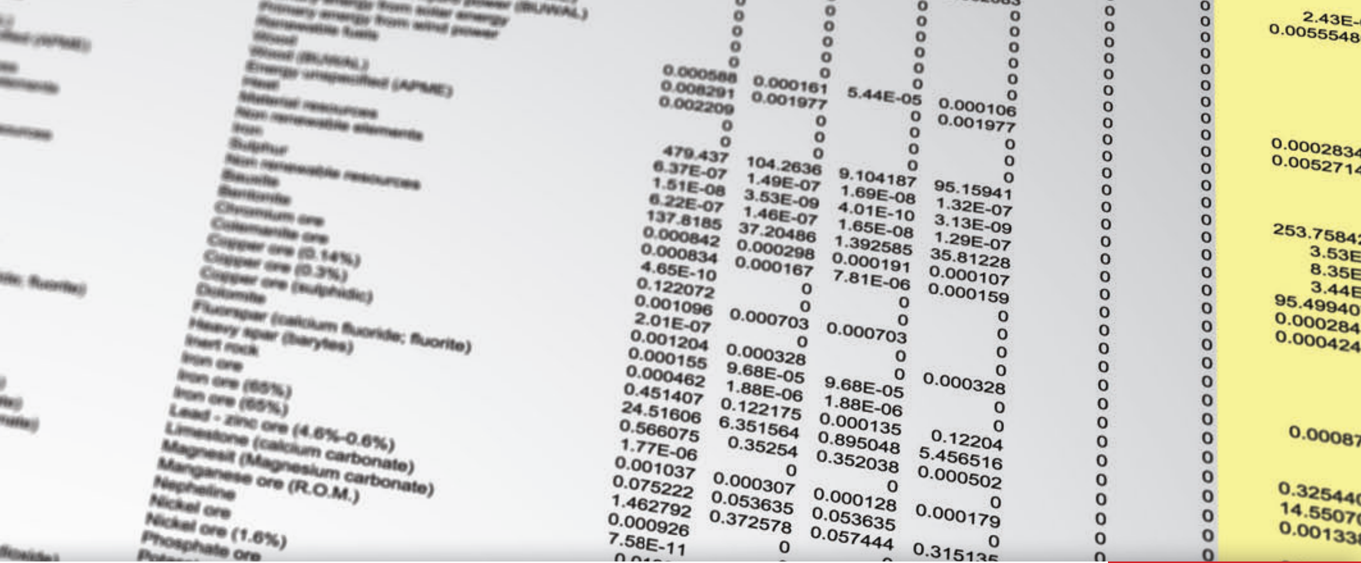


PROJECT :

Life Cycle Thinking

TITLE :

