ΠΟΛΥΤΕΧΝΕΙΟ ΚΡΗΤΗΣ
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ΒΙΩΣΙΜΩΝ ΕΝΕΡΓΕΙΑΚΩΝ ΣΥΣΤΗΜΑΤΩΝ

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

the NATURAL STEP

ΑΝΑΠΤΥΞΗ ΜΕΘΟΔΟΛΟΓΙΑΣ ΓΙΑ ΕΝΑ ΣΤΡΑΤΗΓΙΚΟ ΑΕΙΦΟΡΟ ΣΧΕΔΙΑΣΜΟ ΣΕ ΕΠΙΧΕΙΡΗΣΕΙΣ ΚΑΙ ΚΟΙΝΟΤΗΤΕΣ. ΕΦΑΡΜΟΓΗ ΣΤΗΝ ΠΑΡΑΓΩΓΗ ΤΡΟΦΙΜΩΝ ΚΑΙ ΒΙΟΕΝΕΡΓΕΙΑΣ.

ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

ΤΟΥ

ΑΝΔΡΕΑ ΒΑΤΣΕΛΛΑ

ΥΠΟΒΑΛΛΟΜΕΝΟ ΩΣ ΜΕΡΟΣ ΤΗΣ ΕΚΠΛΗΡΩΣΗΣ ΤΩΝ ΥΠΟΧΡΕΩΣΕΩΝ
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ΠΕΡΙΛΗΨΗ

Ο σκοπός της διπλωματικής εργασίας είναι να συνδέσει έννοιες όπως η αειφόρος ανάπτυξη και η ευημερία με δράσεις που παίρνουμε σε οποιοδήποτε περιβάλλον βρισκόμαστε, είτε αυτό είναι μια επιχείρηση είτε μια άλλη κοινότητα ανθρώπων.

Συχνά έννοιες όπως η αειφορία και η ευημερία φαίνονται πολύ θεωρητικές, αν όχι ακατανόητες. Η διπλωματική αυτή επιδιώκει να χτίσει μέρος ενός οράματος για ένα μέλλον ευημερίας που μπορεί να εφαρμοστεί επιστημονικά σε οποιοδήποτε πλαίσιο.

Έτσι, προσπαθώντας να δώσει έμφαση στην ανάγκη μεταμόρφωσης και αειφόρου ανάπτυξης, και αναλύοντας ορισμένες υποκείμενες έννοιες, η διπλωματική εν συνεχεία συνδέει τις ιδέες αυτές με τη Βιομηχανική Οικολογία και μια συγκεκριμένη μεθοδολογία που μπορεί να υπηρετήσει ως ένα ενοποιητικό πλαίσιο για μια στρατηγική αειφόρο καινοτομία σε επιχειρήσεις και κοινότητες.

Η μεθοδολογία, αφότου εξηγείται και αναλύεται, συνδέεται με ένα συγκεκριμένο εργαλείο, ονομαζόμενο Ανάλυση Κύκλου Ζωής της Βιωσιμότητας (SLCA), το οποίο έχει αναπτυχθεί από το The Natural Step και στοχεύει να δώσει μια συνολική εικόνα αειφορίας ενός προϊόντος σε ολόκληρο τον κύκλο ζωής, σύμφωνα με συγκεκριμένες αρχές αειφορίας της μεθοδολογίας.

Η όλη μεθοδολογία εφαρμόζεται τελικά στο περιβάλλον μιας επιχείρησης που απασχολείται στον τομέα της παραγωγής τροφίμων, πιο συγκεκριμένα στην εταιρία Illy coffee. Ιδιαίτερη προσοχή δίνεται στην ανάκτηση ενέργειας από τα απόβλητα που δημιουργούνται κατά την παραγωγική διαδικασία της εταιρίας.

ΠΕΡΙΕΧΟΜΕΝΑ

ΕΚΤΕΤΑΜΕΝΗ ΠΕΡΙΛΗΨΗ

1. Εισαγωγή

Σήμερα είναι όλο και περισσότερο φανερό ότι η κοινωνία μας, έτσι όπως είναι οργανωμένη, οδηγεί τον πλανήτη σε καταστροφή. Ένας ολοένα αυξανόμενος καταναλωτισμός έχει πιέσει τους αυτοκαθαριζόμενους μηχανισμούς του περιβάλλοντος.

Κανένα από αυτά τα προβλήματα δεν μπορεί να αντιμετωπιστεί ρεαλιστικά χωρίς το συνυπολογισμό των άλλων προβλημάτων. Κανένα πρόβλημα δεν μπορεί να αντιμετωπιστεί χωρίς τη συνεργασία και το συντονισμό σε όλα τα επίπεδα. Οι επιλογές που κάνουμε σήμερα είναι καθοριστικές για το μέλλον.

Το ερώτημα με το οποίο ξεκινάει η διπλωματική εργασία είναι το πώς είναι δυνατόν να έχουμε όλο και μεγαλύτερη πρόοδο στην τεχνολογία και την επιστήμη, ενώ παράλληλα να διογκώνονται τα περιβαλλοντικά προβλήματα.

Ο στόχος της διπλωματικής εργασίας είναι αρχικά να προσπαθήσει να απαντήσει σε αυτό το ερώτημα φέρνοντας στο προσκήνιο τις έννοιες της αειφόρου ανάπτυξης και της ευημερίας, και αναλύοντας ορισμένες σκέψεις γύρω από αυτές τις έννοιες. Ύστερα, να συνδέσει τις ιδέες αυτές με τη φιλοσοφία κύκλου ζωής προσπαθώντας να δώσει μία συνολική εικόνα των εργαλείων που χρησιμοποιούνται, και να προτείνει ένα νέο μοντέλο σκέψης που μπορεί να βοηθήσει επιχειρήσεις ή κοινότητες να έχουν ένα αειφόρο προγραμματισμό. Τέλος, η διπλωματική εργασία έχει στόχο να εφαρμόσει αυτή τη μεθοδολογία στην εταιρία Illy coffee, η οποία ασχολείται με την παραγωγή καφέ. Ένα ξεχωριστό τμήμα αναφέρεται στις ιδιαίτερες ανάγκες της συγκεκριμένης επιχείρησης για την ανάκτηση ενέργειας από απόβλητα που δημιουργούνται κατά τη διαδικασία παραγωγής του καφέ.

2. Διεθνής Επιστημονική Εμπειρία

2.1 Η πρόκληση της αειφόρου ανάπτυξης και της ευημερίας

Κάθε μετάβαση από ένα στάδιο εξέλιξης της κοινωνίας σε ένα επόμενο συνοδεύεται από προφανείς κρίσεις σε πολλά επίπεδα. Αυτό που είναι κοινό σε κάθε μετάβαση είναι η αναζήτηση νέων πόρων. Γενικά, σε μια κοινωνία όπου οι πόροι είναι άπλετοι δεν υπάρχει ανάπτυξη. Ο περιορισμός των πόρων σηματοδοτεί περιόδους εφευρετικές, όπου ο συσχετισμός και οι σχέσεις μεταξύ των ανθρώπων αλλάζουν. Αυτό γίνεται φανερό και σήμερα, που μπαίνουμε σε μια περίοδο εκτεταμένου περιορισμού των πόρων. Η εικόνα ενός κώνου μπορεί να παρουσιάσει την κατάσταση αυτή και να δείξει την ανάγκη μετάβασης προς μια βιώσιμη κοινωνία. Οι πόροι του πλανήτη μειώνονται διαρκώς, ενώ ταυτόχρονα η ζήτηση αυξάνεται.

Τίθεται εύλογα λοιπόν το ερώτημα αν είμαστε σε θέση να οργανώσουμε τις βασικές εντάσεις που συνοδεύονται από κάθε μετάβαση της κοινωνικής οργάνωσης με διαφορετικούς νόμους σε κάθε χώρα. Είναι φανερό ότι χρειαζόμαστε λειτουργικούς θεσμούς σε παγκόσμιο επίπεδο και ένα νέο μοντέλο ζωής που να βασίζεται στην ενότητα της ποικιλομορφίας.

Γι'αυτό το λόγο, έννοιες όπως η ευημερία και η αειφόρος ανάπτυξη αποκτούν μεγάλη σημασία στο σημερινό κόσμο. Όλο και περισσότερο αναγνωρίζεται ότι η ευημερία δεν είναι μόνο υλική, αλλά περιλαμβάνει επίσης την κοινωνική και πνευματική πρόοδο. Επίσης έχει να κάνει και με την περιβαλλοντική πρόοδο.
Η αειφόρος ανάπτυξη μπορεί να θεωρηθεί ως το μέσο με το οποίο μπορεί να επιτευχθεί η ευημερία. Η αειφορία σημαίνει να διατηρούμε την παραγωγικότητα και τον πλούτο της κοινωνίας συνεχιζόμενη στο μέλλον, κάτι το οποίο είναι ιδιαίτερα σημαντικό τώρα, που έχουμε φτάσει στα όρια του πλανήτη. Ο πιο διαδεδομένος ορισμός της αειφόρου ανάπτυξης είναι αυτός που έχει εξαχθεί από το έργο του συμβουλίου του Μπράντλαντ (Brundtland Commission). Ορίζει την αειφόρο ανάπτυξη ως την ανταπόκριση στις τωρινές ανάγκες των ανθρώπων, χωρίς να εμποδίζει επόμενες γενεές να ανταποκριθούν στις δικές τους ανάγκες. Η αειφόρος ανάπτυξη

επομένως περιλαμβάνει επίσης την προοπτική του χρόνου και του χώρου. Πέρα από το οικονομικό, το περιβαλλοντικό και το κοινωνικό μέρος της αειφόρου ανάπτυξης υπάρχει το ηθικό κομμάτι. Η πράξη του να σκέφτεται κανείς τις ανάγκες των μελλοντικών γενεών είναι όμως από μόνη της μια εφαρμογή της αρχής της δικαιοσύνης.

Το επικρατέστερο σενάριο που έχει δοθεί από το Περιβαλλοντικό Πρόγραμμα των Ηνωμένων Εθνών για την μετάβαση της κοινωνίας, είναι αυτό που προτείνει την μετάβαση σε μια πιο βιώσιμη κοινωνία σε επίπεδο πλανητικό.

Ο ρόλος των αξιών είναι ουσιαστικός σε κάθε προσπάθεια προς μια αειφόρο ανάπτυξη, αφού η ανθρωπότητα στο σύνολό της είναι ένας οργανισμός που έχει ανάγκη από κοινούς κανόνες, και αυτοί οι κοινοί κανόνες βασίζονται σε κοινές αξίες. Οι αξίες που επικρατούν στα σημερινά οικονομικά συστήματα δεν είναι λειτουργικές, καθώς μας οδηγούν σε εντελώς μη βιώσιμες κατευθύνσεις. Χρειαζόμαστε επομένως νέες αξίες για να χτίσουμε μια αειφόρο κοινωνία.

Παράλληλα χρειαζόμαστε μηχανισμούς συνεργασίας και διαβούλευσης μεταξύ επιχειρήσεων, και μεταξύ επιχειρήσεων και κυβερνήσεων. Οι επιχειρήσεις χρειάζονται ένα δίκαιο πλαίσιο στο οποίο να λειτουργούν σε ένα παγκόσμιο επίπεδο.
Ο ορισμός του συμβουλίου του Μπράντλαντ είναι σε ένα υψηλό φιλοσοφικό επίπεδο και πρέπει να διασπαστεί σε λειτουργικές αρχές, έτσι ώστε να έχει μια πρακτική χρησιμότητα.

5.2 Βιομηχανική Οικολογία και Φιλοσοφία Κύκλου Ζωής

Η Βιομηχανική Οικολογία έχει ως στόχο να εξηγήσει πώς το βιομηχανικό σύστημα δουλεύει, πώς ρυθμίζεται και πώς αλληλεπιδρά με τη βιόσφαιρα. Θα πρέπει να αντιμετωπίζουμε τα περιβαλλοντικά προβλήματα στο σύνολο τους, όχι ξέχωρα.
Ο σκοπός της Φιλοσοφίας Κύκλου Ζωής (Life Cycle Thinking) είναι η αναγνώριση πιθανών βελτιώσεων σε υπηρεσίες ή προιόντα με τη μορφή λιγότερων περιβαλλοντικών επιπτώσεων σε όλα τα στάδια του κύκλου ζωής, δηλαδή από τις πρώτες ύλες, την μεταποίηση και τη διανομή, μέχρι την τελική χρήση και κατανάλωση. Ολοκληρώνεται με την επαναχρησιμοποίηση, την ανακύκλωση των υλικών, την ανάκτηση ενέργειας και την τελική διάθεση.

Με τη Φιλοσοφία Κύκλου Ζωής λοιπόν αποφεύγεται η μετατόπιση του βάρους, δηλαδή η αντιμετώπιση επιπτώσεων σε ένα στάδιο, με την αποφυγή επιπτώσεων σε ένα άλλο στάδιο του κύκλου ζωής.

