

## Chapter 2

# The Quest so Far—And Why It Has Failed

*The greatest obstacle to discovery is not ignorance—it is the illusion of knowledge.*

Daniel J. Boorstin

So far, the quest has been characterized by either high-profile summits where all the countries in the world, more or less, adjourn to discuss our challenge based on work from researchers, academics and to some extent industry, or by a whole range of less profiled initiatives that are normally more practically oriented. These less profiled initiatives can generally be divided into five groups<sup>1</sup>:

- I. Pollution Prevention, which is also known as waste minimization, green manufacturing, or environmentally responsible manufacturing. The common thread is to *encourage* efficient usage of resources. Legislation falls under this category as do the whole climate debate and the Kyoto treaty in its current trajectory of conformance.
- II. Design for environment (DFE), which deals with how to minimize environmental burdens through design—eliminating the root of the problem at the outset so to speak.
- III. Environmental management systems (EMS), which deals with the tools needed to manage, from an environmental perspective. Here, we can include the ISO 14001 EMS.
- IV. Product stewardship. As with pollution prevention, this is essentially political or strategic in character. Legislation *can* fall under this category such as the Norwegian tack-back legislation of electronics which forces those that sell and produce electronics in Norway to take it back from their customers once the product has reached its end of life.
- V. Environmental accounting is also referred to as life cycle accounting, total cost accounting, green accounting, and full cost accounting. The primary role of environmental accounting is to support environmental initiatives and policies by

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<sup>1</sup>According to Wood, J. C. (1998). Environmental Impacts on Life Cycle Costs. *Handbook of Cost Management*. J. A. Edwards. Boston, MA, Warren, Gorham & Lamont: pp. D6-1–D6-30.

including the costs and benefits that are derived from the effects of the environment on the general ledger. This is therefore essentially a financial reporting and analysis of environmental aspects as they are manifested on the general ledger.<sup>2</sup>

In earlier publications,<sup>3</sup> I have discussed such initiatives from the assessment perspective—cost, energy consumption, and environmental impact—and linked it to design.<sup>4</sup> However, one thing that became apparent after several years of research culminating in my PhD was the difficulty of obtaining information except when it comes to information from the general ledger. This observation is the important input to this book. In this book, however, the assessment side is not discussed—here, the focus is on how to actually secure a more sustainable development by providing a basis for systematic work. The old maxim “what we measure is what we get” applies also in environmental issues but currently it does not work because there is no consistent information flow and the information that is there is often highly politicized and value-laden<sup>5</sup> causing debate and not focus on improvements.

But let us first step back to the beginning; in 1962, Rachel Carson published the landmark book *The Silent Spring*,<sup>6</sup> and it heralded a new time when Nature was no longer seen as unlimited and indestructible. Environmental consciousness became the new mantra for many. A huge amount of research into areas such as sustainable development, climate change, environmental conscious design, EMS, green design, bio-diversity, and pollution prevention have been undertaken since then in addition to the aforementioned high-profile summits around the world. Most of these initiatives have produced relatively minor results and many of them can be classified as cost-management initiatives because they could have been initiated by a normal, cost versus benefit analysis.

There has also been launched a large amount of environmental initiatives, and a couple of them have actually given very good results and been successful such as

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<sup>2</sup>For a thorough discussion, see Keoleian, G. A. and D. Menerey (1994). “Sustainable Development by Design: Review of Life Cycle Design and Related Approaches.” *Air & Waste* 44(May): pp. 644–668.

<sup>3</sup>See;

- Emblemssvåg, J. (1999). Activity-Based Life-Cycle Assessments in Design and Management. *The George W. Woodruff School of Mechanical Engineering*. Atlanta, GA, The Georgia Institute of Technology: pp. 600.

- Emblemssvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.

- Emblemssvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

<sup>4</sup>Also see Bras, B. and J. Emblemssvåg (1996). Designing For The Life-Cycle: Activity-Based Costing and Uncertainty. *Design for X*. G. Q. Huang. London, Chapman & Hall: pp. 398–423.

<sup>5</sup>See for example Liverman, D. M. (2009). “Conventions of climate change: constructions of danger and the dispossession of the atmosphere.” *Journal of Historical Geography* 35(2): pp. 279–296.

<sup>6</sup>See Carson, R. (1962). *The Silent Spring*. Boston, MA, Houghton Mifflin. p. 368.

the global effort to halt and stop the depletion of the ozone layer.<sup>7</sup> This effort, properly referred to as “The Montreal Protocol on Substances that Deplete the Ozone Layer,” which is a protocol to the Vienna Convention for the Protection of the Ozone Layer, is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. According to analyses<sup>8</sup> performed by *The Economist*, this is the single most effective climate policy so far resulting in an effect that is almost equal to the sum of all other policies *combined*. The reason is that the ban is very effective both eliminating the chlorofluorocarbons (CFCs), which destroy ozone (and is also a very potent greenhouse gas) and costing relatively little. The cost of helping out developing countries phase out CFCs was just USD 2.4 billion all told from 1990 to 2010, whereas Germany alone spends about USD 21 billion per year on renewable energy transformation.<sup>9</sup>

Another successful initiative has been the effort in North America to stop acid rain. In fact, the US Environmental Protection Agency (EPA)<sup>10</sup> claims that the Acid Rain Program has the following:

1. Reduced SO<sub>2</sub> emissions by over 5 million tons from 1990 levels, or about 34 percent of total emissions from the power sector. Compared to 1980 levels, SO<sub>2</sub> emissions from power plants have dropped by 7 million tons, or more than 40 percent.
2. Cut NO<sub>x</sub> emissions by about 3 million tons from 1990 levels, so that emissions in 2004 were less than half the level anticipated without the program. Other efforts, such as the NO<sub>x</sub> Budget Trading Program in the eastern USA, also contributed significantly to this reduction.
3. Led to significant cuts in acid deposition, including reductions in sulfate deposition of about 36 percent in some regions of the USA and improvements in environmental indicators, such as fewer acidic lakes.
4. Provided the most complete and accurate emission data ever developed under a federal air pollution control program and made that data available and accessible by using comprehensive electronic data reporting and Web-based tools for agencies, researchers, affected sources, and the public.
5. Served as a leader in delivering e-government, automating administrative processes, reducing paper use, and providing online systems for doing business with EPA.
6. Resulted in nearly 100 percent compliance through rigorous emission monitoring, allowance tracking, and an automatic, easily understood penalty system for non-compliance. Flexibility in compliance strategies reduced implementation costs.

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<sup>7</sup>See EPA, U. S. (2007). *Achievements in Stratospheric Ozone Protection; progress report*. Washington, DC, US Environmental Protection Agency, Office of Air and Radiation. p. 37.

<sup>8</sup>See The Economist (2014a). Curbing climate change. *The Economist*. **412**: pp. 22–26.

<sup>9</sup>According to analyses from The Economist (2014a). Curbing climate change. *The Economist*. **412**: pp. 22–26.

<sup>10</sup>See EPA, U. S. (2005). *Acid Rain Program 2004 Progress Report*. Washington, DC, US Environmental Protection Agency, Office of Air and Radiation. p. 27.

7. A 2005 study estimates that in 2010, the Acid Rain Program's annual benefits will be approximately \$122 billion (2000 dollars), at an annual cost of about \$3 billion—a 40-to-1 benefit-to-cost ratio.

However, when it comes to global issues that cannot be directly legislated in place, we have faced poor results. Why?

If we step back and investigate more what took place during the Industrial Revolution, we realize that legislation that socialized risk in the shape of limited liability laws partly won the day. I believe that there would have been a revolution of some kind irrespective of the technical marvels of the day simply because limited liability took away the risk of imprisonment and so on in case of bankruptcy, and this freed up capital that was already there. The technical marvels, of course, speeded up the transition but did not make a revolution on their own. This was fundamentally speaking a market-based approach—it was the Invisible Hand at its best, thus far.

The problem when it comes to our quest for a sustainable society is that we have not made a system in the bottom that facilitates a market-driven approach. Conformance to politically brokered treaties has been the mantra. With respect to the three aspects of the invisible hand mentioned in Chap. 1)—(1) governance of the economic system, (2) accounting systems, and (3) taxation systems—only taxation systems have been envisioned. Naturally, the bulk of the corporate world sees the quest toward a sustainable future as a cost and is consequently late adopters if not close to rejecters. There are, of course, some corporate leaders that see this as an opportunity such as Ray C. Anderson (1934–2011), Founder and CEO of Interface Flooring Systems who read Paul Hawken's book titled *The Ecology of Commerce*. It changed his life.<sup>11</sup>

Before continuing, I will show why the ISO 14000 standard cannot serve as accounting system as some believe and therefore will fail as link to the economic system. It will also become evident that such approaches are highly value-laden, and this is another problem. Then, we must investigate the root causes of the failure of the Kyoto process so that this can be rectified in a re-engineered capitalist system, which is the main topic of this book.