The Role of Inventory Analysis in New Zealand

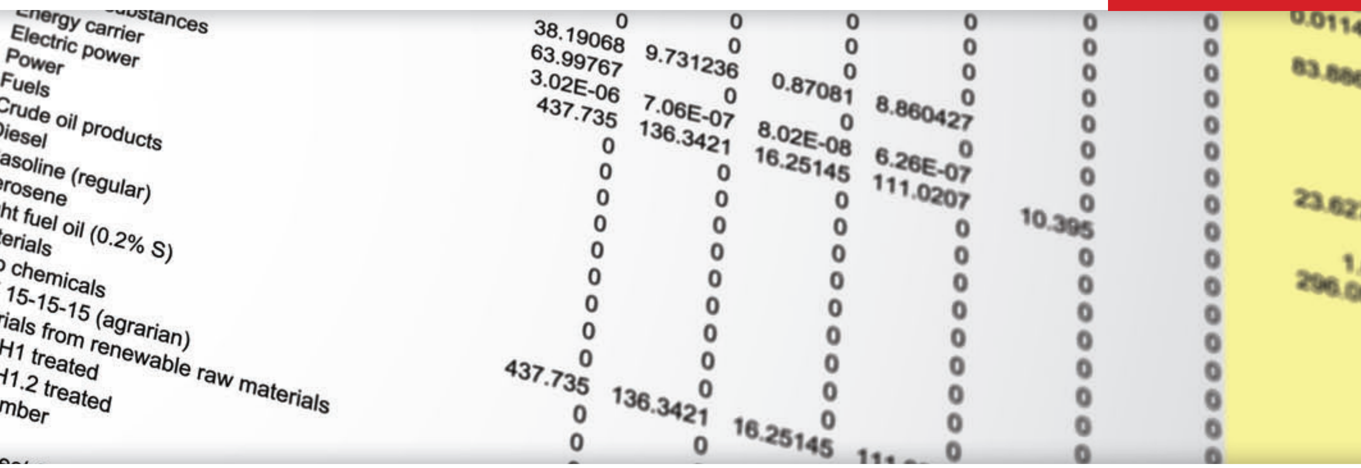
CLIENT : MoRST / MED

PROJECT CODE : 5301-02

DATE : 29/08/08

AUTHOR : Timothy Allan

KEYWORDS : Life Cycle Inventory, Life Cycle Assessment, Life Cycle Thinking



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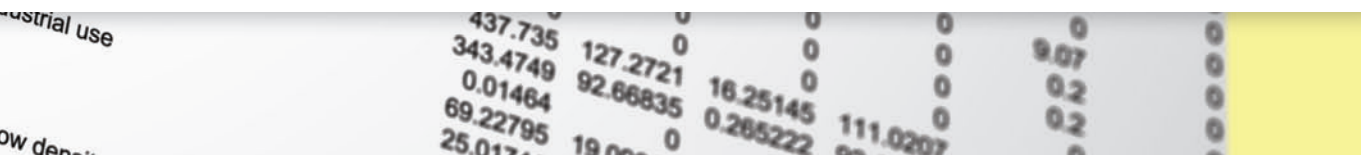
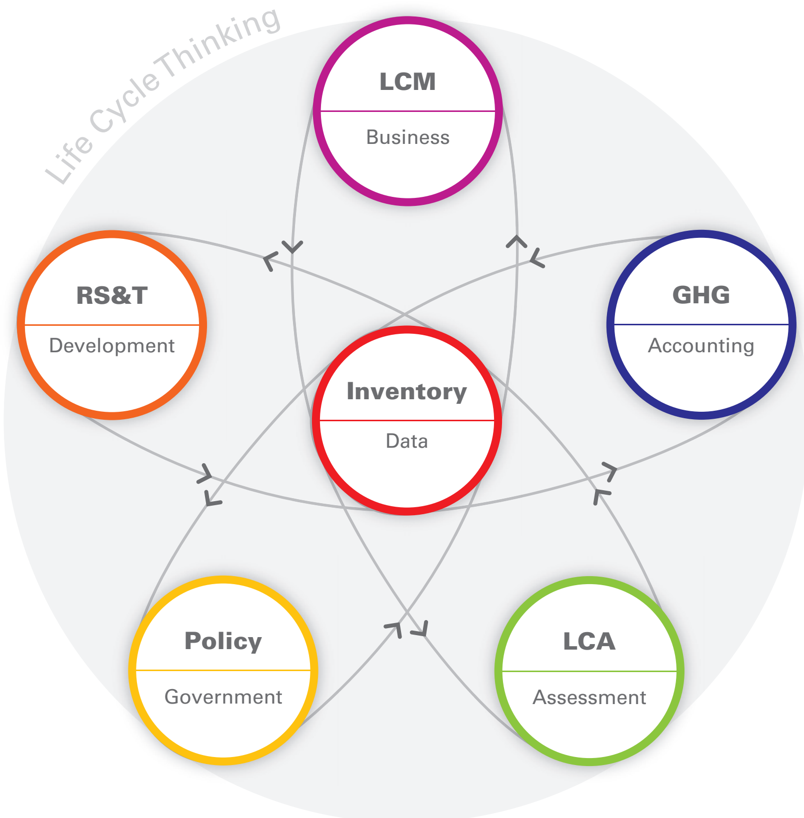


Life Cycle Thinking

Figure 1. The Role of Inventory



Introduction

'Life Cycle Thinking' refers to the development and analysis of product systems (which includes both products and services) by looking at the inputs and outputs of materials over its life. Life Cycle Thinking is the over arching principal which encompasses a wide range of approaches, methods and tools.

Currently there is a strong interest in the government sector surrounding the concept of 'Eco-Verification'. Eco-Verification can be defined loosely as the research, creation and communication of objective and quantitative metrics relating to the environmental impact of products we produce.

These discussions have resulted in some key areas or gaps being defined. A particular gap around Life Cycle Inventory (LCI) methods and parameters has been defined by the Ministry of Research Science and Technology (MoRST) and the Ministry of Economic Development.

This report investigates the application of Life Cycle Inventory (LCI) or Inventory Analysis in the New Zealand context. It sought to understand current activity and isolate key issues and opportunities which could be used by government, research and commercial stakeholders.