Χρειαζόμαστε πρωτοβουλίες σε παγκόσμιο επίπεδο που να περιλαμβάνουν μια φιλοσοφία κύκλου ζωής για τις επιχειρήσεις, καθώς ολοένα και περισσότερα προϊόντα (αγαθά και υπηρεσίες) εμπορεύονται σε παγκόσμιο επίπεδο. Η Διαχείριση Κύκλου Ζωής (Life Cycle Management) στοχεύει να κάνει τη φιλοσοφία κύκλου ζωής και την βιωσιμότητα των προιόντων λειτουργική για τις επιχειρήσεις. Έτσι οι επιχειρήσεις δεν κοιτάνε μόνο τί συμβαίνει στις δικές τους λειτουργίες, αλλά καθ'όλο το μήκος της αλυσίδας αξίας.

Υπάρχουν πολλές διαφορετικές στρατηγικές που χρησιμοποιούνται από τις επιχειρήσεις για να εφαρμόσουν τη διαχείριση του κύκλου ζωής στις λειτουργίες τους. Αυτά τα εργαλεία είναι περιβαλλοντικά, όπως η Ανάλυση Κύκλου Ζωής (Life Cycle Analysis), οικονομικά, όπως η Κοστολόγηση Κύκλου Ζωής (Life Cycle Costing) και κοινωνικά, όπως η Κοινωνική Ανάλυση Κύκλου Ζωής (Social Life Cycle Analysis).

Παρόλο που η Ανάλυση Κύκλου Ζωής οδηγεί σε μια πιο ολοκληρωμένη εικόνα των κοινωνικών και περιβαλλοντικών επιπτώσεων παρά μια απλή αξιολόγηση του προιόντος, ένα πολύ μικρό ποσοστό των επιχειρήσεων έχουν λάβει πρακτικά μέτρα από τα αποτελέσματα της Ανάλυσης Κύκλου Ζωής. Αυτό μπορεί να συμβαίνει, είτε γιατί η Ανάλυση Κύκλου Ζωής είναι πολυσύνθετη, είτε γιατί σε γενικές γραμμές σε μια Ανάλυση Κύκλου Ζωής λείπει μια στρατηγική προοπτική αναπτυξης για τις επιχειρήσεις.

Το Πλαίσιο Βιώσιμης Ανάλυσης Κύκλου Ζωής (Life Cycle Sustainability Analysis) είναι ένα πλαίσιο για μελλοντικές αναλύσεις κύκλου ζωής. Διευρύνει την έκταση των παραδοσιακών Αναλύσεων Κύκλου Ζωής από μονάχα περιβαλλοντικές επιπτώσεις, και σε οικονομικές και κοινωνικές επιπτώσεις. Το Πλαίσιο Βιώσιμης Ανάλυσης Κύκλου Ζωής είναι ένα σύνολο μοντέλων και όχι ένα μοντέλο καθαυτό. Συνδέει τη στοχευμένη στο προϊόν Ανάλυση Κύκλου Ζωής ή Κοστολόγηση Κύκλου Ζωής με συγκεκριμένες ερωτήσεις, για τις οποίες αυτά τα εργαλεία είναι πλήρως αποτελεσματικά.

Έτσι λοιπόν, μια από τις κύριες προκλήσεις είναι να τεθούν σε διάθεση με πρακτικό τρόπο η πληθώρα των μοντέλων-εργαλείων ανάλογα με τύπους ερωτήσεων βιωσιμότητας του κύκλου ζωής. Η αειφόρος ανάπτυξη απαιτεί μια συστημική αντιμετώπιση, με την οποία να γίνονται κατανοητές οι αλληλεπιδράσεις μέσα στο σύστημα.

3. Μεθοδολογία

3.1 Η "πρόβλεψη προς τα πίσω" από Αρχές Αειφορίας

Ο πιο κοινός τρόπος σχεδιασμού για το μέλλον είναι η ανάλυση της τωρινής κατάστασης λαμβάνοντας υπ'όψιν προβλήματα του παρελθόντος και εν συνεχεία προσπαθώντας να αντιμετωπισθούν αυτά τα προβλήματα στο μέλλον. Ο τρόπος αυτός χαρακτηρίζεται προβλεπτικός τρόπος (forecasting). Αντιθέτως ένας διαφορετικός τρόπος σχεδιασμού που δε στοχεύει στα προβλήματα βασίζεται σε ένα τελικό όραμα αειφορίας. Αυτός ο τρόπος καλείται "πρόβλεψη προς τα πίσω" (backcasting).

Η μεθοδολογία "πρόβλεψης προς τα πίσω" με βάση Αρχές Αειφορίας χαρακτηρίζεται από πέντε ξεχωριστά επίπεδα:

1. Το Σύστημα. Η ολοκληρωμένη λειτουργία του συστήματος, που σε αυτή την περίπτωση είναι η βιόσφαιρα και η ανθρώπινη κοινωνία

2. Ένας βασικός ορισμός της επιτυχίας μέσα στο σύστημα, που για αυτή την περίπτωση είναι η αειφορία.

3. Στρατηγικές γραμμές, που στην περίπτωση αυτή είναι μια συστηματική προσέγγιση, η οποία να συμβαδίζει με τον ορισμό της επιτυχίας, εξασφαλίζοντας ότι οι πόροι συνεχίζουν να τροφοδοτούν τις δράσεις.

4. Δράσεις, δηλαδή κάθε συγκεκριμένο βήμα που λαμβάνεται για την μετάβαση προς την αειφορία.

5. Εργαλεία για το συστηματικό έλεγχο των δράσεων, έτσι ώστε να είναι στρατηγικές και να οδηγούνται προς την επιτυχία μέσα στο σύστημα που εξετάζεται.

Η βιόσφαιρα είναι το σύστημα στο οποίο όλα τα είδη, μεταξύ των οποίων και οι ίδιοι οι άνθρωποι, αλληλεπιδρούν. Έτσι λοιπόν, κάθε δράση έχει επιπτώσεις στα υπόλοιπα στοιχεία του συστήματος.

Τα 3 διακριτά χαρακτηριστικά των συστημάτων, στα οποία οι οργανισμοί επιβιώνουν, είναι:
1. Η αυτο-οργάνωση.
2. Η ποικιλομορφία.
3. Η αλληλεπίδραση.

Η βασική επιστήμη εξηγεί πώς:
- Η ύλη και η ενέργεια δεν εξαφανίζονται.
- Η ύλη και η ενέργεια τείνουν να διαχυθούν.
- Η συγκέντρωση και η δομή της ύλης καθορίζουν την ποιότητα της ύλης.
- Η φωτοσύνθεση δημιουργεί μια αύξηση στη συγκέντρωση και δομή της ύλης χρησιμοποιώντας ύλη από τον ήλιο.

Πέρα από τα 3 χαρακτηριστικά κάθε συστήματος υπάρχουν και άλλα παραδείγματα κοινών ανθρώπινων χαρακτηριστικών, όπως οι βασικές ατομικές ανάγκες, η ικανότητα λήψης συνειδητών αποφάσεων και η ικανότητα αξιοποίησης της εμπάθειας.
Οι κοινωνίες επιπλέον αποτελούνται από διαπροσωπικές σχέσεις. Έτσι, χρειάζεται να έχουμε εμπιστοσύνη στους ανθρώπους με τους οποίους σχετιζόμαστε.

Δεν αρκεί μόνο να κατανοήσουμε το σύστημα από μόνο του για να μπορέσουμε να σχεδιάσουμε στρατηγικά. Είναι σημαντικό να έχουμε ενα σταθερό ορισμό του στόχου. Η οργάνωση The Natural Step δημιούργησε μια μεθοδολογία συμπληρωματικών, μή καλυπτόμενων συνθηκών για τη κοινωνική και οικολογική αειφορία.

Αυτές οι 4 Αρχές της Αειφορίας οργανώθηκαν με βάση τα εξής κριτήρια:
1. Να είναι βασισμένες στην επιστήμη.
2. Να είναι αναγκαίες.
3. Να είναι επαρκείς.

4. Να είναι γενικές.
5. Να είναι συγκεκριμένες.
6. Να είναι διακριτές.

Οι 4 Αρχές της Αειφορίας είναι οι εξής:

Σε μία βιώσιμη κοινωνία, η φύση δε θα πρέπει να υπόκειται στη συστηματική αύξηση:

1.Των συγκεντρώσεων των ουσιών που προέρχονται από το φλοιό της Γής.

2.Των συγκεντρώσεων των ουσιών που παράγονται από την κοινωνία.

3. Της υποβάθμισης του περιβάλλοντος.

και, επιπλέον, σε αυτή την κοινωνία:

4. Οι άνθρωποι παντού δε θα υπόκεινται σε καταστάσεις που συστηματικά υποβαθμίζουν την ικανότητά τους να ανταποκρίνονται στις ανάγκες τους.

Καθεμιά από αυτές τις Αρχές Αειφορίας μπορούν να κατηγοριοποιηθούν περαιτέρω σε δύο βασικούς μηχανισμούς:
- Την απο-υλοποίηση, δηλαδή τη μείωση των ροών των υλικών, και
- Την υποκατάσταση, δηλαδή την αλλαγή του είδους των ροών και των δραστηριοτήτων.

Η τέταρτη Αρχή της Αειφορίας, έτσι όπως είναι διατυπωμένη, δεν είναι αρκετά λειτουργική. Μπορούν να αναγνωριστούν 5 Αρχές που εξασφαλίζουν ότι τουλάχιστον δεν καταστρέφεται το κοινωνικό σύστημα.

Αυτές είναι:
1. Η ενσωμάτωση
2. Η επιρροή
3. Η αρμοδιότητα
4. Η καθολικότητα
5. Η σκοπιμότητα

Το τρίτο επίπεδο αναφέρεται στις στρατηγικές για την επίτευξη του στόχου της αειφορίας. Οι Αρχές πρέπει να σχεδιάζονται στρατηγικά. Οι επενδύσεις θα πρέπει να επιλέγονται με βάση 4 Αρχές:
1. Την "προς τα πίσω πρόβλεψη"
2. Τις ευέλικτες πλατφόρμες
3. Την αναγκαία επιστροφή του κεφαλαίου
4. Την αρχή της προφύλαξης

Οι Αρχές της διαδικασίας που αναφέρονται στο τρίτο επίπεδο εφαρμόζονται με τέτοιο τρόπο, ώστε να ενισχύουν συγκεκριμένες δράσεις που εν τέλει θα συμβαδίζουν με τις συστημικές Αρχές της Αειφορίας (επίπεδο 2) μέσα στη βιόσφαιρα (επίπεδο 1).

Τα εργαλεία που χρησιμοποιούνται για να εκτιμήσουμε την εξέλιξη προς την αειφορία στοχεύουν, είτε στην εκτίμηση του κατά πόσο οι δράσεις συμβαδίζουν με το συνολικό σχέδιο και τους στόχους, είτε στην εκτίμηση των επιπτώσεων που δημιουργούνται στο σύστημα που θέλουμε να προστατεύσουμε.

Η πρακτική εφαρμογή της μεθοδολογίας υποβοηθάται από μια διαδικασία A-B-C-D, όπου A (Awareness and Visioning) είναι η δημιουργία του οράματος και η συζήτηση της μεθοδολογίας με όλους τους συμμετέχοντες, B (Baseline Analysis) είναι η εκτίμηση των τωρινών υλικών και ενεργειακών ροών και πρακτικών σχετικά με τις βασικές Αρχές Αειφορίας, C (Creative Solutions) είναι η δημιουργία επιλογών και οραμάτων που να υποστηρίζουν τη συμμόρφωση με τις βασικές Αρχές Αειφορίας, και D (Deciding on Priorities) η θέση προτεραιοτήτων των δράσεων που προκύπτουν από το βήμα (C).
Το βήμα (A) έχει λοιπόν να κάνει με τη δημιουργία οράματος, το βήμα (B) έχει να κάνει με την ανάλυση της τωρινής κατάστασης, το βήμα (C) έχει να κάνει με την εύρεση δημιουργικών λύσεων και το βήμα (D) έχει να κάνει με τις προτεραιότητες που δίνονται σε κάθε λύση.

3.2 Η Ανάλυση Κύκλου Ζωής της Βιωσιμότητας (SLCA)

Η οργάνωση The Natural Step έχει δημιουργήσει την Ανάλυση Κύκλου Ζωής της Βιωσιμότητας (SLCA), που είναι ένα εργαλείο για την αξιολόγηση της βιωσιμότητας των προϊόντων. Είναι ένα ερωτηματολόγιο που παρέχει μια στρατηγική εικόνα της συνολικής

έκτασης της κοινωνικής και οικολογικής αειφορίας στο επίπεδο των προϊόντων.