## 2.1 The Standardization Efforts and Why They Are Insufficient

To every thing there is a season, and a time to every purpose under the heaven.  
King Salomon

Ecclesiastes 3:1

The Coca Cola Company pioneered environmental analyses. In 1969, they studied the resource consumption and environmental releases associated with their

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<sup>11</sup>According to Anderson, R. C. (1998). *Mid-Course Correction*. Atlanta, GA, The Peregrinzilla Press. p. 204.

beverage containers. In Europe, at the time, an analysis technique, later termed “Ecobalance,” was developed. Both were basically an inventory analysis,<sup>12</sup> which is essentially an analysis of an audit. In 1972, Ian Boustead (1939–2011) calculated the total energy consumption of the production of various beverage containers.<sup>13</sup> This can be viewed as the beginning of Life Cycle Assessment (LCA), and it has largely consolidated in the ISO 14000 EMS Standard. There are other systems as well—one is proposed by Society of Environmental Toxicology and Chemistry (SETAC). The only real differences are the choices of impact categories and the weighting schemes. These, and similar approaches, I will refer to as conventional LCA approaches to distinguish them from other approaches such as activity-based LCA.<sup>14</sup>

To help understanding why these approaches have limitations and challenges, I will take you through the ISO 14000 LCA type. The environmental management part of the ISO 14000 standard is similar to the ISO 9000 standard—it is generic and sensible. The critical part is how measurements and improvements are done—hence, the focus on the LCA part here—because it illustrates the problems with all such value-laden approaches.

A conventional LCA consists of the following steps, which is outlined in the ISO 14040–ISO 14042 standards and in SETAC’s “Code of Practice”<sup>15</sup>:

1. Goal definition and scoping,
2. Inventory analysis,
3. Impact assessment, and
4. Improvement Assessment (SETAC term) or Interpretation (ISO term).

I will now review each of these steps more in detail, and at the end of each section, a critique of them is presented.

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<sup>12</sup>According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

<sup>13</sup>See Boustead, I. (1996). “LCA—How it Came About, The Beginning in the UK.” *International Journal of Life Cycle Assessment* 1(3).

<sup>14</sup>This approach was developed by this author and first presented in the PhD dissertation at Georgia Institute of Technology and subsequently in this book; Emblemsvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.

<sup>15</sup>According to Consoli, F., D. Allen, I. Boustead and J. Fava (1993). *Guidelines for Life-Cycle Assessment: A ‘Code of Practice’*. The SETAC Workshop, Sesimbra, Portugal, 31 March–3 April, Society of Environmental Toxicology And Chemistry (SETAC), Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

### 2.1.1 Goal Definition and Scoping

During this initial phase of the LCA, one is supposed to define the following:

1. “Goal,” which shall unambiguously state the intended application, including the reasons for carrying out the study and the intended audience, i.e., to whom the results of the study are intended to be communicated.
2. “Scope,” which describes the model of the systems to be studied. The scope should be defined well enough to ensure that the breadth and depth of a study are compatible with and sufficient to address the stated goal.
3. “Function and functional unit.” The function is the performance characteristics of the system, while the functional unit is selected to measure “the performance of the functional outputs of the product system.”
4. “System boundaries,” which defines the unit processes, which will be included in the system to be modeled.
5. “Data quality,” which must be defined by specific characteristics that describe both quantitative and qualitative aspects of data as well as the methods used to collect and integrate those data. There are five data quality indicators: (1) precision, (2) completeness, (3) representativeness, (4) consistency, and (5) reproducibility.
6. “Critical review process” is added in the end as a quality assurance measure.

These steps are sound and generic for just about any assessment method except one step, the definition of functions and functional units. A functional unit is defined as “the functional outputs of the product system whose primary purpose is to provide reference to which the input and output are normalized.”<sup>16</sup> “For example, systems A and B perform functions  $x$  and  $y$  which are represented by the selected functional unit, but system A performs function  $z$  which is not represented in the functional unit. As an alternative, systems associated with the delivery of function  $z$  may be added to the boundary of system B to make the systems more comparable.”

As we understand, the usage of functional units does not really make comparison possible, and how can we deal with say 20 systems with several important functions each, using functional units? In cases where there is no linear relationship between the function and the functional unit, like fuel consumption of a ship and the mass of cargo, the functional unit is also misleading as a basis for comparison. Add that during design various solution principles can involve various function structures, which effectively prohibit all comparison if functional units are required. Finally, the usage of functional units totally breaks down for consumer products, because the preference of customers cannot be approximated by a functional unit—we do not buy, e.g., a car based on transportation costs per driver

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<sup>16</sup>See Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

mass. For example in one study, the ISO LCA is used to assess a toy manufacturer<sup>17</sup> and a significant problem is that they are unable to identify any functional units for the products. I therefore believe that functional units have limited usage, in general. Any method that relies on such concepts will not suffice.

### 2.1.2 Inventory Analysis

The inventory analysis whose purpose is simply to quantify inputs and outputs of a product system contains the following main issues:

1. “Data collection.” The data can be site-specific or general; in any case, they must be collected for all unit processes within the system boundaries. Even qualitative data are allowed. As noted in the literature, this process may be resource intensive.
2. “Refining system boundaries.” Based on the successes of the data collection, the system boundaries may have to be altered to better fit the available data set.
3. “Calculation” is simply a step to manipulate the data to make the amount of data manageable.
4. “Validation of data” is then employed to ensure the data quality. The purpose is to find areas where the data are insufficient so that better data can be gathered.
5. “Relating data to the specific system” by using the correct unit processes. The purpose is obviously to ensure that the right data are associated with the right unit processes. For each unit process, an appropriate reference flow shall be determined, or functional unit, for normalization purposes.
6. “Allocation” is employed when it is not possible to contain all the impacts and outputs inside the system boundaries. There are two ways out of this problem: (1) expanding the system boundaries to include all the inputs and outputs or (2) allocating the relevant environmental impacts to the studied system. The problem with option (1) is that it may make the whole analysis too complex. In the literature, we find procedures for doing this.

From the cost-management literature,<sup>18</sup> we know that allocations, i.e., in the sense of assignment of costs using estimations, can never become 100 percent correct and with the highly ambiguous procedures in conventional LCA I see no reason to assume that it will be a *lesser* problem. In fact, it will most likely be a *larger*

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<sup>17</sup>See Emblemståg, J. and B. Bras (1998). *ISO 14000 and Activity-Based Life-Cycle Assessment in Environmentally Conscious Design and Manufacturing: A Comparison*. 1998 ASME Design Engineering Technical Conference, Atlanta, GA, American Society of Mechanical Engineers (ASME).

<sup>18</sup>See for example Cooper, R. (1990). “Five Steps to ABC System Design.” *Accountancy* (November): pp. 78–81. and Kaplan, R. S. (1992). “In Defense of Activity-Based Cost Management.” *Management Accounting* (November): pp. 58–63.

problem simply because of the fact that establishing causal relationships between product, functions, inputs, and outputs sound rather impossible. In fact, ISO states that the allocation procedures may vary the allocation factors from 0 to 100 percent. Then, what is the point?

ISO also prescribes the usage of unit processes. A unit process is defined as “the smallest portion of a product system for which data are collected when performing a life cycle assessment,”<sup>19</sup> or “the basic building blocks within the system boundaries.”<sup>20</sup> The major problem with this approach is that if a company uses processes not modeled in any known software, then impact assessments are impossible (or they can in the best case be approximated crudely). Now, taken into account that there are more than eight million chemical compounds in commercial usage at the turn of the century, see the Beilstein and Gmelin databases, establishing unit processes seems a rather daunting, if not impossible approach. Another issue is that such an approach will become incredible bureaucratic and slow when updates are needed, which will probably be needed continuously.