LCI has a number of key steps which impact on the creation of an effective data set that can be widely used. Some of these steps offer opportunities for a homogenous approach while others are too context specific and dependent on the goal and scope of a particular study.

Insights

There are a range of issues confronting Life Cycle Thinking in the New Zealand context. Inventory plays a central role in the application of Life Cycle Management (LCM) in business, as firms undertake LCA and GHG assessments, in RS&T and in policy development by government.

Inventories require ongoing maintenance and research to retain their currency and usefulness, indicating a more interactive approach needs to be taken to creating, maintaining and using key datasets and research.

As an emergent discipline, capability is still developing in this country and needs a 'national interest' approach. This would ensure a consistent spread of practitioner-focused education, and ensure efficient practices build up and retain the confidence of industry and business communities, as well as consumers. There is also a wider case for education around what Life Cycle Thinking can deliver for New Zealand firms and industries, to help them 'manage the expectations' of their stakeholders, customers, supply chain partners, regulators and social stakeholders.

Position of LCI

LCI or 'Inventory Analysis' was developed in the context of the Life Cycle Assessment (LCA) framework. But it is now used by other distinct fields such as greenhouse gas accounting, eco-labels, product development and even governmental policy. Figure 1 presents one view of some of these key relationships.

Impact on SMEs

The creation and maintenance of data at an individual company level can be very difficult without specialised staff or guidance for existing staff in an enterprise. This is a particular hurdle for SMEs, who can be faced with a disproportionate cost relative to their business scale. The challenge becomes very real and present for SMEs as the rollout of carbon labelling gains momentum in European markets.

The development of carbon labelling schemes such as the Publicly Available Specification (PAS) 2050, developed through British Standards International (BSI), requires constant monitoring at a national level to ensure New Zealand is able to contribute cohesively to, and proactively deal with, the outcomes.

Taking a sector level approach to data collection and creation can reduce the burden on individual companies, while providing credible data to instigate emission mitigation measures.

New approaches

It is likely that new methods such as Economic Input Output Analysis (EIOA) are going to increase in importance as a viable way to achieve life cycle thinking outcomes.

EIOA differs from LCA in that it is 'top down', using general economic data instead of detailed process data. EIOA offers some exciting potential to deliver similar results to LCA but comes with some limitations through its use of data averages and research-based assumptions to define and allocate impacts.

Understanding and developing skills in such emerging methods is a valid priority to pursue alongside existing methods (such as LCA), and would ensure New Zealand develops strategic capacity and understanding in new areas.

Data

Primary sector data in New Zealand has been effectively researched and collected over an extended period of time.

This was originally collected up to the farm gate, but has progressively moved to incorporate data from processing and distribution to the end consumer as concern about climate change has tracked through supply chains.

Practitioners have noted that some research has become outdated and may need to be replaced in key sectors where New Zealand industry needs to maintain its momentum in impact mitigation to secure its world market. Research can underpin decisions made in the LCI process and is as important as data collection. Defining what key research areas need to retain their currency is considered an important aspect of the ongoing maintenance of inventories.

There are a wide range of research projects and initiatives currently underway in the private and public sector. These are often not communicated effectively to a wider group of expert stakeholders and therefore do not promote and encourage easy access to the findings or lessons learned. Making this information transparently and centrally available through an online community would provide an effective body of knowledge and discussion on key topics.

It is probable that at least some, if not all, of these projects use common data (for instance energy and vehicle emissions factors) that could be useful to others. At present, there is no unified approach to the cross-sector creation and maintenance of important datasets, which leaves the way open for inefficient behaviours such as duplication, variation and inconsistency of interpretation of the same data.

Establishing a unified register of all New Zealand specific LCI databases and maintaining up-to-date knowledge of their status is likely to foster sharing and collaboration.

A unified NZ LCI dataset register could document both private and public datasets without compromising confidentiality. This would promote the commercial exchange of information between related industries and sectors.

Critical sectors on which many other industries depend (e.g. energy) could be compelled to provide current data on an ongoing basis for the common benefit.

There is an opening for industry to contribute aggregated (sector-body level) data and find ways to fund such an initiative alongside research partners. If these datasets are made more freely available this would directly reduce the cost to undertake LCI and LCA work, thereby reducing the barriers to entry for smaller firms.

The format of common or publicly available databases should be kept open through the use of the most prevalent interchange format, XML.

This data would need common data collection information (ISO14048) to indicate which parameters are essential to reference in the creation and use of pooled datasets.