Το εργαλείο αυτό περιλαμβάνει μια σειρά από ερωτήματα για κάθε στάδιο του κύκλου ζωής ενός προϊόντος με βάση τις 4 Αρχές Αειφορίας. Τα αποτελέσματα παρουσιάζονται σε μια μήτρα (5X4), στην οποία κάθε κελί αντιπροσωπεύει ένα διαφορετικό συνδυασμό Αρχής Αειφορίας και σταδίου του κύκλου ζωής. Έτσι, το κάθε κελί λαμβάνει ένα διαφορετικό χρώμα, ανάλογα με τον αριθμό των θετικών απαντήσεων του συγκεκριμένου συνδυασμού.

Η Ανάλυση Κύκλου Ζωής της Βιωσιμότητας ενός προϊόντος (SLCA) χρησιμοποιείται για 3 διαφορετικούς σκοπούς, ανάλογα με την ανάγκη του χρήστη:
1. Την αξιολόγηση
2. Την εκπαίδευση
3. Την επικοινωνία

Το εργαλείο χρησιμοποιείται στα πλαίσια του επιπέδου (B) της διαδικασίας A-B-C-D.

Υπάρχουν συγκεκριμένες διαφορές μεταξύ της παραδοσιακής Ανάλυσης Κύκλου Ζωής και της Ανάλυσης Κύκλου Ζωής της Βιωσιμότητας. Αυτές αφορούν τους στόχους του κάθε εργαλείου, τη στρατηγική προοπτική τους, την εφαρμοσιμότητά τους και το μέγεθος της ανάλυσης. Το παραδοσιακό εργαλείο της Ανάλυσης Κύκλου Ζωής χρησιμεύει ως συμπληρωματικό της Ανάλυσης Κύκλου Ζωής της Βιωσιμότητας.

Η μεθοδολογία εφαρμόζεται σε οργανισμούς ή κοινότητες. Σε αυτή τη διπλωματική εργασία λαμβάνεται ως οργανισμός η εταιρία Illy coffee.

4. Αποτελέσματα

Πραγματοποιήθηκαν δύο άμεσες συναντήσεις με την εταιρία, μία στην έδρα της, στην Τεργέστη της Ιταλίας, και μία στο Ρίο ντε Τζανέϊρο, στα πλαίσια του συνεδρίου των Ηνωμένων Εθνών για την αειφόρο ανάπτυξη. Πέρα από τις δύο άμεσες συναντήσεις

πραγματοποιήθηκαν πολλές επαφές και ανταλλαγές πληροφοριών μέσω ηλεκτρονικής αλληλογραφίας και τηλεφωνικής επικοινωνίας.

Η μεθοδολογία εφαρμόστηκε με δύο τρόπους:
Πρώτον, με τη σύνδεση των πληροφοριών που συλλέχθηκαν από τις επαφές και τα διάφορα αρχεία για της επίδοση της εταιρίας ως πρός το περιβάλλον και την αειφορία, με τα 5 επίπεδα της μεθοδολογίας. Δεύτερον, εφαρμόζοντας την Ανάλυση Κύκλου Ζωής της Βιωσιμότητας στην εταιρία. Τέλος, δόθηκε ιδιαίτερη έμφαση στην ανάκτηση ενέργειας από τα απόβλητα που δημιουργούνται κατά τη διάρκεια του κύκλου ζωής του καφέ.

Τα στοιχεία, που λήφθηκαν λοιπόν από τις άμεσες και έμμεσες επαφές με την εταιρία, κατηγοριοποιήθηκαν με βάση τα 5 επίπεδα της μεθοδολογίας. Αυτά παρουσιάζονται στο κυρίως σώμα της διπλωματικής εργασίας.

Η Ανάλυση του Κύκλου Ζωής της Βιωσιμότητας εφαρμόστηκε λαμβάνοντας ως μονάδα μελέτης το μεταλλικό δοχείο με τον καφέ 3 kg.

Τα αποτελέσματα από το ερωτηματολόγιο παρουσιάζονται στην παρακάτω μήτρα:

	1. Πρώτες Ύλες	2. Παραγωγή	3. Συσκευασία, Διανομή	4. Χρήση	5. Τέλος Ζωής
Αρχή Αειφορίας 1	6	3	2	5	2
Αρχή Αειφορίας 2	6	4	4	4	4
Αρχή Αειφορίας 3	6	5	4	5	2
Αρχή Αειφορίας 4	7	6	7	5	7

Η εταιρία Illy coffee έχει εφαρμόσει μια δράση για την ανάκτηση θερμότητας από τα απόβλητα που δημιουργούνται κατά τη διάρκεια παραγωγής του καφέ. Αυτή τη στιγμή η εταιρία ανακτάει περίπου το 1% από τη μονάδα καύσης για λόγους θερμότητας. Αυτό σε ισοδύναμους τόνους πετρελαίου ανήλθε για το έτος 2010 στα 3845 ΤΟΕ. Στο κείμενο της διπλωματικής εργασίας παρουσιάζονται τα στοιχεία σχετικά με την κατανάλωση της ενέργειας και την παραγωγή αποβλήτων κατά την παραγωγική διαδικασία. Επιπλέον εκτιμάται η ενέργεια που μπορεί να ανακτηθεί από τη βιομάζα που παράγεται.

Από τη αξιοποίηση της μεθοδολογίας και τα συγκεκριμένα αποτελέσματα μπορούν να εξαχθούν πολλές πληροφορίες, οι οποίες περιγράφονται και αναλύονται στο κείμενο της διπλωματικής.

Σε γενικές γραμμές, αποδεικνύεται ότι η εταιρία Illy coffee παρουσιάζει πολύ καλή επίδοση όσον αφορά θέματα αειφορίας, σύμφωνα με τη μεθοδολογία που εφαρμόστηκε. Περαιτέρω βελτίωση και μια μεγαλύτερη προοπτική μπορεί να επιτευχθεί αν η εταιρία αρχίσει να βασίζει τις στρατηγικές της σε ξεκάθαρες Αρχές Αειφορίας.

Η Ανάλυση Κύκλου Ζωής της Βιωσιμότητας που εφαρμόστηκε απέδειξε ότι πράγματι η εταιρία είναι πρωτοπόρα σε θέματα αειφορίας. Η υψηλότερη επίδοση σύμφωνα με τις Αρχές Αειφορίας παρατηρήθηκε στο τομέα των ανθρώπινων αναγκών, ενώ με βάση τα στάδια του κύκλου ζωής παρατηρήθηκε η υψηλότερη απόδοση στο στάδιο των πρώτων υλών. Αντίθετα, το πιο κρίσιμο σημείο με βάση τον κύκλο ζωής του προϊόντος παρατηρείται στο στάδιο του

τέλους ζωής του προϊόντος, ενώ το κρισιμότερο σημείο σύμφωνα με τις Αρχές Αειφορίας παρατηρείται στην κάλυψη της πρώτης Αρχής Αειφορίας (SP1). Αξίζει να τονιστεί ότι οι αρνητικές απαντήσεις αφορούν συνήθως ερωτήσεις που είναι δύσκολο να απαντηθούν θετικά, καθώς υπεισέρχεται και η εξάρτηση από άλλους παράγοντες. Αυτό δείχνει σε μια επόμενη ανάλυση την ανάγκη για μηχανισμούς διαβούλευσης μεταξύ επιχειρήσεων και μεταξύ επιχειρήσεων και κυβερνήσεων.

Το ποσοστό ανάκτησης ενέργειας από τη μετρήσιμη βιομάζα που απορρίπτεται κατά τη διαδικασία παραγωγής του καφέ είναι πολύ μικρό, και επίσης αυτή η βιομάζα δεν είναι διακριτή, βρίσκεται δηλαδή μαζί με όλα τα υπόλοιπα απόβλητα.
Αυτό βέβαια δείχνει ότι η εταιρία Illy coffee είναι ήδη πολύ υπεύθυνη όσον αφορά την επεξεργασία των αποβλήτων.

5. Προτάσεις

Υπάρχουν αρκετές αλλαγές που προτείνονται και που έχουν να κάνουν με την έκταση μελέτης της Ανάλυσης Κύκλου Ζωής της Βιωσιμότητας, αλλά και γενικότερα όσον αφορά τη μεθοδολογία.

Οι αλλαγές που προτείνονται έχουν να κάνουν με την επάρκεια του εργαλείου, όπως για παράδειγμα ότι δεν υπάρχει ένας παράγοντας βαρύτητας στις ερωτήσεις, με αποτέλεσμα να μη διαφαίνεται απαραίτητα η διαφορά μεταξύ μιας οργάνωσης που λαμβάνει δραστικά μέτρα προς την αειφορία και μιας άλλης που δεν το κάνει αυτό. Όμως αυτό δε σημαίνει ότι το εργαλείο είναι αναποτελεσματικό. Αντιθέτως, παρόλο που κάποια μέρη μπορούν να βελτιωθούν, το εργαλείο θα πρέπει να μείνει απλό και εμβριθές και θα πρέπει να συγκεντρώνεται στήν κατεύθυνση όσον αφορά την αειφορία ενός προϊόντος. Θα πρέπει παράλληλα με το εργαλείο αυτό να χρησιμοποιούνται και άλλα εργαλεία που να δείχνουν τί πόρους επενδύει μια επιχείρηση για την αειφορία και πόσο αποτελεσματική είναι.

Προτείνεται επίσης η συνέχιση της αξιοποίησης της βιομάζας ως εδαφοβελτιωτικό, και η διοχέτευση των ενεργειών της επιχείρησης

στην περαιτέρω απεξαρτητοποίησή της από ορυκτά καύσιμα με την επένδυση σε ανανεώσιμες μορφές ενέργειας.

Η προσέγγιση της Στρατηγικής Αειφόρου Ανάπτυξης είναι πολύ χρήσιμη για τη μελέτη της αειφορίας. Δίνει μια νέα διάσταση, μια συστημική προσέγγιση, που βοηθάει ουσιαστικά τη διαδικασία λήψης αποφάσεων. Παράλληλα, η Στρατηγική Αειφόρος Ανάπτυξη αποφεύγει πολλές από τις παγίδες που μπορεί να εμποδίσουν άλλες πρωτοβουλίες προς την αειφορία. Επιπλέον μια στρατηγική προσέγγιση μπορεί να ενδυναμώσει τα άτομα να δράσουν αποφασιστικά απέναντι στη μεγάλη πρόκληση της αειφορίας.

Παρόλο που η μεθοδολογία Στρατηγικής Αειφόρου Ανάπτυξης που έχει δημιουργηθεί από το The Natural Step είναι αποτελεσματική, μπορεί να αποτελέσει μια ενοποιητική μεθοδολογία μόνο εφόσον λάβει υπ'όψιν της τη σημασία των αξιών, κάτι τόσο ουσιαστικό για τη διαδικασία λήψης αποφάσεων. Αυτό που τελικά χρειαζόμαστε, αν λάβουμε υπ΄όψιν μας τις ανάγκες των ανθρώπων, είναι μια κοινή θεώρηση των αξιών, που θα μας οδηγήσουν σε ένα ενοποιημένο κοινωνικό σώμα. Μια επιχείρηση όπως η Illy coffee μπορεί, και θα πρέπει, να εξετάζει πώς οι έννοιες της αειφόρου ανάπτυξης, της ευημερίας και των αξιών είναι αναπόσπαστα συνδεδεμένες μεταξύ τους και με την επιχείρηση.

ΠΑΡΑΡΤΗΜΑ: ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ ΣΤΑ ΑΓΓΛΙΚΑ

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Lastly, i would like to thank my family for their loving and sacrificial support and everyone who gave a piece in completing my work. This includes of course Illy coffee, for being my business-case and EBBF (European Baha'i Business Forum), where i learned about the framework of The Natural Step and more specifically Stanley Nyoni and Mahmud Samandari.

ABSTRACT

The purpose of this Thesis is to connect concepts like sustainable development and prosperity with actions that we take in whatever setting we are, be it a business or another community of people.

Often such concepts like sustainability or prosperity are seen very theoretical, if at all understandable. What this thesis is trying to build is part of a vision of a prosperous future that can be applied scientifically in whatever context.

So by trying to stress the need of transformation and of sustainable development and by analyzing some underlying concepts, the thesis is then connecting these ideas with Industrial Ecology and a specific methodology that can serve as a unifying framework for strategic sustainable innovation in businesses and communities.

The methodology is based on the framework of The Natural Step, which is a network of non-governmental organizations that is helping other organizations and individuals understand and make meaningful progress towards sustainability.

The framework, after being explained and analyzed, is then connected to a specific tool, namely SLCA (Sustainability Life Cycle Assessment), which is developed by The Natural Step and it aims at giving an overall sustainability picture of a product throughout it's life cycle, according to specific sustainability principles of the framework.

The whole methodology is finally applied to a business setting in the food production branch, namely Illy coffee. Special attention is given on the recovery of energy created by waste produced by Illy coffee.