### 2.1.3 Impact Assessment

The impact assessment consists of the following four steps:

1. “Category definition.” Here, the environmental impact categories are defined by ISO in order to describe the impacts caused by the considered products or product system. Examples of typical impact categories include abiotic resource, biotic resources, land use, global warming, stratospheric ozone depletion, ecotoxicological impacts, acidification, and eutrophication.
2. “Classification.” Classification is a qualitative step based on scientific analysis of relevant environmental processes during which the various inputs and outputs are assigned to the various categories. Since some outputs have to be accounted for in several categories and thereby double and triple accounting may be necessary. The environmental impacts also have to be scaled according to their geographical impact into four groups; local, regional, continental, and global. Throughout this process, there is an implicit assumption that “less is better.”<sup>21</sup>

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<sup>19</sup>According to ISO/TC 207/SC 5 (1996). *Environmental Management—Life Cycle Assessment—Principles and Framework*. International Organization for Standardization. p.

<sup>20</sup>According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

<sup>21</sup>See ISO (1997). *Environmental management—Life cycle assessment—Life cycle impact assessment*. International Standards Organization. p.

**Table 2.1** An example of categorization and weighting factors

| Environmental effect    | Weights | Criterion                                                                                                                            |
|-------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------|
| Greenhouse effect       | 2.5     | 0.1 °C rise every 10 years, 5 percent ecosystem degradation                                                                          |
| Ozone layer depletion   | 100.0   | Probability of 1 fatality per year per million inhabitants                                                                           |
| Acidification           | 10.0    | 5 percent ecosystem degradation                                                                                                      |
| Eutrophication          | 5.0     | Rivers and lakes, degradation of an unknown number of aquatic ecosystems (5 percent degradation)                                     |
| Summer smog             | 2.5     | Occurrence of smog periods, health complaints, particularly among asthma patients and the elderly, prevention of agricultural damage |
| Winter smog             | 5.0     | Occurrence of smog periods, health complaints, particularly among asthma patients and the elderly                                    |
| Pesticides              | 25.0    | 5 percent represented an approximate reduction of ecosystem degradation                                                              |
| Airborne heavy metals   | 5.0     | Lead content in children's blood, reduced life expectancy and learning performance in an unknown number of people                    |
| Waterborne heavy metals | 5.0     | Cadmium content in rivers, ultimately also impacts on people (see Airborne heavy metals)                                             |
| Carcinogenic substances | 10.0    | Probability of 1 fatality per year per million people                                                                                |

3. "Characterization" whose aim is to model categories in terms of indicators. The model should be based on scientific knowledge where possible, but may have simplifying assumption and value choices.
4. "Valuation/weighting" is a step designed to overcome that fact that "comparison of these categories is not immediately possible."<sup>22</sup> By assigning weights to the various categories based on policies, goals, stakeholder opinions, and the like, a number that described the environmental impact is produced. Several approaches for this process are found in the literature.

In my opinion, the impact assessment step is a significant problem for the conventional LCA methods because it leads to political debate<sup>23</sup> as people disagree which emissions impact which impact categories and to what extent. In fact, consensus has not been reached for a single list thus far to my knowledge. This is probably also explaining the reluctance from a number of countries to ratify some agreements.

Consider Table 2.1, which shows a possible categorization of impacts and the associated weighting scheme. It is obvious that we will end up in never-ending discussions and political debate and ultimately no action if taxes associated with environmental impacts are to be imposed based on such a weighting- and

<sup>22</sup>A fact acknowledged by ISO (1997). *Environmental management—Life cycle assessment—Life cycle impact assessment*. International Standards Organization. p.

<sup>23</sup>According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

categorization scheme. In fact, during the Kyoto meeting in December 1997, the delegates had enormous problems of agreeing upon just the greenhouse effect, which is just one out of roughly ten categories, and it did not stop there: The legislative environment in the US congress in 1997 was so bad that the Clinton administration did not even try to ratify the Kyoto treaty.<sup>24</sup> But disagreement is common among researchers as well if we go to details that have important consequences.

Regardless of the category definition, even if that happens to be the same, there are more than enough issues where people can misinterpret or simply go wrong:

1. After defining the categories, the next step of the impact categorization is classification. Due to the fact that various emissions can contribute to several categories, double, triple, etc., counting is needed. This requires that the practitioners have good understanding in the effects of every emission, because otherwise they will not be able to classify correctly.
2. An implicit assumption in the classification is “less is better” as mentioned earlier which in cases where compromises between various emissions must be made can lead to wrongful decisions.
3. The next step within the impact categorization is characterization, where one tries to assign the relative contribution of the relevant environmental processes. This is based on scientific knowledge, however, when that is not available one simply makes value choices. The result is that one mixes apples and pears whose result cannot be comparable, which is a major problem.<sup>25</sup>
4. The last step is the weighting or valuation. The purpose is to rank, weight, and possibly aggregate the results in order to arrive at the relative importance of the results. What completely ruins the credibility that might be left after the previous steps is now totally eradicated by allowing organizations and groups of stakeholders impact how the weights are chosen.
5. Throughout this process of impact categorization, they also try to establish a geographical area of impact. This is done by using highly ambiguous, subjective, and incomparable scales: “Global,” “Continental,” “Regional,” and “Local.” Global and continental are fairly accurate although incomparable. However, the two other scales are very inadequate in all respects, because it is inherently confusing, e.g., how local is local?

When all this is said, we should remember that the ISO 14000 standard, just like the ISO 9000 standard, is focusing on how a corporation can improve themselves and as such these issues are not that critical, but in order to tackle the issues discussed in this book they are disastrous. Achieving comparability is the key and without it there is no basis for measurement and improvement between corporations and ultimately nations.

<sup>24</sup>According to Meserve, J. (1998). *Environmental Legislation Going Nowhere Fast*. Washington, DC, AllPolitics. p.

<sup>25</sup>See the critique by Ayres, R. U. (1995). “Life cycle analysis: A critique.” *Resources, conservation and recycling*(14): pp. 199–223.

### 2.1.4 Interpretation

Interpretation, or “improvement assessment,” revolve around three issues to facilitate decision-making:

1. “Identification of significant environmental issues” in a prudent and justifiable manner which obviously is a necessity if a company should have any use of a LCA.
2. “Evaluation.” The first element of this step is to conduct a qualitative check of the selection of data, processes, etc. to discuss the possible consequences of leaving out information. The second element is to apply a systematic qualitative or quantitative analysis of any implications of changes in the input data caused by data, methodological, and/or epistemological uncertainties. The last step (third) is to discuss the variations identified in relation to the goal and scope of the study. Check for completeness, sensitivity, and consistency as well as for uncertainty and data quality is only developed to a limited degree.
3. “Conclusions and recommendations” which is similar to any scientific or technical assessment, investigation or alike.

From this we understand that neither uncertainty analysis nor sensitivity analysis is well developed. In fact, some researchers say it flat out that “it is not possible to give a general rank of priorities of strategies and options for improvements.”<sup>26</sup> From this we understand that whatever result may be left to interpret, it does not have much value for a corporation, or for anybody else for that matter.

### 2.1.5 Some Closing Remarks

As if the four aforementioned issues are not bad enough, the whole ISO 14000 standard is so loosely defined that the implementation can vary so much that two studies of the same case can in principle be incomparable. That can occur if only one of the following issues is occurring, in order of severity (the worst first):

1. The studies have different system boundaries, goals, and/or scope. This can be easily exemplified by the fact that when Interface Flooring Systems in La Grange, Georgia, USA, asked Exxon to assess the embodied energy, i.e., what we refer to energy content in Chap. 6, for some chemicals, Exxon came up

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<sup>26</sup>See Hanssen, O. J. (1998). “Sustainable Product Systems—Experiences Based upon Case Projects in Sustainable Product Development.” *Journal of Cleaner Production* 7(1): pp. 27–41, which according to Christiansen, K., R. Heijungs, T. Rydberg, S.-O. Ryding, L. Sund, H. Wijnen, M. Vold and O. J. Hanssen (1995). *Report from Expert Workshop at Hankø, Norway on LCA in Strategic Management, Product Development and Improvement, Marketing and Ecolabelling and Governmental Policies*. Østfold Research Foundation. p. has developed ‘one of the most comprehensive methods for Environmentally Sound Product Development’.

with negative embodied energy.<sup>27</sup> It does not take long to figure out why. By choosing the systems boundaries in certain ways, this is possible.

2. The functional units are chosen differently.
3. The software used in the two studies has different set of unit processes.
4. The impact categorization is different.
5. The implementation itself is different. That is, various factors are included in one of the studies which are not included in the other study based on the various critical reviews throughout the entire process.