An example of this approach exists in the Australian Life Cycle Inventory (AUSLCI) initiative whose aims are to *"provide a national, publicly-accessible database with easy access to authoritative, comprehensive and transparent environmental information on a wide range of Australian products and services over their entire life cycle. It will be an invaluable tool for those involved in LCA, as it will also define and develop consistent guidelines, principles and methodologies for the collection of LCI data, along with protocols for LCA processes for different sectors."*

One of the key drivers for the establishment of the AUSLCI project was the need to create a common approach that would give industry and consumer confidence to the application and use of LCA data.

There is evidence that the New Zealand building sector is moving in this direction with the support of the Department of Building and Housing.

AUSLCI has provided New Zealand an invitation to join the programme, a proposal which would warrant consideration by key stakeholders. Such a decision would require consultation around the small community of practitioners in this country to avoid a risk of creating divisions among them.

A leading practitioner (Alcorn, 2008) has suggested that Statistics New Zealand could collect data on key environmental metrics. This could be a mechanism in some sectors to reduce the individual cost of data collection and might open the way for increased uptake of LCA and other analytical methods, such as carbon foot printing.

Other data collected and maintained by Statistics New Zealand, such as economic input/output tables, could also be reviewed and improved (Andrew, 2008) to deliver more advanced information to those using EIOA and hybrid processes.

To align effectively with government policy and RS&T spending, it is crucial that the environmental data needed for new high growth industries is identified. Without this step, there could be a risk that their entry into new markets is frustrated, particularly in emerging and high technology sectors.

Leadership

The formation and maintenance of a 'Life Cycle Thinking' leadership group drawn from key stakeholders including top practitioners, government and business would provide an effective platform to ensure continual improvement.

It would provide a platform for the discussion of issues and opportunities that exist in the national and international context. This group could also provide more consensus and leadership than presently exists.

Capacity & Capability

There is limited LCA capability in New Zealand.

A few practitioners have a comprehensive understanding of the whole LCA method and the wider related issues that were raised in this study.

This group tends to advise the wider peer group of practitioners about best practice and structure for various studies. This creates a bottleneck for rolling out any substantial studies that need to be undertaken concurrently. It is also a risk to New Zealand's ability to undertake and maintain complex datasets to ensure integrity of downstream assessments. In addition it shifts the cost of education onto research providers, practitioners and ultimately their industrial clients, which further exacerbates the existing resource constraint and the squeeze on sectors and firms.

The absence of any formal tertiary education on LCA or analytical environmental assessment or management (with the exception of the University of Auckland's ICSER unit) provides little incentive for students in science or engineering fields to pursue post graduate study in Life Cycle Thinking.

The 'Life Cycle Management (LCM) initiative', led by Sarah McLaren at Landcare Research, aims to address this lack of capability and capacity by taking six masters students, training them and then embedding them in six exporting companies. In effect up this up-skills the companies in Life Cycle Management. If successful this concept could be extended to incorporate a wider range of companies to accelerate uptake further.

The community of practitioners in New Zealand appears to be grouped into commercial (private) and research (public) arenas. The linkages and collaborations in the public research domain are relatively effective, but the linkages between public research and private consulting appear to be relatively weak. Creating the impetus for life cycle 'thinkers' from all sectors and practitioner groups to get together would increase knowledge exchange and assist in the formation of functional links between the sectors, likely leading to increased uptake.

This report has investigated a wide range of applications and found leading practitioners operating in interesting, innovative, and productive ways. However, their impact on New Zealand industry and on development of the discipline is hampered by a lack of unity. The suggested actions outlined in Figure 2 are some of the steps that could contribute to building up a stronger and more vital New Zealand approach to Life Cycle Thinking that is tailored to our context.

Figure 2. Suggested Actions

National LCI register and common format

Assuming that a data collection policy was instituted, create a national register with consistent data descriptions and requiring data in an open XML format. This would be an effective tool to build a clearer picture of where gaps are and therefore would help to target new research accurately.

Data collection policy

Defining the information that needs to be specified for data collection instituted with government endorsement. This might follow the ISO/TS 14048 outline which already exists.

Code of practice

A government-endorsed code of practice to develop consistency in application. This would provide businesses with confidence that they are employing a practitioner who is using the most current, appropriate and efficient approaches for the New Zealand context.

LCI Co-Funding

Co-funding LCI development would provide practitioners with the ability to reduce the cost burden to companies. This could also be made conditional on the practitioners submitting their aggregated data to a national register and contributing to a wider pool.