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LIST OF ABBREVIATIONS

BSP:	Backcasting from Sustainability Principles
FSSD:	Framework for Strategic Sustainable Development
H&S:	Health and Safety
IE:	Industrial Ecology
LCA:	Life Cycle Assessment
LCC:	Life Cycle Costing
LCM:	Life Cycle Management
LCSA:	Life Cycle Sustainability Analysis
PLT:	Packaging, Logistics and Transportation
R&D:	Research and Development
S-LCA:	Social Life Cycle Assessment
SLCA:	Sustainability Life Cycle Assessment
SP:	Sustainability Principle
SSD:	Strategic Sustainable Development
TNS:	The Natural Step
TOE:	Tons of Oil Equivalent
UNEP:	United Nations Environment Program

1. Introduction

Nowadays there are a considerable number of contrasting signs which highlight that our society is contributing to the planet's collapse: a growing environmental burden, tremendous wealth imbalances, an ecological footprint that is exceeding the earth's carrying capacity, people who can not cover their basic needs, etc. increase year after year.

An ever increasing consumerism has increased dramatically the environmental pressure in the creative self-cleaning ability of nature but it is utopia to think that our resources are limitless. Materialistic civilization that replaces the idea of "citizen" with the "consumer" cannot concern itself with the long-term viability of life on earth.

For the first time humans are in such a scale pervasive and dominant forces in the health and well-being of the earth and its inhabitants. [Segalas et al., 2009]

None of these problems can be realistically addressed without considering all others. None can be fully addressed without a magnitude of cooperation and coordination at all levels that far surpasses anything in humanity's collective experience. [Baha'i International Community, 1992]

Choices made today will determine how these threats will unfold in the future and reversing the immense environmental trends that are so apparent will be an immense challenge. [UNEP, 2007]

It is clear signs though, that two distinctive and ever increasing forces are operating in the world nowadays. The one is a disintegrative or destructive force, which can be testified by the collapsing of our present systems and social structures and the other is an integrative or constructive force, which can be seen in the great advancements in science and technology.

How is it possible then that even though we can see a great progress in technology and science, we have greater environmental problems?

The aims of the following sections are:

- To try to answer to that question by bringing the concept of sustainable development and prosperity in the forefront and analyzing some ideas behind them.

- To connect these ideas with Life cycle thinking by trying to give an overall picture of tools that are used and suggesting a new way of thinking that would assist a business or a community to have a sustainable planning process.

- To put into practice this methodology in a structure of a food company, namely Illy coffee, and giving special attention to their specific needs of recovering energy from waste created in all phases of the life cycle.

2. The Challenge of Sustainable Development and Prosperity

In order to understand better the significance of the concepts of sustainable development and prosperity, as well as the link between them, it would be helpful to explore what is the experience of humanity in terms of the natural resources and to raise our understanding of how crucial is the period in which we live in.

2.1 Natural Resources and Experience of Humanity

We could consider the history of our planet evolving through ever widening and complex social aggregations, passing through the following distinct stages of the individual, the family, the tribe, the village, the city, the city state, the empire and the nation, as seen in the following picture.

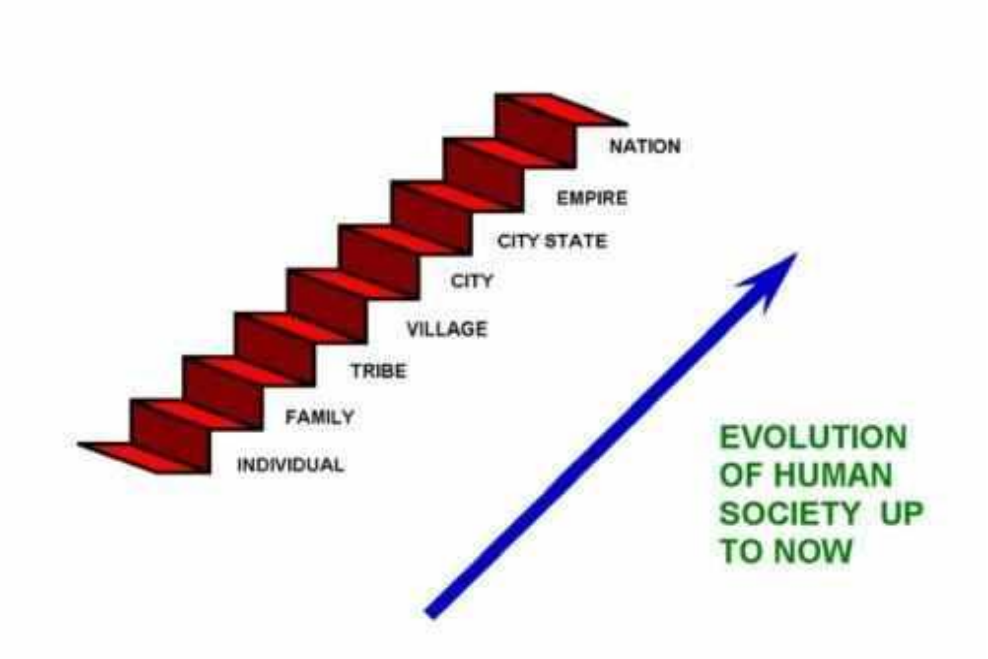


Figure 2.1: Evolution of humanity [Robiati, 2004]

What is pictured above occurred everywhere on Earth in different evolutionary times and rhythms. Usually the passage from a traditional to a more modern aggregation derives from a profound crisis that involves values, religion, political and economical organizations, and that is increasing as the following phase approaches. But why is this happening?

Studying this evolution of humanity we can note that the moment that signals a change of a system of life has had a constant in common with all the other passages in history, and this is recognizable in resources. Generally in a society where resources abound, there is no development, and life proceeds at an ever faster rate of consumption of the available assets. As soon as the resources begin to become scarce, a new climate of preoccupation takes over and leads individuals to first struggle for socioeconomic survival, and then to understand how this situation began. It's just through these difficulties and sufferings that a new process of maturation initiates and leads society to vibrate in order to make it "leap forward".

When resources become more and more scarce and crisis arises, it signals inventive periods where relationships between the individuals, the communities and the institutions change. Primitive people, for example, were involved in hunting and began to work the land only to satisfy their pressing need for food. Lacking rational organization and planning, animals and eatable plants became more and more scarce; indiscriminate exploitation caused scarcity of resources, which resulted in a crisis that forced them to try out new systems so that, gradually, agriculture and cooperation among villages replaced the system based on the individual and founded on hunting. The same occurred in other societies with different social organizations. Past history shows that big changes occurred not after the establishment of a situation of abundance, but as the consequence of dissipation of existing resources. [Robiati, 2004]

Exactly the same can be evidenced today in another level. In fact our twenty first century society is coming out of a period of extreme waste of resources and is entering a period of enormous scarcity. Problems are overwhelming a humanity that finds it difficult to come up with a suitable solution.

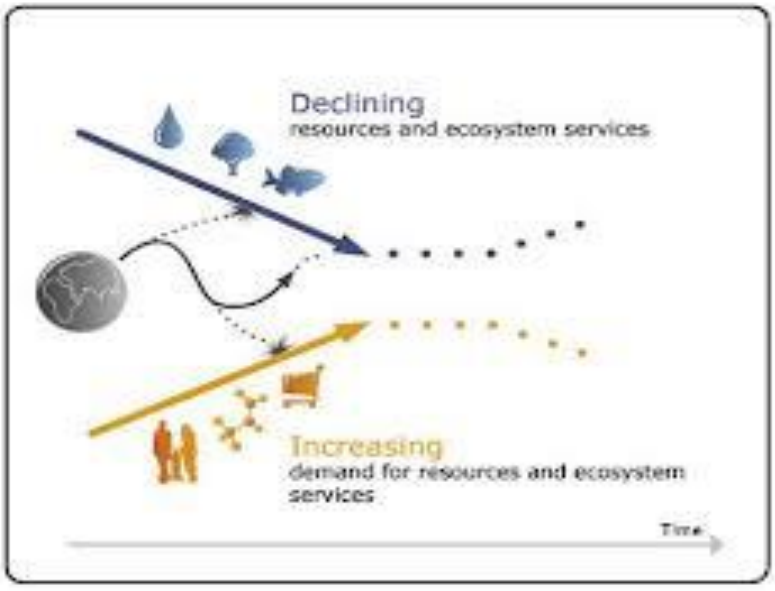


Figure 2.2: The "funnel" analogy [http://3sevensolutions.tumblr.com]

The above picture represents a simple analogy of what is happening today with regard to the resources of the planet. It is often described as the "funnel analogy", and it is an analogy used extensively by the Natural Step (see paragraph 3.5) to explain the need of businesses or communities to put sustainability in the center of their strategies, in order to reduce the risk of hitting on the walls of the funnel and thus moving towards a sustainable society. It is a very good example that anybody would agree upon. That resources and ecosystem services are declining, whereas the demand for resources and ecosystem services are increasing and that we need to reverse this situation.

Now the question arises: Can we organize the environment and the other main vibrations, mentioned earlier, with different laws in each country?
It is evident that environmental problems cannot be dealt differently in each country, simply because they cannot be confined to the borders of one country. Environmental problems nowadays are global. So even only from the perspective of the environment it becomes evident that we need to deal with the problems on a planetary level.

The present crisis that involves each one of us is due to those impulses that push humanity to leap towards the next level: from the current one, based on the individuality of nations, to the next one, which is probably transnational and international. The world is giving birth to a new model of life, that of oneness of humankind, of unity in diversity. And this can happen only if we have a clear vision of prosperity and as soon as we manage to live it.

2.2 Prosperity

Prosperity has multiple dimensions. Increasingly, it is recognized not only to include materiel well being but also social and even spiritual progress. Nor is it merely a matter of one's net worth, the size of one's house, or the kind of car one drives. It includes - or should include - environmental prosperity, which we can define as keeping the environment rich and productive. Moreover, prosperity must also reflect the richness of the interactions among the members of society and the spiritual dimensions of the world they inhabit. So we must start by recognizing these broader, more extensive dimensions of prosperity and match our approach toward development to this multi-dimensional prosperity. [Dahl, 2002]

2.3 Sustainable Development

We can think of sustainable development as a way to reach prosperity. Indeed the ultimate purpose of a business or a community could be to generate prosperity within a framework of sustainable development.

With reference to development, sustainability means to keep the productivity and wealth of our society going continuously into the distant future. Yet we know through history that this has never been achieved because all civilizations reached environmental or social limits and collapsed. And here we are

now that humanity has for the first time run up against planetary limits. [Dahl, 2002]

Sustainable development remains a useful term, despite being difficult to define, let alone translate. The United Nations usually refers to two working definitions of sustainable development. One derives from the work of the Brundtland Commission. It defines sustainable development as meeting the needs of the present generation without preventing future generations from meeting their own needs. [UNWCED, 1987] The other definition, called Agenda 21, was negotiated and agreed upon by most states at the Rio Earth Summit in 1992. Set out in 40 chapters and 120 program areas, Agenda 21 takes the form of a plan of action for achieving sustainable development. So various are the definitions that the term can mean almost anything to anybody, to the point that some consider it in need of replacement.

But what is critical about any definition of sustainable development is that it refers to prosperity as a state that can continue indefinitely and apply to all. In other words, sustainable development has dimensions both in time and in space. It covers not just some small segment of the planet's population but everyone everywhere. And it is not just for now but extends into the future. Sustainability is very dynamic and process oriented. It does not occupy a point in time at which we suddenly attain sustainable development.

Sustainable development is thus generally considered to have economic, environmental and social aspects, with sets of indicators reflecting the evolution within each one as society develops. Less apparent is the ethical component because sustainable development means linking its practical or material elements to human values. The act of looking at the needs of all the planet's people and considering the needs of future generations is rooted in ethics. Though the concept that whatever we do must be done for future generations as well as our own is an application of the principle of justice. [Dahl, 2002]

The individual has a key role in the unfolding of a planetary system of sustainable development. To meet the environmental

and developmental challenges, the top-down model of community development will need to give way to a more participatory, knowledge-based and values-driven process of governance.

2.4 Alternative Futures

One way of understanding where society is going and the importance of a sustainable development is to consider alternative scenarios. The United Nations Environment Program, in collaboration with various research institutes, has produced clusters of such scenarios.

One of them is that of "business as usual". This scenario assumes that we continue operating as we are and projects what the results of doing so would be fifty years later. It shows the developed world proceeding reasonably well, with the middle class broadening, incomes rising, and businesses generally profiting. Nor does the shorter-term perspective look bad. However, after fifty years, this scenario shows the world reaching significant resource limits as fossil fuels diminish relative to demand and natural resources become depleted. At that point, society reaches fundamental limits. Thereafter the outlook becomes increasingly grim as the economy struggles to deal with the effects of depleted resources all over the planet.
A second scenario, sometimes called "the fortress scenario", looked somewhat extreme - at least until the terrorist attacks in the United States on September 11, 2001. This scenario portrays wealthier countries giving up on the problems of Africa, much of Latin America and Asia. Rather than dealing with them, they withdraw behind their frontiers, keeping everybody else out and trying to achieve internal sustainability. Such an approach may appeal to those who see immigration as the source of their problems and who, therefore, seek to protect their own countries from the rest of the world. Though imaginable, is such a scenario realistic? Can countries really choose to stay behind walls, as in the Middle Ages, holed up in a castle on the hill and manning the ramparts against potential intruders, while chaos and confusion reign outside? What kind

of a life might we expect under such a scenario? Clearly it is not a very desirable one.