The ISO 14000 standard basically leaves too many issues open to the practitioners.<sup>28</sup> This is of course very convenient from a political point of view, but it ruins comparability, benchmarkability, and finally *credibility*—particularly with respect to the topic in this book.

Finally, the framework is bureaucratic and there are substantial risks that it will never be used in the daily operations of a corporation. It serves best as a strategic tools to help companies improve themselves, locally, but as basis for becoming sustainable they will never work simply because they do not allow a systemic approach since they fail to establish consistency and comparability. Rolf Bretz of Ciba, for example, predicts that if comparability is not achieved, “LCA will be short-lived in the commercial world.” This he said more than a decade ago, when LCA was relatively hot, but today it is largely forgotten so it seems he was right.

Despite these shortcomings, the International Organization for Standardization (ISO) keeps pushing for even more standardization along the same lines and argues for “tackling climate change through standards” in the 2009 September issue of ISO Focus; The Magazine of the ISO. I believe that climate change, or sustainable development, cannot be tackled through standardization at all. The issues are much too complex for simple approaches like that.

Next, we investigate the climate change issues and how the international community has handled it thus far.

## 2.2 The Climate Change Effort and Why It Fails

The secret of change is to focus all of your energy, not on fighting the old, but on building the new.

Socrates

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change.<sup>29</sup> It was established by the

<sup>27</sup>Personal communication with Director of Process Development Stuart Jones at Interface Flooring Systems in LaGrange January 13 1999.

<sup>28</sup>See Emblemståg, J. and B. Bras (1998). *ISO 14000 and Activity-Based Life-Cycle Assessment in Environmentally Conscious Design and Manufacturing: A Comparison*. 1998 ASME Design Engineering Technical Conference, Atlanta, GA, American Society of Mechanical Engineers (ASME).

<sup>29</sup>See <http://www.ipcc.ch/organization/organization.shtml>.

United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge on climate change and its potential environmental and socioeconomic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.

The assessments of IPCC form the basis for the Kyoto treaty and for a number of high-profile summits where the governments around the world are to agree on cuts in carbon dioxide (CO<sub>2</sub>) emissions. So far, the results are abysmal—why?

Without going into the scientific part of this in significant depth, for which I am unqualified, it should be mentioned that there not only exists serious counterarguments on the scientific side, see Sect. 2.2.2, but also on the socioeconomic side. In fact, one key problem<sup>30</sup> with the IPCC's report, sufficient by itself to declare the document "technically unsound," is the way the scenario-builders have based their projections of future output on national GDP estimates which have been converted to a common measure using market exchange rates. This procedure leads them to overstate the initial gaps in average incomes between rich and poor countries—because prices tend to be much lower in poor countries. Those gaps are in turn crucial for the IPCC's projections, because the method used in the scenarios assumes not only that the rich countries will continue to get richer but also, in most of the 40 scenarios considered, that the greater part of the (overstated) initial gaps between rich and poor will be closed by the end of the century.

This critique, also known as the Castle-Henderson critique, was subsequently published in the journal *Energy and Environment* (Vol. 14, No. 2–3) and the IPCC was invited to respond. The tragedy is that instead of taking this critique seriously from highly qualified people, IPCC chose to amass 15 authors to supply a response in which they defended previous work. This caused *The Economist*<sup>31</sup> to conclude that IPCC is "dangerous economic incompetent" explaining this incompetence by pointing to another obvious fact, "...that this horde of authorities is drawn from a narrow professional milieu." Later, in Sect. 2.2.2, we will see that this narrowness is also a problem for the climate scientific part as well.

In light from the diffusion of innovation discussion in Chap. 1 and Fig. 1.5, it is clear that we fail at decision type V both in establishing the need for change, a clear diagnosis and so on. Perhaps, more seriously, there is no agency that acts as a change agent and certainly not as a change agent in the sense that the agricultural extension service did with huge success, as discussed later. The whole change process is to take place in highly unconventional ways. The innovation decision process that the Kyoto process lends itself to is somewhere between the authoritative one and the collective one, but with no enforceable supranational organ authority becomes a hollow threat and a collective search for a solution take ages. From the

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<sup>30</sup>According to Ian Castles of the National Centre for Development Studies at Australian National University, formerly the head of Australia's national office of statistics; and David Henderson of the Westminster Business School, formerly the chief economist of the OECD. See *The Economist* (2003a). Hot potato. *The Economist*. 366: pp. 74.

<sup>31</sup>See *The Economist* (2003b). "Hot potato revisited." *The Economist* 369(8349): pp. 78.

discussion in Chap. 1, it was concluded that only an optional-/market-based approach can stand the chance of succeeding but this is not chosen. Instead, it is highly political—even the summary part of the IPCC report is so politically laden that scientists are “angry at the deletions and astonished by the process.”<sup>32</sup>

There are a number of parties calling for a carbon trading system, but the root cause for climate change is not carbon emissions per se—it is the quest for energy. This is one reason why this book tries to focus on the energy issues more than the emission issues. Emission is largely a choice due to economic constraints or costs and lack of political will, but the need for energy is not (unless we are to prevent emerging economies from rising, which is an intolerable line of argument). Another issue is that focusing on energy leaves out a lot of policy and can be handled in an accounting-like fashion as outlined in Chap. 6.

However, for the sake of argument, let us also review how the carbon trading system has worked so far and how it will work in the future. To help us on the way, it is useful to first explore a trading system that actually works, the SO<sub>2</sub> allowance-trading system in the U.S.

### 2.2.1 The SO<sub>2</sub> Allowance-Trading System

A landmark example of a cap-and-trade system that works well is the SO<sub>2</sub> allowance-trading system<sup>33</sup> which was established under Title IV of the Clean Air Act Amendments (CAAA) of 1990 in the USA. This system is a landmark example for several reasons<sup>34</sup>:

1. The SO<sub>2</sub> allowance-trading system in the USA was the first large-scale application of cap-and-trade to control pollution. For long, it was the largest and is to this day (2015) only superseded by the European Union (EU) Emissions Trading System (ETS) which was implemented in 2005.
2. The purpose of the program was to reduce the emissions in the USA by 10 million tons relative to 1980, when total US emissions were about 25.9 million tons. This goal was to be accomplished in two phases; from 1995 to 1999 and from 2000 and onwards and represented an approximate reduction of 50 percent from 1980 levels, or 17.5 million tons. The targets were met by 2007 even though electricity generation from coal-fired power plants increased 25 percent from 1990 to 2004.
3. The estimated costs were \$6.1 billion, but they turned out to be less than \$2 billion (although there are various estimates), and later estimates are as low as

<sup>32</sup>See The Economist (2014b). Inside the sausage factory. *The Economist*. 411: pp. 69.

<sup>33</sup>This system is also known as the Acid Rain Program and the SO<sub>2</sub> cap-and-trade system.

<sup>34</sup>According to Chan, G., R. Stavins, R. Stowe and R. Sweeney (2012). *The SO<sub>2</sub> Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation*. Cambridge, MA, Harvard Environmental Economics Program. p. 39.

\$0.5 billion.<sup>35</sup> Moreover, the health benefits, however, were estimated at more than \$50 billion per year by 2010.

4. This was achieved without extensive price volatility and compliance was close to perfect. This was largely achieved by transparent data systems, public access to information and strict and certain penalties for non-compliance.

In this program, the allowances were distributed for free due to prior regulatory benchmarks associated with emissions per unit of heat. According to theory,<sup>36</sup> at the time the initial distribution of allowances including, specifically, how many allowances a given firm holds at the outset will have approximately no effect to the ultimate outcome. What matters to corporation's decisions to trade or abate are marginal abatement costs, and these costs are generally unaffected by the initial allocation of allowances. Later economic analyses have, however, elucidated the relative merits of free allocation and actions of allowances in cap-and-trade programs and three conclusions are relevant for the SO<sub>2</sub> allowance-trading system<sup>37</sup>:

1. Unless the overall emission cap is very stringent, the sum of the market value of allowances is likely to substantially exceed the total abatement costs incurred to meet the cap causing recipients of free allowances to be overcompensated for their actual compliance costs resulting in windfall profits. This problem increases with size of the cap-and-trade market.
2. If there is no price regulation, emitters can easily pass on the bill of compliance to the customers. In many US states, however, there are cost-of-service regulations causing emitters to look for more cost-effective solutions and not merely pass the bill to customers.
3. An action of allowances is more economically effective for society although for the emitters the abatements costs remain the same. In a sense, this represents a general principle of shifting taxation from social "goods" to social "evils" such as pollution.