Tertiary & Continuing Professional Education

A clear imperative which requires urgent action is the implementation of teaching at a tertiary undergraduate and post-graduate level to educate and train new practitioners and build capability in this strategic area. (Such as the Landcare Research LCM programme).

Establishment of Advisory groups

On Life Cycle Thinking (Incorporating LCA and LCM and other areas), Inventory Analysis, and Impact Assessment, to ensure specific advice on these three critical areas. These groups should be facilitated in such a manner as to involve key practitioners without creating unnecessary work for them.

Establishment of a structured community

To support wider discussion, presentation and learning about life cycle thinking and its application within New Zealand.

Investigation

This research looked at a number of areas that influence or impact upon LCI within New Zealand. The results are detailed in the following pages.

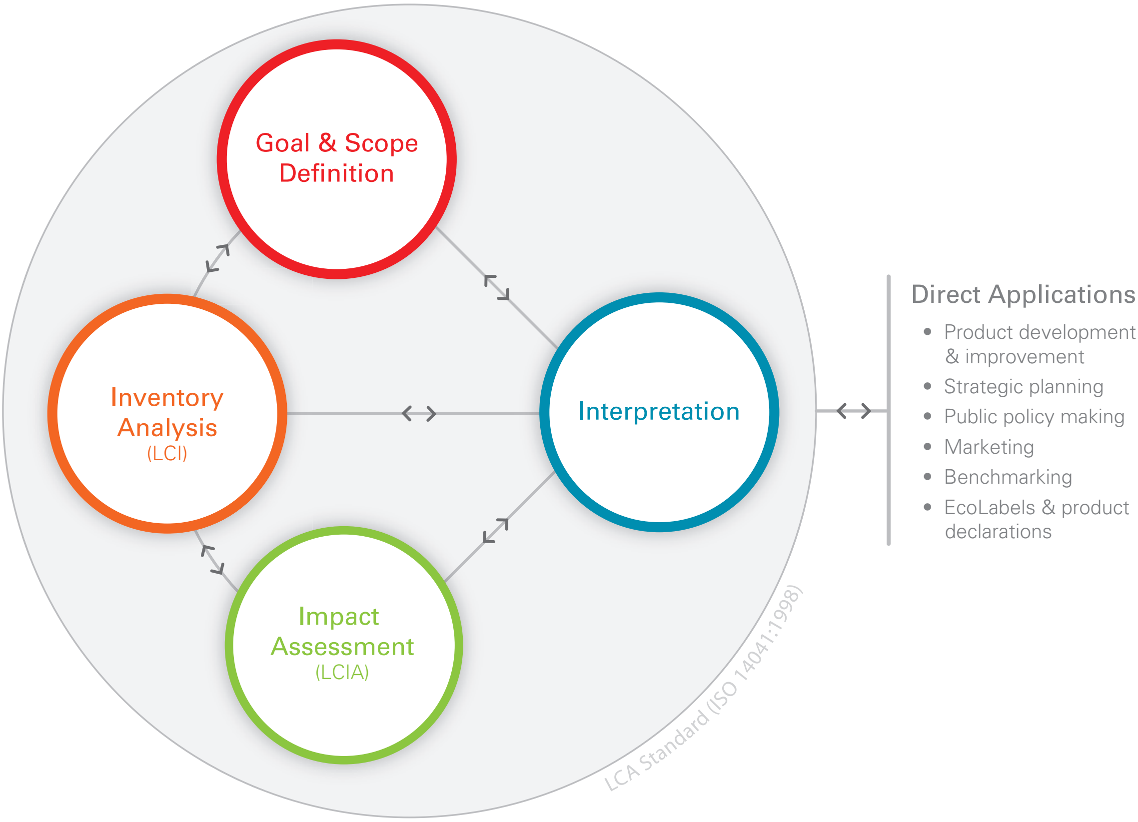
LCA Process

Life Cycle Assessment (LCA) is included here as the LCI Process was created and defined in the context of the LCA Framework. It is therefore useful to discuss the LCA framework and the position of LCI in this.

Life Cycle Assessment (LCA) is a framework or methodology for the quantitative environmental assessment of product systems. It is a structured approach that is defined in ISO 14040 standards. It establishes the context, goal, scope and intent of a study to ensure that the correct aspects of the life cycle are considered along with the appropriate impacts to provide balanced and objective assessment.