These scenarios suggest a third: a transition to a more sustainable kind of society, conceived on a global scale. Research into models that support such a scenario demonstrate that we can, in fact, make the necessary adjustments to achieve such a society. We have sufficient resources, if we redistribute them more justly and use them more efficiently. The studies show that, far from being some absurd utopia, we can indeed make the transition to a more sustainable future, providing that we start now and make a serious effort. Even from a technical perspective, this is a real option for us. [Dahl, 2002]

To begin turning this third option into reality, we must first rethink the concept of prosperity and put it into a systems framework. We should consider development not merely as some desirable state of material well being, but as a series of processes for advancing society as a whole. We cannot isolate the material side of the development process from the social and environmental. Pollution, for example, goes everywhere and cannot be ignored. There is no way we can separate ourselves from that reality. Similarly, we cannot separate ourselves from the social dimension, as demonstrated by the September 11th attacks. No matter how hard we try to stand aside and remain aloof from the social and economic problems and crises abroad, in one way or another, they will force themselves upon us. This means that any attempt to achieve sustainable development and prosperity must be broad, all encompassing and global.

2.5 The Role of Values

The concept of values is fundamental to any further attempt to work towards a sustainable development.

We could well imagine values to be the principles that define how people should act with each other, as physical laws define

how objects should react. For example gravity is a physical law that applies to everything. It applies even if we disagree. In the same way values affect every single decision we make in our lives even if we are unconscious of them. General values are universal such as the natural laws. Any difference that exists between them could be sought either in the degree of their implementation or in their interpretation. For example most people would basically agree that kindness is a value, but in what extent it is implemented or how it is implemented varies between people or cultures.

Humanity though as a whole is an organism that needs common rules of function and these rules have to be supported by a common interpretation of values. Any effort to improve human relationships, human structures, or human institutions must begin by addressing basic values. So we need more consultative mechanisms that would facilitate this process.

Our present economic and business systems, our present rules and the underlying implementation of values are seriously dysfunctional. They are driving us in extremely unsustainable directions, environmentally and socially. They also are unethical. Carried to a logical conclusion, the implications of such values are unacceptable in human terms. In purely economic terms, however, the unemployed and the impaired ought not to be helped because they burden society without contributing to production. Consider the example of a report submitted by a tobacco company to the Czech government that said tobacco use should be encouraged because earlier deaths would save considerable sums in pensions and health-care spending. When this report became public, the company apologized and withdrew it, but the episode demonstrates the ethical problems underlying purely economic thought. Another example is the case of the leaked memo drafted by a World Bank official that proposed moving polluting industries from rich, developed countries to poor, developing countries where, it suggested, human life was worth less and so pollution would be less costly to the economy. The fact that the memo's author may have been motivated by a sense of satire does little to lessen the purely economic relevance of such a view. [Dahl, 2002]

What are the values that would underlie a more sustainable society?

On the individual level, they are readily apparent: if we want to improve human relationships we need more love, more altruism. We need a sense of justice, a willingness to share wealth and make sacrifices. We need a sense of solidarity with the human race, a sense of serving all humanity. We need a more spiritually oriented work ethic, a sense of moderation and contentment with fewer material goods. If we want to achieve sustainability, if we want to share resources effectively around the world and allow everybody to develop so that wealth is open to all, we must change our personal values with respect to material things and adopt a willingness to see wealth redistributed in order to reduce the dangerous extremes of wealth and poverty. We must become trustworthy and more respectful of creation and all that surrounds us. At the individual level, the more we can strengthen those values in each of us, the more we shall be equipped with the right kind of operating principles to build a sustainable society.

The same is true institutionally, since these same values can be applied to business. We can, at the business level, create a sense of service to society, recognize that business does not exist just to make money, but also to serve society. We can build the value of service into business. Business systems can easily adapt to a service orientation, but only if the goal broadens beyond profit seeking. If that is done, the driving force behind business becomes much more constructive than it is now. [Dahl, 2002]

2.6 Towards a more sustainable society

How do we apply these values to make businesses working more sustainable?

If we are to overcome the present fragmented approach to decision-making, we need more consultative mechanisms between businesses as well as between business and

government. If we are to make decisions within a planetary perspective that involve whole systems or resources, we need to devise mechanisms and processes to make possible consultation among all stakeholders. Consultation and communication offer the means of overcoming the compartmentalization of society into isolated domains, each of which seeks to maximize its own particular area without collaborating with the other domains.

Businesses need fairness operating on a global basis. They have difficulty dealing with differing regulations, corrupt systems, and so forth. It is, therefore, in the interest of business to strengthen global mechanisms and establish a level playing field. To achieve that, it would be reasonable for businesses to pay taxes, assuming, of course, that the taxes were applied fairly. As business becomes more enlightened, it will become a leading force to establish effective global institutions, since these institutions will be good for business. Governments hold back for fear of losing power and eroding national sovereignty. So leadership has to come from elsewhere. Businesses are, in many ways, well placed to lead the effort to build the structures all of us need to make this system operate more effectively on a global basis. [Dahl, 2002]

So how could businesses or communities respond practically to the exigencies of sustainability?

There most popular definition of sustainable development was given at the United Nations World Commission on Environment and Development in 1987 (see paragraph 2.3). It is known also as Brundtland Commission, from the name of the Prime Minister of Norway at that time.
The Brundtland definition of sustainability is at a very high philosophical level, and need to be broken down into operational principles for practical use. In response to the complex nature of interrelated socio-ecological problems, a vast range of sustainability-related ideas, methods, tools, concepts, and approaches have been developed. Most of these have dealt with particular aspects of the societal sustainability problems from the perspectives of established research fields. While proven successful for the study of isolated expert fields, for instance the study of carbon dioxide emissions throughout

product life cycles, such approaches cannot be solely relied upon. That would be not sufficient when dealing with complex systems such as human society in the biosphere. Trans-disciplinary, trans-sector, and other interactive approaches for sustainability will be needed in such cases [Ny, 2006].

3. Industrial Ecology and Life Cycle Thinking

Industrial ecology (IE) is an emerging research field that aims to explain how the industrial system works, how it is regulated, and how it interacts with the biosphere. Then, on the basis of present knowledge about ecosystems, IE aims to determine how the industrial system could be restructured to make it compatible with the way natural ecosystems function [Ny, 2006]. So it can be defined as a "systems-based, multidisciplinary discourse that seeks to understand emergent behavior of complex integrated human/natural systems" [Allenby and Brad, 2006]. The field encompasses and relates to areas of research and practice such as “material intensity per unit service” (MIPS) and factor 10 [Scmidt and Bleek, 2001], ecological footprint [Wackernagel, 1994], life-cycle assessment (LCA) [Lindfors et al., 1995], zero emissions [Pauli, 1998], and extended producer responsibility [Lindhqvist, 2000].

We have been for many years seeing environmental impacts from production processes, treatment of waste etc. separated from one another. This remains important but not enough. It does not account for the shifting of burdens, which means solving one problem while creating another. Solutions therefore may not be optimal and may even be counter-productive.

Businesses do not always consider their supply chains or the 'use' and 'end-of-life' processes associated with their products. But without consideration of the full life cycle of goods and services a business is evidencing poorer financial performance and higher risk and potential for reputation damage.

The purpose of life cycle thinking is to identify possible improvements to goods and services in the form of lower environmental impacts and reduced use of resources not only by considering the processes within our direct control but across all life cycle stages. This begins with raw material extraction and conversion, then manufacture and distribution,

through to use and consumption. It ends with re-use, recycling of materials, energy recovery and final disposal.

So the key purpose of life cycle thinking is to avoid burden shifting. This means minimizing impacts at one stage of the life cycle, or in a geographic region, or in a particular impact category, while helping to avoid increases elsewhere. For example, saving energy during the use phase of a product, while not increasing the amount of material needed to provide it. [Institute for the Environment and Sustainability - European Commission, 2010]

There are multiple situations to which Life Cycle Thinking can be applied including every day life of consumers, business and government policy. By applying life cycle thinking to multiple aspects of the community, the consumers, businesses and governments can have a largely positive aspect on the environment.

Policy makers recognize this desire, and act to create policy that not only helps consumers do this, but will do so while keeping a growing economy in mind.

There are many aspects of Life Cycle Thinking incorporated into European policy. The Sustainable Consumption and Production Action Plan is a piece of legislation that aims to reduce environmental impact and consumption of resources associated with the complete life cycles of goods and services. On July 16, 2008 the European Commission presented this legislation. This proposal suggests plans on how to not only reduce the environmental impacts of goods and services, but also encourages the use of more sustainable goods and production technologies. This action plan also encourages the European Union to seek out every opportunity to innovate in industry [The European Commission's Directory of Environment, 2012]

The Integrated Product Policy is another legislative action that Europe has taken in order to facilitate life cycle thinking. The Integrated Product Policy seeks to minimize the environmental degradation caused from the manufacturing, use and disposal of all products. This legislation looks at all aspects of the product’s life cycle and takes action where necessary to reduce

[The European Commission's Directory of Environment, 2012]

The Thematic Strategy on Sustainable Use of Natural Resources was implemented on the 21st of December in 2005 to reduce environmental impacts associated with resource use and to do this in a growing economy. The objective can be described as "ensuring that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment and breaking linkages between economic growth and resource use" [The European Commission's Directory of Environment, 2012]

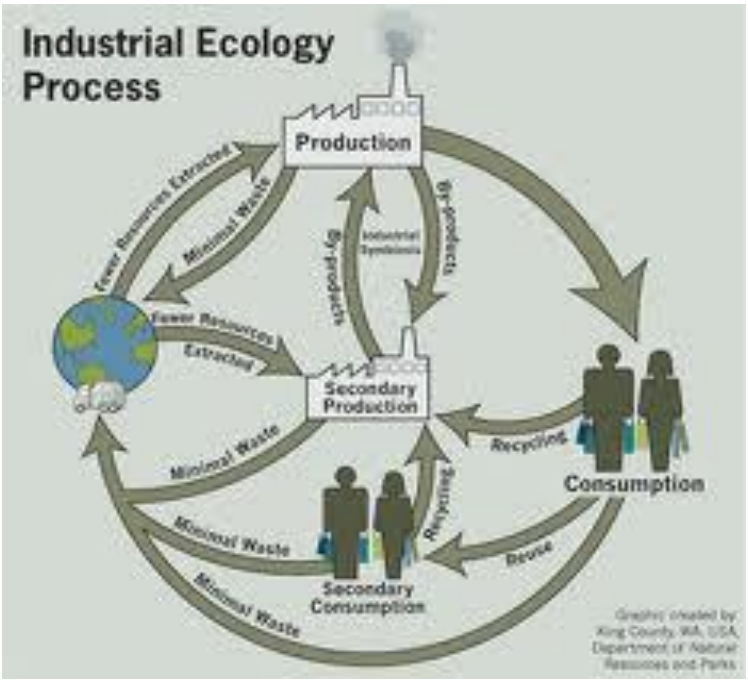


Figure 3.1: Industrial Ecology [ISIE]

3.1 Life Cycle Management (LCM)

Today as more products (goods and services) are traded regionally and globally, we need international initiatives that incorporate life cycle thinking and approaches to help businesses respond to the challenges posed by today's global marketplace.

Sustainability is an emerging and evolving concept used with increasing frequency in today's globalized business world. Corporate decision makers are more and more responding to the need of guaranteeing sustainable business practices into the future. They have realized that reducing the company's ecological footprint and increasing it's resource efficiency and productivity can go hand in hand with a sufficient profit and the creation of social value.

Life cycle management is a business management approach that can be used by all types of businesses (and other organizations) to improve their products and thus the sustainability performance of the companies and associated value chains. A method that can be used equally by both large and small firms, its purpose is to ensure more sustainable value chain management. It can be used to target, organize, analyze and manage product-related information and activities towards continuous improvement along the life cycle.

Life cycle management is about making life cycle thinking and product sustainability operational for businesses that are aiming for continuous improvement. These are businesses that are striving towards reducing their footprints and minimizing their environmental and socio-economic burdens while maximizing economic and social values.

When a product passes from one part of a product chain or life cycle stage to the next, it gains value. At all stages of this process, value is added as it passes through each part of the value chain.

Partnering with customers and suppliers to achieve the minimum impact within the complete value chain creates value and benefits society at large. If managed effectively and by taking direct as well as indirect effects into account, life cycle management helps not only to provide this overall benefit, but also delivers positive bottom-line consequences for each company involved.

Adopting a sustainable value chain approach will allow businesses to meet the challenges ranging from poverty,

climate change, resource depletion, water scarcity, globalization and demographic shifts, to name a few, and to reshape the world and the way business is done. And business leaders have a central part to play in ensuring sustainable development.