All these three conclusions are violated in the global carbon market—(1) the system is much bigger than the US SO<sub>2</sub> allowance-trading system, (2) there are no price regulatory bodies so the temptation to pass the costs on to customers is huge, and (3) the allocation of allowances is very questionable. Before seriously criticizing the system, however, it is useful to first investigate it.

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<sup>35</sup>See for example EPA, U. S. (2011). *The benefits and Costs of the Clean Air Act from 1990 to 2020: Final Report*. Washington, DC, US Environmental Protection Agency, Office of Air and Radiation. p. 238.

<sup>36</sup>See Montgomery, W. D. (1972). "Markets in licenses and efficient pollution control programs." *Journal of Economic Theory* 5(3): pp. 395–418.

<sup>37</sup>See Chan, G., R. Stavins, R. Stowe and R. Sweeney (2012). *The SO<sub>2</sub> Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation*. Cambridge, MA, Harvard Environmental Economics Program. p. 39.

### 2.2.2 *The Emissions Trading System*

The global carbon market is more properly known as the emissions trading system (ETS) because carbon is just one of several greenhouse gases (GHGs) and not the one with highest global warming potential either. Therefore, a whole set of gases have been assessed with respect to their global warming potential and they all fall under this ETS. It is therefore more correct to talk about emissions with global warming potential. So much for definitions, if we step back and look at how the system came about it will be easier to understand how it works.

The origins of the international concern about climate change is traceable to the publication of the Mauna Loa<sup>38</sup> series which showed an increase in atmospheric carbon dioxide and this was linked to the rise of consumption of fossil fuels and what this might mean in terms of global temperatures. For an excellent overview of the whole story written by insiders review the accounts of Diana Liverman<sup>39</sup> and David Demeritt.<sup>40</sup> This publication series and a number of other simplistic publications “were enough to provoke a small but influential group of scientists to build the case for institutions and policies to coordinate research and responses to the risks of climate change. In turn, this led to a series of meetings and reports between 1985 and the Rio Summit in 1992 laid the scientific groundwork for an international agreement on climate change.”<sup>41</sup> The rest of the story is more or less as described earlier in this book.

To build the case, these scientists and others produced three key narratives that have been used internationally to rally politicians, the public, and other scientists around the world for global warming and climate change<sup>42</sup>: (1) “dangerous climate change” must be avoided, (2) the responsibility for climate change is common although somewhat differentiated, and (3) the market—using cap-and-trade

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<sup>38</sup>The location of Mauna Loa has made it an important location for atmospheric monitoring by the Global Atmosphere Watch and other scientific observations. The Mauna Loa Solar Observatory (MLSO), located at 3400 m, has long been used for observing the sun. The NOAA Mauna Loa Observatory (MLO) is located in the proximity. From its location high above local human-generated influences, the MLO monitors the global atmosphere, including the greenhouse gas carbon dioxide. Measurements are adjusted to account for local outgassing of CO<sub>2</sub> from the volcano. For more information see page 95 in Rhodes, J. M. and J. P. Lockwood, Eds. (1995). *Mauna Loa Revealed: Structure, Composition, History, and Hazards*. Geophysical Monograph Series (Book 92). Washington DC., American Geophysical Union. p. 348.

<sup>39</sup>See Liverman, D. M. (2009). “Conventions of climate change: constructions of danger and the dispossession of the atmosphere.” *Journal of Historical Geography* 35(2): pp. 279–296.

<sup>40</sup>See Demeritt, D. (2001). “The Construction of Global Warming and the Politics of Science.” *Annals of the Association of American Geographers* 91(2): pp. 307–337.

<sup>41</sup>According to Liverman, D. M. (2009). “Conventions of climate change: constructions of danger and the dispossession of the atmosphere.” *Journal of Historical Geography* 35(2): pp. 279–296.

<sup>42</sup>According to Liverman, D. M. (2009). “Conventions of climate change: constructions of danger and the dispossession of the atmosphere.” *Journal of Historical Geography* 35(2): pp. 279–296.

system—is the most cost-efficient way to reduce the danger. They are therefore embedded in international climate agreements such as the 1992 United Nations Framework Convention on Climate Change and the 1997 Kyoto Protocol. The problem is that science has become political<sup>43</sup> because these three narratives do not stand up to scientific scrutiny.<sup>44</sup> In many ways, they suffer from the same conceptual problems as the ISO 14000 system discussed earlier in that there are too many value-laden judgments causing debate. The worst, however, is that in order to win support from politician and the public, the IPCC intentionally makes the scientific advice more certain than what it is, which the climate sceptics use against them.<sup>45</sup> In fact, in one study<sup>46</sup> where they studied paleoclimate data from 19,000 to 23,000 years ago, the results suggest a lower probability of imminent extreme climatic change than previously thought. In fact, despite considerable efforts over the last 32 years, the uncertainty of the initial estimates of  $3 \pm 1.5$  °C remains. In other words, climate study is an area of doubt and uncertainty.

It is important to understand that science rests upon a process of selection<sup>47</sup> and what is crucial to understand is that it is a narrow selection which means that results obtained through scientific processes should be viewed as true within limits and then we must judge whether these limits have practical consequences or not with respect to reality. The term “theoretically laden facts” introduced by Lev Semjonovitsj Vygotsky (1896–1934) is therefore extremely relevant,<sup>48</sup> and also the simple fact that of all the “inexorable laws of Nature” before 1900 only Newton’s law of gravity have stood the test of time.<sup>49</sup> In other words, the scientific process is a process of continuous improvements, sometimes changed by radical innovations, where improved theories replace outdated ones—and we are, of course, not at the end of this process (if it will ever come). It is therefore plainly naïve to believe that the climate models we have today of such a hugely complex topic as climate change are so correct that there is negligible room for debate and hence will form a clear basis for a huge volume of economic transactions that will

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<sup>43</sup>See Demeritt, D. (2001). “The Construction of Global Warming and the Politics of Science.” *Annals of the Association of American Geographers* 91(2): pp. 307–337.

<sup>44</sup>For an excellent review see Liverman, D. M. (2009). “Conventions of climate change: constructions of danger and the dispossession of the atmosphere.” *Journal of Historical Geography* 35(2): pp. 279–296.

<sup>45</sup>See Demeritt, D. (2001). “The Construction of Global Warming and the Politics of Science.” *Annals of the Association of American Geographers* 91(2): pp. 307–337.

<sup>46</sup>See Schmittner, A., N. M. Urban, J. D. Shakun, N. M. Mahowald, P. Clark, U., P. J. Bartlein, A. C. Mix and A. Rosell-Melé (2011). “Climate Sensitivity Estimated from Temperature Reconstructions of the Last Glacial Maximum.” *Science* 334(9 December): pp. 1385–1388.

<sup>47</sup>See the classic work of Merz, J. T. (1915). *Religion and Science, A Philosophical Essay*. London, William Blackwood and Sons. p. 192.

<sup>48</sup>See Vygotsky, L. S. (1988). *Thought and Language*. Cambridge MA, The MIT Press. p. 285.

<sup>49</sup>See Merz, J. T. (1915). *Religion and Science, A Philosophical Essay*. London, William Blackwood and Sons. p. 192.

be respected internationally. The belief in the infallibility of science is tantamount to rising science to the level of becoming an ideology based on the rhetoric of objectivity. The trouble with this rhetoric is that it suggests that "...science somehow stands above and outside the fray as a uniquely privileged vehicle to Truth."<sup>50</sup> In fact, Demeritt<sup>51</sup> has identified a number of potentially contentious judgments, assumptions, and practices:

1. Anthropogenic climate change is a global-scale, environmental (as opposed to political or economic) problem.
2. It is caused by the universal physical properties of GHGs (as opposed to underlying political structures or moral failings).
3. These objective entities have universal meanings that can be discovered scientifically by experts.
4. The best way to understand global warming scientifically is to model it mathematically.
5. An important objective of climate science should be the construction of more complex, comprehensive, and physically reductionist models.
6. Model simulations provide the basis of future climate predictions.
7. Rational policy is (or should be) founded on general circulation model (GCM) projections about the regional-scale impacts of climate change.
8. The regional scale is the most meaningful one for policy making.
9. Model parameterizations adequately simulate the climate system variability, or soon will.
10. Modelers should focus first on (what they perceive to be) the most likely outcomes, as opposed to the most extreme.
11. Experts are best placed to decide the legitimacy and credibility of these practices.