The Life Cycle Assessment process is defined as the investigation and valuation of the environmental impacts of a product or service caused or necessitated by its existence. The process has evolved through a lengthy gestation period with the current methodology being finalised in the 2006 ISO 14040 and 14044 standards.

Figure 3. Life Cycle Assessment Framework



The ISO standards prescribe the LCA process and methodology through the following two standards:

- **ISO/DIS 14040:** Principles and Framework
- **ISO/DIS 14044:** Requirements and Guidelines

These standards provide practitioners with a wide range of choices which influence the shape or efficacy of any targeted LCA study.

A standard LCA is defined as being formed through a four-step process:

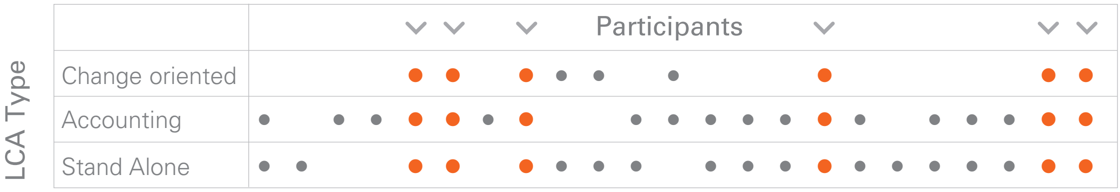
- Goal & Scope Definition: Determining what the aims are and whether these can be delivered in the given scope.
- Inventory Analysis (LCI): Modelling the flow of the life cycle and collecting any underlying data that is required.
- Life Cycle Impact Assessment (LCIA): characterising the impacts and evaluating against the defined impact categories (such as Global Warming Potential).
- Interpretation: Analysing the information and determining whether the aims of the study can or have been met.

Life Cycle Inventory (LCI) refers to the inventory analysis phase of Life Cycle Assessment. LCI is a base step and is an essential part of any quantitative environmental assessment. The LCI is a mass and energy balance of environmental flows (Baumann & Tillman) and as such forms the cornerstone of eco-verification.

The LCI phase is primarily concerned with the capturing, research, creation and modelling of Inventory data related to the inputs and outputs of processes and product systems. There is a separate ISO standard for LCI data documentation ISO/TS 14048. This format is a standard for LCA data;

"This Technical Specification provides the requirements and a structure for a data documentation format, to be used for

Figure 4. LCA Type



transparent and unambiguous documentation and exchange of Life Cycle Assessment (LCA) and Life Cycle Inventory (LCI) data, thus permitting consistent documentation of data, reporting of data collection, data calculation and data quality, by specifying and structuring relevant information".

This study had a focus on the 'Inventory analysis' or LCI part of the process. A wide range of parameters that influence or are part of the LCI process were considered and discussed with participants of the study. Please refer to the main report for a complete list of parameters considered.

LCA Type

To more effectively understand the nature and purpose of the LCI work currently being undertaken these were grouped into LCA types. The three classifications used were:

- Stand alone: Single and exploratory, used to describe a single product.
- Accounting: Comparative and retrospective.
- Change oriented: Comparative and prospective.

The prevalent types of LCA study being undertaken are stand alone or accounting based, therefore retrospective and comparative. These are being used for identifying areas that can be mitigated but are not product development oriented or integrated into the product development process.

Figure 4 illustrating LCA type is also useful in highlighting the number of experienced practitioners from the total pool surveyed. Six practitioners actively practised across all three types indicating a good level of experience and depth in the application of LCA.

System Boundary

The 'system boundary' is largely defined in to the goal and scope of an LCA study. What processes are selected for consideration and analysis depend largely on the intentions and aims of the environmental assessment.

For example a farmer would primarily be interested in considering the impacts up to the farm gate (i.e. one tonne of greasy wool) and the impact to produce this, while the apparel manufacturer would have to take this through processing, fabric and distribution to the end consumer.

Due to its relationship with the goal and scope of a study the system boundary is context specific and cannot be harmonised. It may however be possible to create a consistent 'approach' amongst New Zealand practitioners.