One key characteristic of LCM is that this approach requires companies to move away from just looking at their own operations and to look at what is happening in their value chain (upstream and downstream operations that are outside the company's direct control). Traditionally, the focus on improving production conditions has been at a local level. Today, as more products (goods and services) are traded regionally and globally, we need international initiatives that incorporate LCM thinking and approaches to help businesses respond to the challenges posed by today's global marketplace. [UNEP and SETAC, 2009]

Figure 3.2: Life Cycle Thinking
[http://en.wikipedia.org/wiki/Life_Cycle_Thinking]

3.2 Measurement tools for implementing LCM

Companies have used several strategies in order to implement LCM in their operations. Among these concepts and tools are (eco-) design methods, green procurement, LCA, LCC, eco- and energy labeling, environmental product declarations, ecological and carbon footprint analyses, environmental performance indicators, and social sustainability assessments and approaches, in addition to organizational strategies that are essential for actual implementation.

3.2.1 Environmental tools

Environmental life cycle assessment (LCA) has developed fast over the last three decades. Whereas LCA developed from merely energy analysis to a comprehensive environmental burden analysis in the 1970s, full-fledged life cycle impact assessment and life cycle costing models were introduced in the 1980s and 1990s, and social-LCA and particularly consequential LCA gained ground in the first decade of the 21st century [Guinee et al., 2011]

Life cycle assessment is a structured, comprehensive and internationally standardized method. It quantifies all relevant emissions and resources consumed and the related environmental and health impacts and resource depletion issues that are associated with any goods or services ("products"). So it relates full life-cycle impacts to a final product (ISO 2006a).

LCA is an appropriate framework for measuring impacts of products because it uses a full life cycle perspective, from “cradle-to-grave” thus omitting no product stages during which significant impacts might occur, including all production and consumption stages. This begins with assessing the goal and scope of a product system and continues with an inventory of inputs and emissions by product stage relevant to estimation of impact, which is used to estimate relevant environmental impacts with impact characterization factors developed from

impact models. Impacts are all related to a unit of the product serving a particular functional purpose, called a functional unit. These impacts typically measure use of environmental sources (resource use indicators) or stressors on environmental sinks (impact indicators). Impact indicators depict impacts at varying points in the chain of causality from the release of an emission to its ultimate impact (end-point) on primary areas of concern (human health, natural environment, resources, manmade environment), depending upon how evolved the science is for modeling impacts along this chain [Bare et al., 2006]

Critically, LCA studies thereby help to avoid resolving one environmental problem while creating others: This unwanted “shifting of burdens" is where you reduce the environmental impact at one point in the life cycle, only to increase it at another point. Therefore, LCA helps to avoid, for example, causing waste-related issues while improving production technologies, increasing land use or acid rain while reducing greenhouse gases, or increasing emissions in one country while reducing them in another.

Figure 3.3: Life cycle Assessment [http://www.solidworks.com/sustainability/design/2722_ ENU _HTML.htm]

3.2.2 Economical tools

There are different tools to assess the economical sustainability of products or services. Life cycle costing (LCC) is a method of calculating the total cost of a product (goods and services) generated throughout its life cycle from its acquisition to its disposal, including design, installation, operation, maintenance, and recycling/disposal, etc.

LCC can be used for a wide range of different purposes. In general, the most common uses of LCC are selection studies for different products and design trade-offs, relating to both comparisons and optimization. The construction industry is the main user of affordability studies, and cases from the energy sector often focus on the source selection for different services. Quite understandably, the public sector uses LCC mostly in sourcing decisions, while the private sector also uses LCC as a design support tool. [UNEP and SETAC, 2009]

The conventional LCC techniques that are most widely used by companies are based on a purely financial valuation. Four main cost categories are assessed: investment, operation, maintenance and end-of-life disposal expenses. [The European Commission's Directory of Environment, 2012]

Environmental LCC extends traditional LCC – it assesses all costs associated with a product's life cycle that are covered by one or more of the actors in the product's life cycle. These actors include suppliers, manufacturers, customers, end-users or end-of-life actors. While environmental LCC does not include external costs not related to real monetary flows and the decision or analysis at hand, it does look at the external costs of social externalities or environmental impacts that are anticipated in the decision-relevant future. [Rebitzer and Hunkeler,2003]

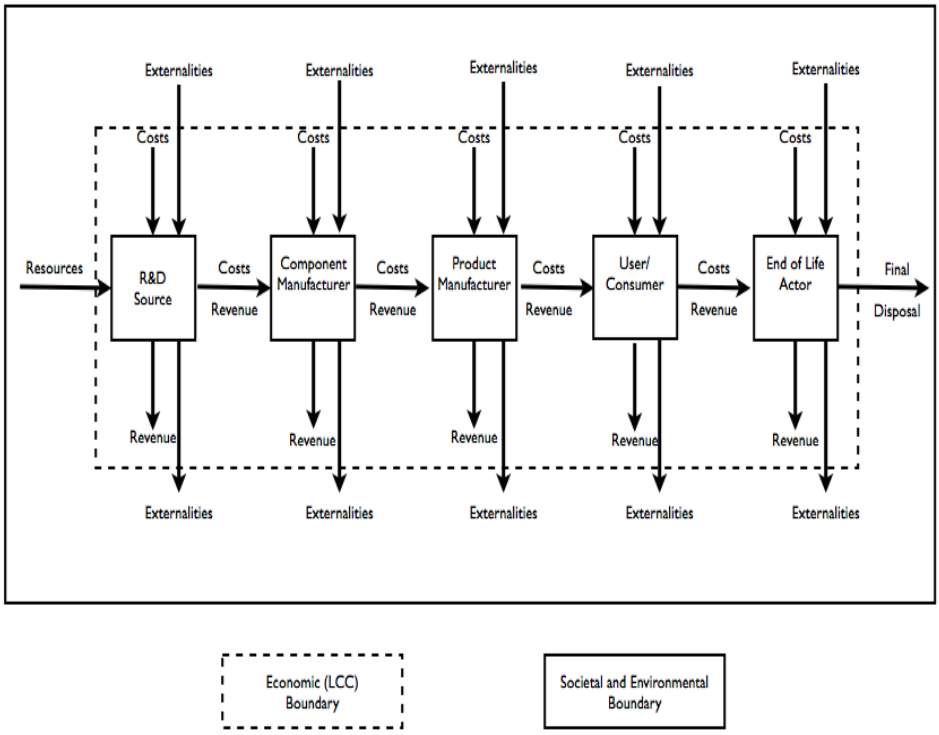


Figure 3.4: Conceptual Framework for Environmental LCC [Rebitzer and Hunkeler, 2003]

The goal is to provide a more comprehensive assessment of the product system to detect hidden cost drivers, compare total costs and trade-offs for alternative technologies, plan technology developments for new product offerings, develop a carbon-trading strategy, inform a decision to upgrade or replace capital equipment and more. Therefore, it is a tool for management accounting (also coined "cost management"), but is not related to financial accounting. [Rebitzer and Hunkeler, 2003]

To be introduced into 'accounting' LCC process, environmental costs must be expressed in monetary terms. In other words, environmental costs should be quantified and monetized so they can be considered as an additional cost input in a LCC analysis. [The European Commission's Directory of Environment, 2012]

3.2.3 Social tools

A social life cycle assessment (S-LCA) is a method that can be used to assess the social aspects of products and their potential positive and negative impacts along the life cycle. This looks at the extraction and processing of raw materials, manufacturing, distribution, use, reuse, maintenance, recycling and final disposal. S-LCA makes use of generic and site-specific data, can be quantitative or qualitative, and complements LCA with social aspects. It can either be applied on its own or in combination with LCA. S-LCA does not provide information on the question of whether a product should be produced or not – although information obtained from an S-LCA may offer "food for thought" and can be helpful for taking a decision. Although S-LCA follows the ISO 14040 framework, some aspects differ, are more common or are amplified at each phase of the study. The UNEP Guidelines for Social Life Cycle Assessment of Products proposes one methodology to develop life cycle inventories. A life cycle inventory is elaborated for indicators (e.g. number of jobs created) linked to impact categories (e.g. local employment), which are related to five main stakeholder groups (e.g., [i] worker, [ii] consumer, [iii] local community, [iv] society and [v] value chain actors). Examples of impact categories for "local community" are: access to material resources, access to immaterial resources, delocalization and migration, cultural heritage, safe & healthy living conditions, respect of indigenous rights, community engagement, local employment and secure living conditions. [UNEP and SETAC, 2009]

3.3 Life Cycle Assessment and Business Decisions

Life cycle assessment leads to a more comprehensive view of societal environmental impacts than if only the material or product itself would be evaluated. Nevertheless, a Swedish study of the implementation of environmental management systems in Swedish companies concluded that only 10% of corporations have allowed results from LCAs to influence the measures taken [Zackrisson et al., 2000]. The study did not

explain why this was the case, but others have discussed the issue [Frankl and Rubik, 2000], and according to business leaders [Broman et al. 2000], some presumptive reasons can be suggested for the (as yet) relatively low use of LCA by decision makers in business [Robert, 2002]:

- The results from LCA, performed by scientists to evaluate a scientific question, may be too complex to interpret from a business perspective.

- Efforts to aggregate information from different categories of impacts into simplistic figures for decision makers may be perceived as questionable.

- The impact perspective may be too narrow, that is, missing important aspects of sustainability such as social aspects, unsustainable management routines for ecosystems, and unsustainable emissions of compounds with as yet undiscovered impacts.

- The commonly applied LCA methods generally lack a strategic business perspective.

In line with the above, it is possible that the relatively low impact of LCAs on business decisions is related not only to a relatively low use of the method by decision makers in business, but also to a relatively low relevance of traditional LCA for such purposes. LCA as currently practiced is neither complete from a sustainability perspective, nor business-oriented, nor user friendly.

3.4 Life Cycle Sustainability Analysis (LCSA)

Many of the more recent developments were initiated to broaden traditional environmental LCA to a more comprehensive Life Cycle Sustainability Analysis (LCSA).

The LCSA framework is a framework for future LCA. It broadens the scope of current LCA from mainly environmental

impacts only to covering all three dimensions of sustainability (people, planet, and prosperity). It also broadens the scope from predominantly product-related questions (product level) to questions related to sector (sector level) or even economy-wide levels (economy level). In addition, it deepens current LCA to also include other than just technological relations, e.g. physical relations (including limitations in available resources and land), economic and behavioral relations, etc. In addition as part of deepening, normative aspects such as discounting, weighting, and weak versus strong sustainability can be explicitly incorporated [Heijungs et al., 2010].

The term framework is used because, unlike LCA, LCSA is a trans-disciplinary integration framework of models rather than a model in itself. LCSA works with a plethora of disciplinary models and guides selecting the proper ones, given a specific sustainability question. Structuring, selecting, and making the plethora of models practically available in relation to different types of life cycle sustainability questions is then the main challenge. Below is a picture that shows how an LCSA framework works.

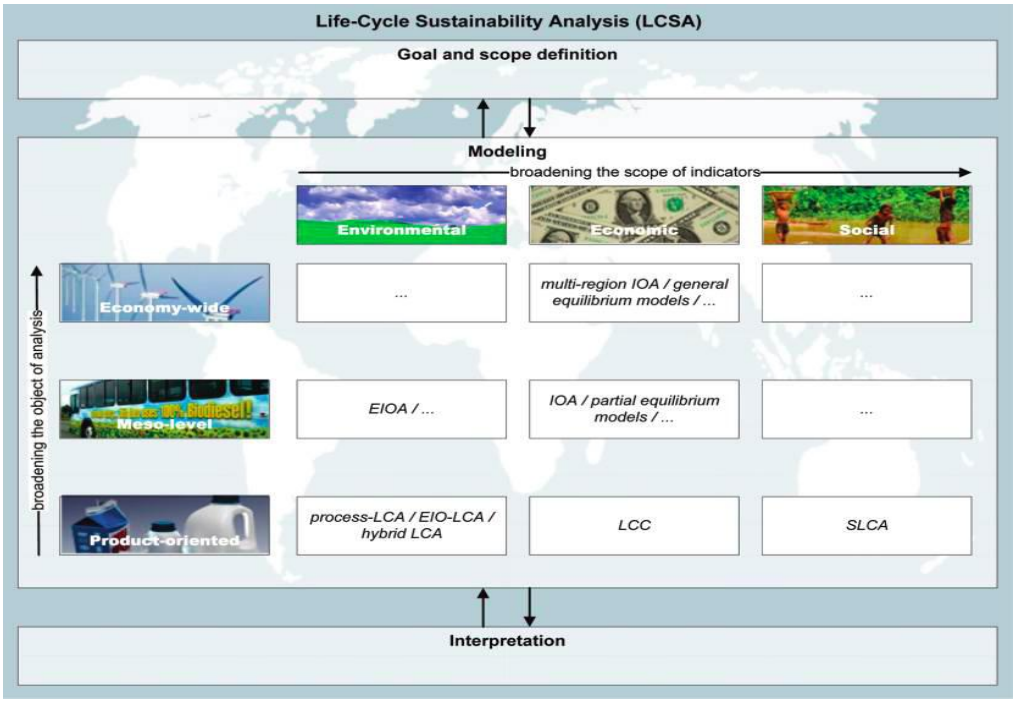


Figure 3.5: Trans-disciplinary integration framework for life cycle sustainability analysis [Guinee, 2011]

Establishing a framework for LCSA does not make present day product-oriented LCA and LCC superficial. On the contrary, it only relates product-oriented LCA and LCC to specific questions, for which these specific methods are perfectly suitable. One of the main challenges faced then is to structure and make available in a practical way the plethora of LCA and disciplinary models to various types of life cycle sustainability questions.