The sum of this is that "a socially contingent form of scientific knowledge is being shaped by an emergent international policy regime that, in turn, is being constructed and legitimated by this same body of scientific knowledge."<sup>52</sup> This is a self-reinforcing system without check and balance and this is very troublesome. This results in low credibility and hence opening up for fossil-fuel industry to debunk it scientifically, but we also risk groupthink and ultimately erroneous decisions with huge consequences. This said, it should be noted that "Even Exxon Mobil, *bête noire* of the climate-change activists, has now withdrawn funding

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<sup>50</sup>According to Rorty, R. (1990). *Objectivity, Relativism, and Truth: Philosophical Papers, Vol. 1*. Cambridge, Cambridge University Press. p. 236.

<sup>51</sup>A highly interesting paper on this is Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* 91(2): pp. 307–337.

<sup>52</sup>A highly interesting paper on this is Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* 91(2): pp. 307–337.

from the CEI<sup>53</sup> and appears to accept the need for controls on carbon emissions.”<sup>54</sup> However, whether this is due to reputational risks or new insight is unclear to me.

This is a prime reason for writing this book—I also believe that we go in the wrong direction. Not that I reject climate change; on the contrary, change is inherent in Nature and climate along with it—to believe something else would not only be naïve but also in plain contrast to geological- and historical records. The extent of human impact, however, is another thing which is why I try to argue that it is better to focus on what we know to have impact on sustainability instead of betting everything on a contentious issue. This said, I believe that climate research is important because the climate is a complex adaptive system and complex systems have bifurcation points after which dramatic and irreversible effects can take place. We therefore need climate research not only for long-rang planning purposes but also to be sure that we do not develop our societies on an irreversible and destructive path.

If we expand our thought a little, we can investigate the so-called logistics equation from population biology as an example:

$$x_{n+1} = r \cdot x_n \cdot (1 - x_n) \quad (2.1)$$

where

$x_n$  is a number between 0 and 1 and represents the population at year  $n$ . Hence,  $x_0$  represents the initial population (at year 0)

$r$  is a positive number and represents a combined rate for reproduction and starvation.

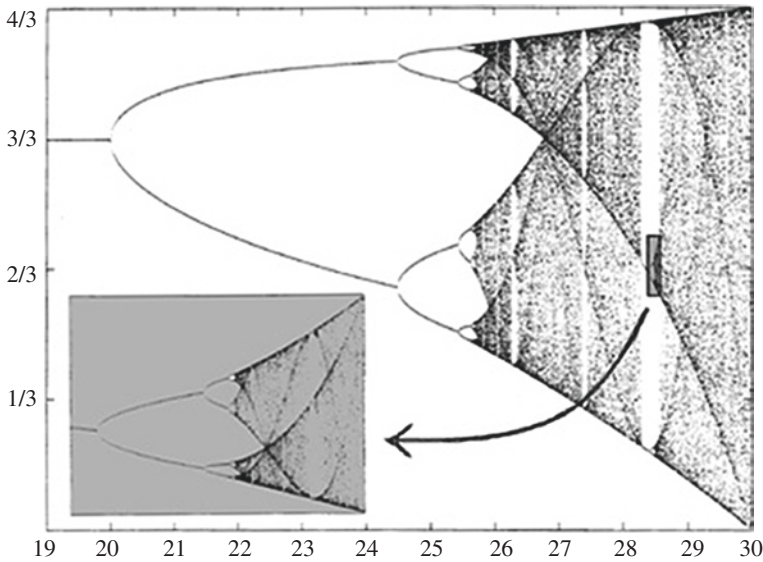
By creating a program where this equation is iterated<sup>55</sup> upon itself ( $x_{n+1}$  in the first iteration is set to  $x_n$  in the second iteration and so on) hundreds of times, the bifurcation diagram in Fig. 2.1 is produced. In general, a bifurcation diagram shows the long-term solution of a system as a function of the variables that constitute the so-called attractor,<sup>56</sup> and in this case it represents all possible population

<sup>53</sup>Competitive Enterprise Institute (CEI) is an organization that casts doubt on the science of climate change and campaign against greenhouse-gas reductions, see The Economist (2007). *Cleaning up: A special report on business and climate change*. London, The Economist. p. 32.

<sup>54</sup>According to The Economist (2007). *Cleaning up: A special report on business and climate change*. London, The Economist. p. 32.

<sup>55</sup>An iteration is the mathematical equivalent of a feedback loop.

<sup>56</sup>Unfortunately, there are no universally accepted definitions for attractors, but an attractor can be defined as subset—due to a contraction—of an abstract mathematical space called phase space that describes a dissipative dynamical system by representing all possible states of the system with each possible state of the system corresponding to one unique point in the phase space. A dissipative dynamical system is characterized by the presence of some sort of internal ‘friction’ that tends to contract phase-space volume elements and hence induce attractors. Therefore, an attractor can be thought of as the long-term behavior of a complex system. There are three types of attractors; (1) fixed point attractors, (2) periodic attractors and (3) strange attractors—also known as fractal attractors, see Ilachinski, A. (1996). *Land Warfare and Complexity, Part I: Mathematical Background and Source Book (U)*. Alexandria, VA, Center for Naval Analyses. p. 231.



**Fig. 2.1** Change in a population governed by the logistics equation whose growth is a strange attractor. *Source* Wikipedia, the free encyclopedia

growth scenarios over time as the combined rate for reproduction and starvation is changed. The resulting figure is a strange attractor, or fractal attractor—the fractal itself is commonly known as the Feigenbaum fractal. The points shown in Fig. 2.1 where the lines split are so-called *bifurcation point*.

Before, we can discuss what bifurcation points are, we must first introduce what Ilya Prigogine (1917–2003) called *dissipative structures*<sup>57</sup> to highlight two apparently contradictory tendencies in all living systems—points of instability where order and structure can emerge. These emerging orders and structures arise in living systems, as well as in social systems, because there is internal “friction” which leads to irreversibility in the system. When a system is forced to change for whatever reasons, it consequently cannot go back to its initial state due to friction which results in dissipation of old structures into the breakdown or breakthrough to new, emergent structures. Hence, a dissipative structure can be likened to an island of order in a sea of disorder and it describes the paradoxical coexistence of change and stability, according to Prigogine. For students of innovation, political science, history, and so on, this should be familiar... This is common throughout our world, which is one of the reasons I find complexity theory so interesting to better understand our areas of study and link it toward real life. With this in mind, bifurcation points can be explained.

<sup>57</sup>See Prigogine, I. and I. Stengers (1989). *Order Out of Chaos*, Bantam Doubleday Dell Publishing Group. p.

Bifurcation points are states at “...a threshold of stability at which the dissipative structure may break down or break through to one of several new states of order”<sup>58</sup> resulting sometimes in evolution or other times in revolution. This process of change via self-organization and attractor bifurcation will create a heavy strain on existing structures and hence push toward the dissipation process. Even the amplifying feedback (“things go out of control”), which always has been considered destructive, appears to be a source of new order and complexity because “stress” is increasingly alleviated via multiple cycles of bifurcation and dissipation and a more relaxed state occurs. Thus, dissipative structures become a source of order.

A very important point about bifurcation points is indeterminacy. Indeterminacy is a key characteristic at the bifurcation points, according to Prigogine,<sup>59</sup> because at the bifurcation point several potential paths or changes exist for the system, but which path it will take depends on past history and various external conditions and can never be predicted for long. Furthermore, minute fluctuations in the environment can cause great changes in the dissipative structure at the bifurcation point. Thus, the dissipative structure can only be predicted over a short-time span. This is, of course, another reason for the climate scientists to be a little less sure—it is only destructive to the cause of sustainability, because there are a number of contentious judgments, assumptions, and practices to debate and hence open up for the commercial interests of the fossil-fuel industry or even the climate research industry if you like.

With all these contentious issues surrounding the climate research and hence the importance of gasses with global warming potential, including carbon dioxide, it is clear that a cap-and-trade system is based on shaky and uncertain foundations. On top, it is complicated further by introducing sinks and carbon equivalents hence making it even more value-laden than it could have been. This is perhaps one of the reasons why Larry Lohmann sees strong conceptual similarity between the trade of derivatives in financial markets and trading carbon equivalents in the ETS.<sup>60</sup> His arguments are compelling and in Table 2.2 I have attempted to summarize some of them to show how similar it is. In Chap. 4, I have expanded on how financial markets work so here it suffices to highlight the similarities. These similarities are interesting because we all know how well the financial markets fared in 2008. Do we want to take the same risk with our environment? Obviously not, and we cannot repeat the same mistakes all over again.