Figure 5. Allocation Type

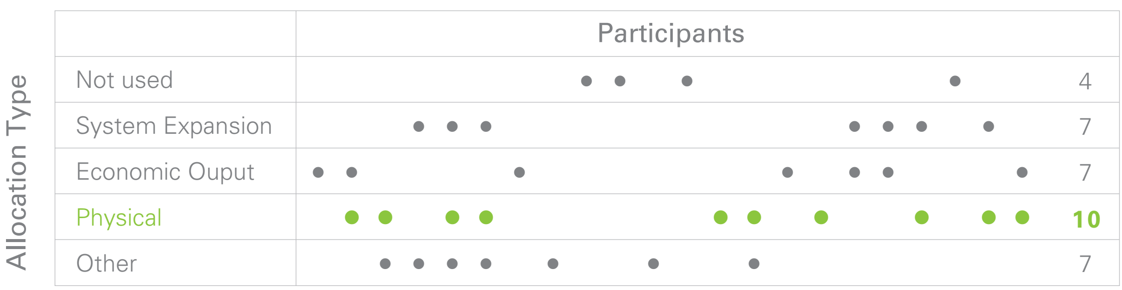


Figure 6. Impact Assessment Categories

Allocation

'Allocation' is defined as "partitioning the input or output flows of a process to the product system under study" (ISO14040 1997). Put in simpler terms many products are linked and share processes and resources. This means that the impact or the burden of the impact needs to be allocated between different products and processes.

'Allocation' provides a framework to do this. An example might be a log which is split into a percentage allocated to milled graded timber and another percentage allocated physically (by mass) to pulp and paper production.

Allocation is one of the most difficult areas in LCA methodology. It complicates the data collection process and can greatly increase the threshold of data required in the given system. Most practitioners surveyed adhere to the ISO standard prescription for the procedure of allocation procedure which specifies system expansion as the preferred method, with physical the next preferred, and economic the least preferred.

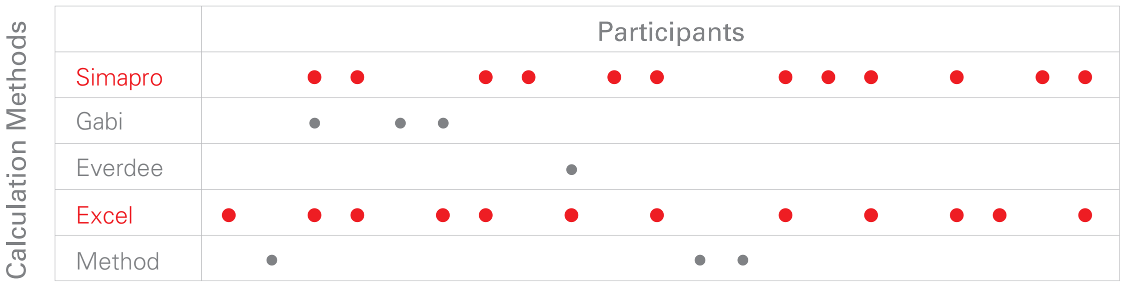
Allocation is an important consideration for inventory analysis due to its potential impact on New Zealand industry. Figure 5 illustrates most practitioners utilise the ISO preferred method of Physical allocation with the more advanced practitioners using system expansion to discover additional relevant details.

Impact Categories

The definition of impact categories falls under the 'impact assessment' (LCIA) phase of the LCA process. Technically it does not have a bearing on the data collected, but the decisions made during the goal and scope phase about what impact categories are used are of interest to this study. It is during this phase that inputs and outputs are related to the environmental impact they have (i.e. CO2 would be attributed to Global Warming).

The ISO classification (illustrated in Figure 6) of impact categories provides three broad categories or groupings; human health, resources and ecological consequences. In the New Zealand context there is an overriding focus on Global Warming Potential and Energy and Materials, with only experienced practitioners working in other impact categories. There are exceptions, such as eutrophication which is an important consideration in pastoral farming.

Figure 7. Tools



Participants noted that the restriction of impact categories through the focus on energy and green house gas (GHG) emissions has impacted on the data collected. This was jointly attributed to budget and the current focus and pressure around climate change. This may potentially lead to a reduction in quality and coverage of the data sets being created, and could limit their potential application in other areas.

Experienced practitioners have stated that the restriction of impact assessment categories should not affect the integrity of data collected, as all critical inputs and outputs should be collected. It would therefore be important to further define what data is being omitted and what steps could be taken to address this issue.

Uptake of Tools

Development of the LCA methodology has resulted in the creation of software tools which enable dynamic modelling of systems.

These tools allow the performance of calculations and visualisations, making the process easier and more streamlined.

The adoption of these tools in New Zealand is patchy, with a range of practitioners still using self-generated Excel spreadsheets, mainly due to the intermittent nature of LCA projects and the capital cost of software purchase (not necessarily that they resist uptake).