3.5 Strategic Sustainable Development

A new exciting IE-related field, tentatively called "strategic sustainable development" (SSD), may deal with such questions. A framework has been developed since the early 1990s that applies a five-level model to structure complex planning endeavors like societal transition towards sustainability (26). This framework is also called "The Natural Step (TNS) Framework" from the NGO that has facilitated its development and application, or the "backcasting from sustainability principles (BSP) framework" from its main operational philosophy.

The Natural Step (TNS) is a non-profit organization founded in Sweden in 1989 that deals with scientific research and education. Moreover it is a consulting firm specialized in strategic innovation towards sustainability. TNS provides support to organizations in developing sustainable practices through research, coaching, education and counseling in order to develop a clear understanding, solid skills and capacity for action towards sustainability. The methodology of TNS is scientifically based and employs an approach tested in thousands of cases that create consensus on actions to do and motivation to translate the knowledge acquired.

Several pioneers on tools, concepts and approaches for sustainable development have already used this framework to assess how their respective tools relate to sustainability and to each other. Before analyzing the Backcasting from Sustainability Principles framework, it would be useful to say a

few words about systems science, on which the framework is based.

3.6 Methods to study complex systems - Systems Science

Sustainable development requires a kind of process engineering to ensure that we are driving society towards a more sustainable future.

Twenty or thirty years ago, some questions seemed simpler than they do today. Environmental problems could be summed up in single images. It becomes evident now that environmental problems are global and much more complex and to be able to tackle complicated problems, we need an over-arching perspective of the situation - a system approach. System thinking creates understanding of the connections within the system. A system is made up of many different parts that are connected to each other according to principles that constitute the system.

So, a system consists of interrelated components. Some systems contain so many components and relationships that it is impossible to get a robust overview of their behavior without scientific approaches and sophisticated tools. Systems science is a field that has emerged to face such challenges and as a result, for example, quite a lot can now be said about both short-term local weather and long- term average weather (climate) of different regions. Systems science uses a trans-disciplinary approach to build understanding of complex causal relationships and feedbacks between system components.

One way of visualizing this idea is to see the system as a tree. The basic principles represent the trunk and the branches. The leaves symbolize details - value judgments, priorities, design solutions or behavioral changes, all seeking to align with the basic principles. The leaves and the trunk and branches are important aspects of a functioning whole. Without the trunk

and branches, the leaves have nothing to hang upon – in other words, the detailed solutions must align with the basic principles.

A system's approach consistent with basic principles and the requirements of sustainability shows that the tools and approaches to develop sustainability, like the LCA, are complementary and can be used in parallel for strategic sustainable development.

4. Backcasting from Sustainability Principles

The most common way of planning for the future is to review the present state by looking in the rear view mirror for problems and then trying to remedy these problems in the future. We call this forecasting. With a pressing need for fundamental change and a high level of complexity this planning technique has many disadvantages.

Perhaps it´s most crucial flaw is that whatever seems important in the present comes to define the future. Planning strategies and measures become based on present-day tax levels, present-day costs for sustainable technology, present day fuels, present-day working environment and present-day demands from customers. The risk of allowing the trends to be the main drivers of the problems is obvious. Acting in this way, we risk bringing today's problems into the future.

The traditional forecasting perspective used in most action plans, provides a planning procedure starting with a list of negative impacts in nature and society that have already been discovered. Estimates are then made as to which activities/resources that cause the largest effects (from a scientific point of view it is often impossible to tell, due to complexity). This leads into a debate about effects and makes it difficult to deal strategically with tradeoffs. [The Natural Step, 2004]

Instead of applying a problem-oriented approach to planning, where impacts are dealt with one by one as they appear in the system, it is possible and desirable to plan ahead with the ultimate objective of sustainability in mind. Doing so requires a backcasting approach where a successful outcome is imagined, followed by the question, "What shall we do today to get there?" [Dreborg, 1996]. This approach could inform life-cycle management, allowing coverage of the full scope of sustainability for material and product life cycles.

4.1 The five levels

The Backcasting from Sustainability Principles (BSP) framework lets five interdependent but distinct levels communicate with each other as their respective contents and relationships are explored [Robert, 2000]:

1. The System. The overall principal functioning of the system, in this case the biosphere and the human society, are studied enough to arrive at a . . .

2. Basic definition of success within the system, in this case sustainability, which, in turn, is required for the development of . . .

3. Strategic guidelines, in this case a systematic step-by-step approach to comply with the definition of success (backcasting) while ensuring that financial and other resources continue to feed the process of choosing the appropriate . . .

4. Actions, that is, every concrete step in the transition toward sustainability, which should follow strategic guidelines, which, in turn, require . . .

5. Tools for systematic monitoring of the actions (level 4) to ensure they are strategic (level 3) to arrive at success (level 2) in the system (level 1).

The BSP approach recognizes that there are principled flaws of societal design upstream in cause-effect chains that systematically undermine the ecosystem and the social fabric – the two ”commons” on which the whole human society relies. The ecosystem provides services like fresh water and natural resources while the social fabric provides services like personal safety and help from fellow human beings [Folke, 2004]. Metaphorically speaking, as the two commons are eroded more and more, society is moving deeper and deeper into a declining window of opportunity for long-term prosperity. The environmental and social problems that have

surfaced to date are serious, but the most serious problem is that such problems are bound to systematically increase due to the basic design and operation of today's society. This is the meaning of unsustainability.

4.2 The Overall System - The Biosphere (Level 1)

A starting point when developing the BSP framework was that strategic progress towards sustainability could probably not be achieved by a sole focus on gaining ever more knowledge about the system as such – in this case "society within the biosphere" [Robert et al., 2002].

The biosphere is a system in which all species - including humans - are interrelated. As a result of interdependence within this system, every action has consequences and secondary effects in other parts of the system effecting other human beings and/or species. The biosphere can be divided into two categories of subsystems, the ecosystems and the social systems.

Figure 4.1: The Biosphere [http://courseweb.hopkinsschools.org/mod/page/view.php?id=94546&inpopup=1]

4.2.1 System characteristics

We could point out 3 distinctive characteristics of the systems which living organisms inhabit. These are:

i. *Self-organization*. All living systems rely upon the self-organizing capacity of their individual parts. The individuals have the physical, chemical and biological capacity to meet their needs. The functioning of the system is dependent upon them having the opportunity to exercise that capacity. People have an in-built capacity to organize themselves in ways that increase their prospects of satisfying their needs. To make this possible we organize ourselves in social structures.

ii. *Diversity*. A basic characteristic of robust systems is diversity. Diversity increases the amount and variety of functions and competences within the system, which makes it potentially less vulnerable and more capable of responding to challenges.

iii. *Interdependence*. All resilient living ecosystems and social systems are interrelated and consist of interdependent individuals and species.

4.2.2 Ecosystem

The earth can be regarded as a closed system for matter because gravity does not allow matter to escape. Almost all the atoms that were here when the earth was created about 4.6 billion years ago are still here, although in different combinations. However, when it comes to energy, the earth is an open system. Energy is continuously entering the system in the form of sunlight. The amount of solar energy that flows is approximately 10,000 times greater than the current global energy use of the entire human population. At the same time, energy exists in form of heat radiation into the universe. There is a balance between the amounts of energy flowing in, and the amounts flowing out.

Basic Science is that [The Natural Step, 2004]:

- *Matter and energy do not disappear*. Matter and energy can only be transformed. Where has the gasoline gone when the tank is empty? It may look as if it has disappeared, but in fact the atoms have simply been dispersed as gaseous emissions. Energy does not disappear either. It is only changing form, and ends up as heat radiation. (First law of thermodynamics and law of matter conservation).

- *Matter and energy tend to disperse*. The fact that energy changes into heat radiation is not too serious a problem. It leaves the earth's atmosphere at the same time as we receive new solar energy. However, dispersed matter can become a problem because gravity retains it in the atmosphere. Examples of matter tending to disperse are numerous: rusting cars, carpets turning to dust, or spreading pollution. (Second law of thermodynamics)

- *The concentration and structure of matter determine material quality.* If matter and energy do not disappear, what then are we consuming? What is useful to us? It is as simple as having the right stuff, in the right place at the right time. When we consume something, we consume its concentration and its structure. The quality, or value, of matter increases as its concentration rises. For example, a gold ingot is more valuable than an identical amount of gold dispersed in nature. In addition to this, if we also add form or structure to the matter, its quality or value goes up even more. A gold ring, for instance, commands a higher price per gram than the gold ingot.

- *Photosynthesis creates a net increase in concentration and structure of matter using energy from the sun.* But if all matter disperses, surely most if it should be converted into waste by now? Or, is new material quality being created out of the waste, and if so, how? By photosynthesis, green cells, such as plants, are able to use the solar energy that flows continuously into the earth’s system. Photosynthesis gathers dispersed matter

and assembles it into new structures – i.e. plants – thus creating a net increase in material concentration and structure on the earth. Plants' uniqueness lies in the fact that they obtain their energy from outside the system. Even nature's mechanisms couldn't function sustainably if the natural cycles would not fuel by the sun. That input from the sun is converted into useable energy by plants-photosynthesis. In other words, we are completely dependent upon photosynthesis.

To effectively address the consequences of human action for nature, we need to move from assessing our impacts in nature to finding the root-causes for these effects.

4.2.3 Social System

As stated before, self-organization, diversity and interdependence are examples of characteristics of any system, including humans. Other examples of common human characteristics are basic individual needs, the ability to make conscious choices and the capacity to use empathy:

i. *Individual Human needs*. Science and technology can only provide answers to sustainable development when they take into account the needs of human. For example, there is little value in building high-efficiency vast networks of concrete roads if the style of architecture blocks sunlight and prevents people from walking [Dahl, 2002]. There have been many attempts at understanding individual human needs. One of the most well known examples is the definition of nine distinct human needs by the Chilean economist Manfred Max-Neef:
    - Subsistence
    - Idleness
    - Understanding
    - Protection
    - Creation
    - Identity
    - Participation
    - Affection
    - Freedom

Max-Neef states that if one of the human needs is in systematic short supply, this "leads" to poverty regardless of how well the other needs are satisfied.

ii. *Conscious Choices.* One difference between the high organizational level of a human society and a lower level lies in the human capacity to make conscious choices.

iii. *Empathy.* Empathy is an in-built human capacity to detect even the most subtly of signals from other people and enter into their situation. This competence helps us build trustful relationships and social structures, crucial for us to be able to satisfy our needs.

We are not just collections of individuals. We are born into relationships and the way we relate to each other in those relationships plays a vital role in helping us to actualize our needs at the individual level. The way we act and the way we are perceived in social relations is vital.

Societies are complex webs of interpersonal relationships. We create social structures to deal with our interdependences and our inability to actualize our needs alone. We need interpersonal trust which means confidence in people we are relating to in our daily life regardless if we are connected in the same community or not. Reciprocal trust may be a prerequisite for effective interpersonal relations and self-organization in social structures at large. Power is the potential to influence the social system. As individuals we empower others, from smaller groups to large organizations, to act on our behalf.

4.3 Principles for prosperity / Success (Level 2)

To be able to plan strategically, it is essential to not only understand the system per se, but to also have a robust definition of “purpose” or overall goal. To that end, it is essential to study the system level enough to approach a rigorous principled definition of sustainability, in other words prosperity.

The Natural Step developed a framework of complementary, non-overlapping conditions for social and ecological sustainability - The Four System Conditions.

The sustainability principles (SPs) of the five-level framework (level 2) were developed with the following criteria in mind. The set of SPs should be [Ny, 2006]:

- science-based, that is compliant with relevant scientific knowledge available to date
- necessary for sustainability, that is, failure to comply with any one of the SPs would make sustainability impossible
- sufficient for sustainability, that is, the SPs taken together should cover all relevant aspects
- general, that is, people from various societal sectors and scientific disciplines should be able to understand and use them
- concrete, that is, capable of guiding actions and problem solving, and preferably
- distinct, that is, mutually exclusive to facilitate comprehension and monitoring

After several revisions the current wordings of the sustainability principles (level 2) are [Ny, 2006]:

In the sustainable society, nature is not subject to systematically increasing …

I. concentrations of substances extracted from the Earth's crust

II. concentrations of substances produced by society

III. degradation by physical means

and, in that society . . .