The ETS is complex and beyond this book to discuss in all facets, but some are crucial to note. First, due to the foundations of the ETS and possibilities of offsets, it is hard to determine whether the ETS actually promotes sustainable development or not. In fact, Deutsche Bank claims<sup>61</sup> that any minimal shortfall in carbon

<sup>58</sup>See Capra, F. (1996). *The Web of Life*. New York, Anchor Books, Doubleday. p. 347.

<sup>59</sup>See Capra, F. (1996). *The Web of Life*. New York, Anchor Books, Doubleday. p. 347.

<sup>60</sup>See Lohmann, L. (2010). “Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes.” *New Political Economy* 15(2): pp. 225–254.

<sup>61</sup>According to Lohmann, L. (2010). “Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes.” *New Political Economy* 15(2): pp. 225–254.

**Table 2.2** Similarities between derivatives in financial markets and ETS

| Areas of similarity      | Financial markets                                                                                                                                                                         | Emission trading system                                                                                                                                                         |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Basis for trade          | <ul style="list-style-type: none"> <li>Derivatives mostly devoid of reality. Packaging and repackaging of securities makes it impossible to understand what the trade is about</li> </ul> | <ul style="list-style-type: none"> <li>Great confusion as to what the market is trading in. It can be viewed as a commodification of climate benefits/'costs'</li> </ul>        |
| Market value             | <ul style="list-style-type: none"> <li>Set at some initial level, but over time achieve unrealistic trading values compared to real economy</li> </ul>                                    | <ul style="list-style-type: none"> <li>Governments decide supply levels, set scarcity levels, and either sell or give away commodities to large industrial polluters</li> </ul> |
| Background for valuation | <ul style="list-style-type: none"> <li>Heavy usage of models to create commodities and price them</li> </ul>                                                                              | <ul style="list-style-type: none"> <li>Heavy usage of models to create commodities</li> </ul>                                                                                   |
| Offsets                  | <ul style="list-style-type: none"> <li>Trading of equivalences in the shape of derivatives</li> </ul>                                                                                     | <ul style="list-style-type: none"> <li>Polluters can invest in cheaper measures with equivalent effect according to models instead of reducing GHG emissions</li> </ul>         |
| Speculation              | <ul style="list-style-type: none"> <li>Speculation is rampant and is an important factor in short-termism and herding</li> </ul>                                                          | <ul style="list-style-type: none"> <li>By 2008, about 80 carbon investment funds were largely oriented toward speculation</li> </ul>                                            |
| Traders                  | <ul style="list-style-type: none"> <li>Financial institutions</li> </ul>                                                                                                                  | <ul style="list-style-type: none"> <li>The same financial institutions, specialist financial institutions, and energy companies</li> </ul>                                      |

In June 2008, the nominal value of various derivatives was 683 trillion USD—many times global economic output, see Bank of International Settlements (2008). “Statistical Annex; Table 19: Amounts outstanding of over-the-counter (OTC) derivatives.” *BIS Quarterly Review*(December): pp. A103

See Cochran, I. T. and B. Leguet (2007). *Carbon Investment Funds: The Influx of Private Capital*. Paris, Caisse des dépôts et consignations, Département développement durable. p. 36

See Cochran, I. T. and B. Leguet (2007). *Carbon Investment Funds: The Influx of Private Capital*. Paris, Caisse des dépôts et consignations, Département développement durable. p. 36

For example in the 70s most currency exchange was for financing international purchases of goods and services, after 2000 the figure was less than 0.1 percent, according to Hart, K. (2001). *Money in an Age of Inequality*. Knutsford, Texere Publishing. p. 340

See Environmental Data Services (2004). “Editorial.” *The ENDS Report*(July): pp. 3

According to Lohmann, L. (2010). “Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes.” *New Political Economy* 15(2): pp. 225–254

permits that might appear through 2020 can be met via existing fossil-fired installations; even if circumstances change, the most that could happen would be that some new gas-fired plant gets built ahead of new coal-fired plant.

Second, ETS gives polluting industries additional incentives for delaying structural changes not only because it gives them the alternative of buying or being given bankable pollution permits but also because it relies on prices that cannot be set 40 years in advance.<sup>62</sup>

<sup>62</sup>According to Lohmann, L. (2010). “Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes.” *New Political Economy* 15(2): pp. 225–254.

Third, because the carbon credits were given away for free to polluters, there are significant opportunities for windfall profits, profits that occur unexpectedly due to fortuitous circumstances, and because there is no price regulation as in the SO<sub>2</sub> allowance-trading system, the cost of compliance is suspected to be passed on to customers. Several studies confirm this, for example:

1. The level of windfall profits is significant across many countries, with the estimated level in the five countries (Germany, United Kingdom, Spain, Italy, and Poland) included in one study<sup>63</sup> to be between 23 and 71 billion euros, in total, during the second period of the EU ETS (2008–2012)—based on an EUA price of 21–32 €/t CO<sub>2</sub> and a range of pass-through assumptions.
2. The total magnitude of windfall profits is difficult to discern as the evidence was here only shown for a few products in three sectors. However, if we would apply the here discovered full cost-pass-through rates to all products in the refineries and iron and steel sectors, it can be calculated that the total amount of windfall profits would equal € 14 billion between 2005 and 2008. This implies a substantial transfer of money from consumers to the energy intensive industry.<sup>64</sup>

In a market-based system, there are only two principal alternatives<sup>65</sup>: (1) cap-and-trade and (2) taxation. With cap-and-trade system largely malfunctioning<sup>66</sup> concerning climate change on global scale, we are left with taxation as an option. This view is also held by Financial Times which stated that “...carbon markets leave much room for unverifiable manipulation. Taxes are better, partly because they are less vulnerable to such improprieties.”<sup>67</sup> The issue of taxation will be discussed in Chap. 8, but the point is to realize that the ETS is complex, value-laden and susceptible to manipulation, rent-seeking and creating wind-fall profits that has nothing to do with improvements. Basically, cap-and-trade system for carbon dioxide and other GHGs simply does not work or is at least highly questionable. A better solution must be found, and later in this book some suggestions will come.

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<sup>63</sup>See Point Carbon Advisory Services (2008). *EU ETS Phase II—The potential and scale of windfall profits in the power sector: A report for WWF*. Oslo, Thomson Reuters Point Carbon. p. 29.

<sup>64</sup>According to de Bruyn, S., A. Markowska, F. de Jong and M. Bles (2010). *Does the energy intensive industry obtain windfall profits through the EU ETS? An econometric analysis for products from the refineries, iron and steel and chemical sectors*. Delft, CE Delft. p. 73.

<sup>65</sup>According to Chan, G., R. Stavins, R. Stowe and R. Sweeney (2012). *The SO<sub>2</sub> Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation*. Cambridge, MA, Harvard Environmental Economics Program. p. 39.

<sup>66</sup>As of 2007 it was concluded that “the carbon market is working, but not bringing forth as much innovation as had been hoped for” by The Economist (2007). *Cleaning up: A special report on business and climate change*. London, The Economist. p. 32.

<sup>67</sup>See Financial Times (2007). Carbon markets create a muddle. London. **April 27th**: pp.

## 2.3 Some Final Reflections

Judge a tree by its fruit  
and not by its leaves.

Euripides

When all this is said, there is one final remark to make—one that is not scientifically rooted or empirically proven, but one that everybody who has worked in industry will realize. If something is to stand the scrutiny of real life, it has to be simple, robust and in this context also provide standardized and consistent information. The approaches chosen by ISO and IPCC are in a sense scientifically rooted, but therein also lay their greatest weakness—they invite too much debate and valuations and this will be their undoing in the end. Only scientists deeply steeped in the ideology of science fails to see this.

Let me just mention that in the USA, they have spent more than 50 years just trying to come up with a formula to divide corporate tax revenues among individual states without succeeding.<sup>68</sup> What makes anybody believe that reaching meaningful, global agreements on the environment will be any easier? In fact, I believe that it will be far more difficult. Even if we ignore the practicalities of reaching agreements, the fundamental problem is that these approaches pretend to be much more reliable and objective than what they are. However, science is not value-free—not even hardcore science such as physics.<sup>69</sup>

Two telling tales we all have heard about are instructive: the tales of Galileo Galilei (1564–1642) and Sir Isaac Newton (1642–1727). Those of us with an education in engineering and natural science may believe that we know their stories from standard textbooks we have read in physics/mechanics, but we do not—at least I did not.