Both GABI and SimaPro are advanced LCA software tools with a range of available databases for different industries. A greater number of participants used SimaPro, although GABI has only recently started to be taken up in Australasia, and may develop a greater following over time.

Excel is used across the board for the collation and documentation of data in the inventory process. It is also used in relatively advanced applications, as various research organisations have their own formulas and custom spreadsheets for working carbon emissions.

Some research organisations also used Excel as a tool to prepare the inventory information prior to insertion in an LCA tool. Experienced practitioners using Excel cited the transparency as a key benefit.

Other practitioners said they did not have a requirement to conduct a full LCA so were content with using spreadsheet tools and formulas for completion of data collection and inventory analysis.

The other two tools recorded in use were; Everdee, a free tool created through the EcoSMEs initiative in the EU, and the Landcare CarboNZero programme which has developed its own tool with a built-in GHG protocol.

The intermittent nature of LCA work in recent years appears to have been an impediment to the uptake of more advanced life cycle engineering tools. This is likely to change with increasing demand and the requirement for standardisation.

Data collection

The inventory analysis stage relies on the ‘bottom up’ collection of process data from the production, consumption and disposal of products and services. It is reliant on the quality of research data and hinges on the availability of usable data to form an accurate picture of the system being assessed. The credibility of any LCA results rests substantially on the data’s quality.

Most of the work in generating data in New Zealand has been biased toward the primary sector. As a result, there is a growing body of information up to and past the farm gate to processing.

As markets have become more interested in climate change, studies are increasingly considering the whole supply chain including distribution, use and end of life.

The evidence gathered in this study shows that manufacturing and value-added industries have little New Zealand-specific data to reference. At the same time these manufacturing sectors have increased offshore production which has led to difficulties in procuring environmental information from extended supply chains (McLaren, 2008).

Data quality and availability appear to be variable, with some studies from basic literature research (which may be of uncertain age and provenance).

Most practitioners cite data quality as a serious issue, both in terms of availability and accuracy for New Zealand's context. In addition, they expressed real concerns about the cost of data collection and maintenance, which were seen as a recurrent hurdle cost to both SMEs and even to larger enterprises.

This hurdle is due in part to the requirement for continuous data collection that requires technically-sophisticated methods or devices and specialised staff.

Dataset creation

There are a range of approaches taken by most participants which could be broadly categorised as:

- Created Datasets: researched and created for the environmental assessment
- Modified Datasets: existing datasets modified for a particular application
- Existing Datasets: using existing datasets for a particular application

Most of the advanced practitioners have been, or are, involved in the creation of homogenous datasets, as well as using modified international databases of materials and processes where required.

Datasets that were created ranged from highly detailed studies (direct measurement), to studies which are based solely on research papers. One particular study went as far as collating all material and energy used in the construction of the plant and using that in the final assessment of the product (the capital cost of producing the goods). Most studies would not consider the cost of capital.

Modified datasets and existing datasets are primarily international (originating from the EU or the USA), that are generally linked to, or embedded in, LCA software tools. These databases, such as Ecoinvent, contain a wide variety of materials and processes which enable modelling at a schematic level and in some cases offer detailed levels at which there is parity in application and context.

Data availability

Many datasets are classed as private, which prevents them from being openly exchanged or used for the benefit of other companies.

There are a number of data exchange formats available. The most widely used exchange file format is XML (extended mark-up language). This supports a fast and easy exchange of LCI data into different software packages, such as GABI or SimaPro.

Research organisations often retain the right to use aggregated data for other applications (in their projects). This type of practice would appear to work against wider transparency, discourage openness, and generally encourage a competitive approach.

Some data is published, and is therefore partly available in aggregated form (although not accessible at a detailed application level) and some data is made available on specific request.

Currently there is no central repository for data collection and therefore no easy way to determine if a study has been conducted in the area or if there is other useful data in New Zealand that could be used in other studies.

Currently there is strong interest in the government sector around the concept of 'Eco-Verification', which is, in broad terms, the enabling, quantifying and substantiating of improved environmental performance by industries.

The Ministry of Economic Development and the Ministry of Research, Science and Technology commissioned this publication from authors Locus Research in 2008 to learn more about the activities of New Zealand Life Cycle Inventory (LCI) practitioners, the LCI approaches and methods in common use, and their key parameters.

This report investigates the application of LCI in the New Zealand context to provide evidence about current activities, and to isolate potentially significant issues and opportunities, so that all parties can advance Eco Verification activity more effectively.

Research undertaken by Locus Research (2008)

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