Science is a product of the curiosity born by the works of significantly people like Nicolaus Copernicus (1473–1543), Galileo, René Descartes (1596–1650), and not to mention Sir Isaac Newton. They presented an explanation to the many mysteries of those days that the Church did not seem to provide answers for. The Jesuit Thomas Corbishley (1903–1976) notes, however, that “the Church has never been hostile to scientific advance, and the tension between Church and Science can be attributable to, on one hand, the way scientific discoveries were presented to oppose the religious truths and, on the other hand, some theologians being nervous about its possible repercussions in their domain. In fact, hostility has often originated from the side of science.”<sup>70</sup> It is easy to dismiss this because it comes from a Jesuit, but what did really take place?

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<sup>68</sup>See The Economist (2014c). *Special report: companies and the state*. London, The Economist. p. 16.

<sup>69</sup>For a thorough and compelling review, see Cartwright, N. (2002). *How the Laws of Physics Lie*. Oxford, Clarendon Press. p. 221.

<sup>70</sup>See Corbishley, T. (1997). Christianity: The Catholic Church since the Reformation. *Encyclopedia of the World's Religions*. R. C. Zaehner. New York, Barnes & Noble Books.

In school, we were taught that the Church was solely at fault, however, by reading what really took place we get a much more nuanced picture actually more in line with what Corbishley says. This is well documented by Paul Karl Feyerabend (1924–1994), a philosopher of science.<sup>71</sup> A highly interesting sourcebook is also *A History of European Thought In The Nineteenth Century, Vol. 3* written by John Theodore Merz (1840–1922) and first published in 1903. His work forms the basis for our understanding of philosophy on a number of subjects prior to 1900 so it is time well spent reading (it is surprisingly readable too-perhaps because Merz was a chemist and not a philosopher).

Recall that Galileo presented the idea that the Earth was rotating around the Sun and that the whole universe followed inexorable laws (the heliocentric worldview or the Copernican System of Cosmology) and not everything rotating around the Earth (the geocentric worldview) as the Church held to be true at the time. He had support from his observations with the telescope but he was unable to explain how the clouds in the sky could follow the Earth if it was rotating around the Sun in high speed to keep its orbit. Therefore, when the matter was investigated by the Roman Inquisition in 1615, they concluded that it could be supported as only a possibility, not an established fact.<sup>72</sup> In retrospect, it is obvious that Galileo was right because later more physics was discovered that allowed us to explain why the clouds did not float away in space as the Earth rotated around the Sun. However, at the time, with the arguments presented in 1615, it is unquestionable that the Church had a more scientific approach than Galileo since they rejected a hypothesis that could not explain all observations. Also, Galileo used an instrument that was poorly understood at the time to support his findings.

Feyerabend suggests along the lines of other scholars that the *real* reason for Galileo coming into trouble was that he violated the rules of patronage vis-à-vis his powerful patron Pope Urban VIII. A final source for Galileo's misfortune that Feyerabend lists is his temper. He was easily irascible and full of contempt for people not up to his standards. These two factors are, of course, not unimportant in a politicized atmosphere that could easily exist in this case particularly when Galileo's defense presented in *Dialogue Concerning the Two Chief World Systems* appeared to attack Pope Urban VIII and hence alienated him and the Jesuits who had both supported Galileo up until this point.<sup>73</sup> He was subsequently tried by the Inquisition, found "vehemently suspect of heresy", forced to recant, and spent the rest of his life under house arrest. During his house arrest, however, he was urged by people from the Church to finish his work which shows that it was not necessarily what he said that was the problem but more that it lacked complete scientific foundation at the time or maybe even the way he said it...

<sup>71</sup>See Feyerabend, P. (2011). *The Tyranny of Science*. Cambridge, Polity Press. p. 153.

<sup>72</sup>See Pantin, I. (1999). "New Philosophy and Old Prejudices: Aspects of the Reception of Copernicanism in a Divided Europe." *Studies in history and philosophy of science* 30: (2): pp. 237–262.

<sup>73</sup>See Hilliam, R. (2004). *Galileo Galilei: Father of Modern Science*. New York, Rosen Publishing Group. p. 112.

The story of Galileo is not unique, however. Before the twelfth century another issue was at stake—was the Earth flat? There were plenty of references in the Bible suggesting that it was flat. However, based on the evidence the Church changed position. So, the Church has not be alien to new arguments as many claims—is has only exercised skepticism.

However, the best example is possibly Newton's law of gravity. Newton's law of gravity was presented in 1687 in his masterpiece *Philosophiæ Naturalis Principia Mathematica*. Using geometric methods, however, gave the startling result that the solar system would fall apart despite the fact that ancient Babylonian records indicated that the solar system had remained stable considerable time.<sup>74</sup> Newton observed that the solar system did not fall apart, and then concluded that the Almighty once in a while gave the planets a jolt to get them back into position. Hardly, a very scientific proposition, yet, Newton is proclaimed as one of the greatest in history of Science and rightfully so.

I do not tell these tales to belittle these great scientists—it should more serve as a warning against making science an ideology that is infallible and perfect. Science has its flaws and it is work in progress—always. As Bertrand Russell so eloquently phrased it:

Although this may seem a paradox, all exact science is dominated by the idea of approximation.

Then, does this approximation reduce the validity? In many cases, the answer is no, like Newtonian mechanics, for which this author has formal training at university level, but where is the borderline? Is trying to model such a hugely complex system such as the climate of the Earth a valid approach or is it deceptive? Many believe it is deceptive and with just cause as argued in the previous section. Just because a model can produce nice graphs and a massive output of numbers does not validate it. If the fundamentals are questionable—trying to model a hugely complex system without reference cases—a layer of advanced technology on top does not correct its fundamental shortcomings.

There are numerous examples of how people can be duped by someone saying something the right way even though the content is outright nonsensical or inaccurate to say the very least. The problem is that people mix the right way of expression as evidence of sincerity and truthfulness.<sup>75</sup> Take for example the essay Alan Sokal, a professor in physics at New York University, presented in the journal *Social Text* where he suggested a link between quantum mechanics and postmodernist philosophy of the kind popular in cultural studies. The essay, however, was a hoax, which Sokal announced in another journal *Lingua Franca*. Needless to say, the editors (and the reviewers) of *Social Text* appeared rather silly. Although Sokal

<sup>74</sup>See Feyerabend, P. (2011). *The Tyranny of Science*. Cambridge, Polity Press. p. 153.

<sup>75</sup>See Mercer, N. (2006). *Words and Minds; How we use language to think together*. London, Routledge. p. 206.

blatantly violated the Gricean<sup>76</sup> maxim of quality in communication, as well as partly violated the others maxims, his actions raise interesting question concerning the quality of researchers ability to judge truth content. In this case, the community subscribing to *Social Text* was duped, but what about those cases where it is the other way around. In fact<sup>77</sup>:

People offering new and interesting ideas to members of a community, but doing so in ways that do not correspond with the communicative ground rules of the communities, may find that their ideas are ignored or rejected simply because they are not presented in the right kind of language.

Sounds like a basis for Galileo's misfortune.... Furthermore, Albert Einstein in fact compared the scientific method to a game<sup>78</sup>:

One may compare these rules [related to the scientific method] with the rules of a game in which, while the rules are arbitrary, it is their rigidity alone which makes the game possible. However, the fixation will never be final. It will have validity only for a special field of application.

This said, science has amassed enough knowledge today for our societies to start the journey—what is missing is a more productive context that can unlock human ingenuity, just like the laws of limited liability did in the past. This process cannot start, however, by proclaiming that some scientists are right and others are wrong. We must use science where it applies correctly for enlightenment and not for debate which will stifle action toward sustainability. Therefore, the approaches today are too ambitious because they require a level of scientific infallibility and perfection that is impossible to achieve in foreseeable future. Yet, largely due to the politics of science,<sup>79</sup> this is the path pursued.

This book tries to argue that we should rather focus on what can be realistically managed and then institute policies accordingly. It is better to be approximately right than exactly wrong.

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<sup>76</sup>See the maxims in Grice, H. P. (1991). *Studies in the Way of Words*. Cambridge, MA, Harvard University Press. p. 394.

<sup>77</sup>See Mercer, N. (2006). *Words and Minds; How we use language to think together*. London, Routledge. p. 206.

<sup>78</sup>See Einstein, A. (1950). *The Theory of Relativity & Other Essays*. New York, MJF Books. p. 75.

<sup>79</sup>See Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* 91(2): pp. 307–337.

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