> IV. people worldwide are not subject to conditions that systematically undermine their capacity to meet their needs.

Using the example of the funnel, which was briefly described on paragraph 2.1, we could picture a sustainable society to start building when the resources will not be anymore declining and the demand for them will not be anymore rising.

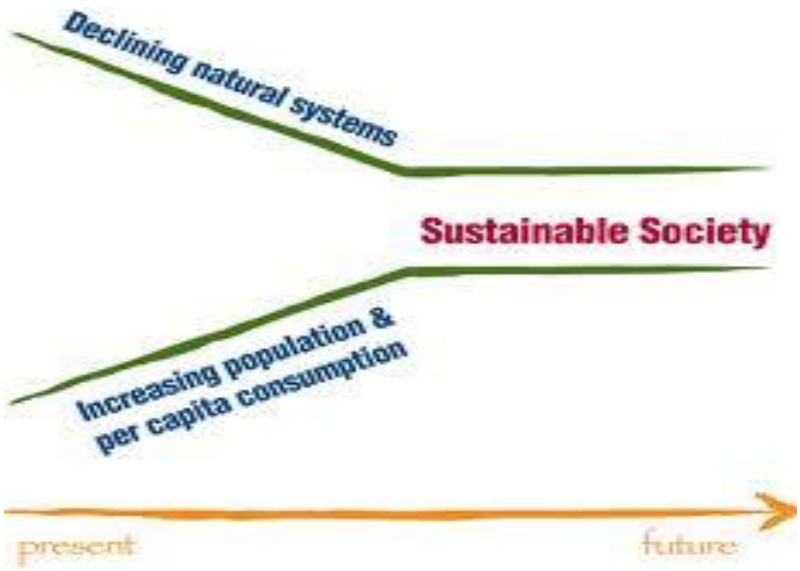


Figure 4.2: A Sustainable Society [http://www.cityofmadison.com/Sustainability/naturalStep/overview.cfm]

The System Conditions for ecological sustainability are derived from the three basic mechanisms by which natural life sustaining systems can be destroyed, followed by inserting a

”not” to create the converse of those mechanisms. The System Condition for social sustainability is simply stated the requirement to meet human needs (within the frame set by the three System Conditions for ecological sustainability).

By utilizing a successful outcome in the future as the starting point for planning, objectives in relation to the system conditions can be formulated:
Our ultimate sustainability objectives are to [Robert et al., 2002]:

1. Eliminate our contribution to systematic increases in concentrations of substances from the Earth's crust. This means substituting certain minerals that are scarce in nature with others that are more abundant, using all mined minerals efficiently, and systematically reducing dependence on fossil fuels.

2. Eliminate our contribution to systematic increases in concentrations of substances produced by society. This means systematically substituting certain persistent and unnatural compounds with ones that are normally abundant or break down more easily in nature, and using all substances produced by society efficiently.

3. Eliminate our contribution to the systematic physical degradation of nature through overharvesting, introductions and other forms of modification. This means drawing resources only from well-managed ecosystems, systematically pursuing the most productive and efficient use both of those resources and land, and exercising caution in all kinds of modification of nature.

4. Contributing as much as we can to the meeting of human needs in our society and worldwide, over and above all the substitution and dematerialization measures taken in meeting the first three objectives. This means using all of our resources efficiently, fairly and responsibly so that the needs of all people on whom we have an impact, and the future needs of people who are not yet born, stand the best chance of being met.

Below we can picture the four sustainability principles and their relation with the biosphere:

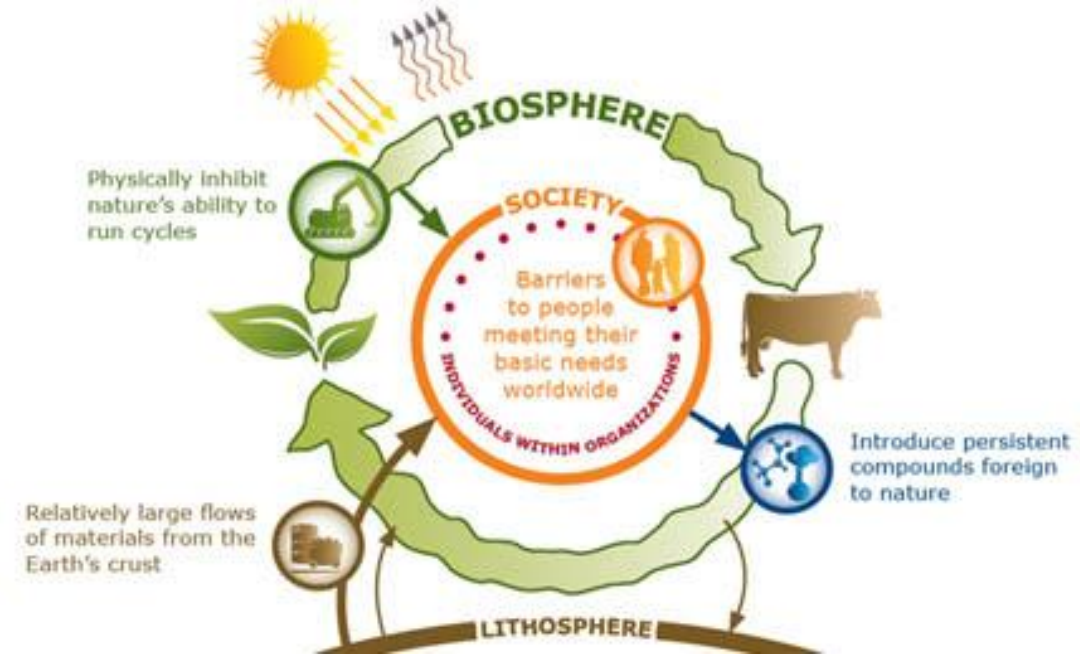


Figure 4.3: The Four Sustainability Principles [http://www.svid.se/sustainabilityguide/Possibilities-Tools/Design-strategies/The-Natural-Step/]

Each of the sustainability objectives described by the System Conditions can be further divided into two basic mechanisms: dematerialization, i.e. reduction of material flows, and substitution, i.e. exchange of type/quality of flows and/or activities. These two aspects of sustainability can be used in parallel and on different scales, e.g. from changing amounts and types of fuel in the same process (e.g. from petroleum fueled to more efficient bio-fueled vehicles), through a more radical change of the whole process (e.g. from combustion engines to more efficient and cleaner fuel cells), to completely new and less resource demanding and more ecologically and socially sound ways of satisfying the same human need (e.g. from a road-transport dependent business model that does not integrate social costs in developing countries, to licensing and fair trade utilizing information technologies). Both dematerializations and substitutions can be further subdivided. Dematerialization can be further subdivided into various

means of increased resource productivity, e.g. more efficient engines, and less waste, e.g. recycling, or to allow waste from one process to be raw material for another. The subdivision of substitutions differs from system condition to system condition [Robert et al., 2002]

4.3.1 Social Sustainability

The first three principles are addressing the overriding mechanisms by which we as human beings are destroying the ecological system. They are phrased and applied as exclusion criteria for re-design. Sustainability principle 4 has shown itself to still not be operational enough. Unlike the 3 principles for environmental sustainability, this principle only states that in a sustainable society "people are not subject to conditions that systematically undermine their capacity to meet their needs." Can this statement be fleshed out into robust principles for sustainable redesign of the social system? What could be principles that ensure that we at least do not systematically destroy the social system?

We could point out the following 5 principles:

i. *Integrity* - is about safeguarding of, "self" and "privacy" of each individual affected by an organization. It implies that the individual is not abused, covering questions about working conditions, enough wages, time for leisure and family so far as all stakeholders are concerned.

ii. *Influence* - is about safeguarding that every individual has the right to express his or her opinion, a freedom of thought and speech. This includes ensuring, that each individual affected by the organization is clear about structure of rights and responsibilities and is listened to.

iii. *Competence* - is about utilizing diversity and empowering people to develop and contribute to satisfying people's needs in organizations. It includes the securing of sufficient resources for education and other sources for continuous personal and professional development.

iv. *Universalism* - is about acknowledging that all people have the rights and are of equal worth. It includes the individual's values, the organization's values and extends to society at large through traditions, norms and the law.

v. *Purposefulness* - relies on purposeful working cultures. Any successful organization needs to transmit a clear sense of "Reason for being" of it. It includes safeguarding honesty about motives and actions and transparency in letting stakeholders know what the organization is up to.

4.4 Principles for sustainable development / Strategy (Level 3)

Level 3 focuses the process to reach the goal. To move society towards sustainability the actions should be fostered through a set of principles for the process.

First of all principles should be planned strategically. Investments should be selected by four principles [Robert et al., 2002]:

- Backcasting, which means that the starting point of the planning is an envisioned successful outcome of the planning.

- Flexible platforms, which means that each investment should provide technically feasible stepping-stones to link to future investments in the same direction.

- Good return on investment, which means that priority should be given to those investments that have a relatively good chance of yielding a good return. This can seed the subsequent "flexible platforms" with money.

- Precautionary principle, which is mostly applied when there is uncertainty regarding the ecological consequences of a

specific activity. It should also be applied when there are serious economic doubts.

There are then social principles that may be more obvious, though sometimes not taken into account. These are the principle of dialogue and encouragement, which is essential for teamwork and community development, and the principle of transparency, which creates trust, helps in recruiting the entire supply chain and all stakeholders into the same playing field, and opens up possibilities for business agreements and cooperation.

Political action can be the leading and cutting edge. This may be needed when role models in society have exhausted the full potential of their individual strategies, and when the pace of their joint leaps forward turns out to be insufficient from the whole society's point of view. Political means, like "differentiated taxes", subsidies or norms and standards are then designed to protect our commons.

4.5 Actions (Level 4)

The process principles described (level 3) are applied to foster concrete actions (level 4) to eventually comply with the system conditions for sustainability (level 2) within the ecosphere (level 1). Actions such as turning to renewable energy, recycling, and turning to more resource-efficient engines can sometimes be of value to approach compliance with the system conditions. However, since renewable energy, for example, may lead to destruction of forests through over-harvesting (thereby violating system condition 3), since recycling of cadmium as an alternative to phasing it out (e.g. large flows of cadmium in batteries between industry and households) may lead to increased concentrations of this metal in ecosystems (thereby violation of system condition 1), and since more efficient car-engines may lead to increased use of fossil fuels through rebound effects, rather than to savings which — within the same or even reduced global use of fossil fuels — would allow a more equitable distribution to the developing world (thereby

violating system conditions 1 and 4) [Schipper and Johnson, 1993], it is important that activities are chosen and examined from a complete sustainability perspective. Compliance with all system conditions is the strategic starting point for planning. To that end, tools and metrics should be selected and designed from the same perspective [Robert, 2000].

4.6 Tools (Level 5)

The next level, which means the monitoring of the process should utilize tools that are designed from a total systems perspective to indicate and audit progress towards sustainability. There are two levels to consider [Robert et al., 2002]:

i. The first focuses on evaluating how the actions comply with the overall plan and objectives, i.e. to monitor if the selected path of transition is actually bringing societies and the manufacturing sector closer to the objectives (compliance with the system conditions). Were the specified flows actually reduced or phased out, and were the planned substitutions actually put into place? This is the crucial level to monitor from a strategic point of view, since the monitoring of steps towards compliance with basic principles of success allows one not only to "fix" problems, but to avoid them. This includes problems that we are not yet aware of.

ii. The second level to monitor is the actual impacts in the system we want to protect. This focus is essential, since it is the direct target of the planning. In the end, society as a whole needs to see success on this level -i.e. was unemployment reduced or not? Have the forested areas, topsoil levels, and fish stocks, been maintained, or not?

4.7 The A-B-C-D Procedure

Practical application of the BSP framework is facilitated by an A-B-C-D procedure (figure 1), including (A) sharing and discussing the suggested BSP framework with all participants of the planning exercise, (B) assessing current material and energy flows and practices in relation to the basic sustainability principles (SPs) rather than relying solely on today's perception of impacts, (C) creating options and visions that support society's compliance with the basic SPs, and (D) prioritizing early actions from the list C that not only takes care of the short-term challenges but also prepares for coming actions to eventually make society comply with the SPs. This means that each investment, at least if it is large and tie resources for relatively long time periods, should (i) strengthen the organization's platform (Flexible) for coming investments that are likely to take it towards success as defined by the SPs (and other goals set up by the organization). As a basic mindset, the organization should in each investment (ii) seek to move towards reducing its contribution to society's violation of the SPs (Direction) and (iii) strive to be "economic" with resources so that the process is continuously reinforced (Payback). However, in the decision regarding an individual investment, (ii) and (iii) need to be assessed in a dynamic interplay between each other and with the longer term plan (i). Just as it in chess may sometimes be smart to lose a piece or "take a detour" if it creates interesting options for the longer term, it could sometimes be smart to temporarily increase an organization's expenses or its contribution to society's violation of some SP if that is a necessary early step to get a long term proactive plan started. An example could be a government sending delegates, by fossil fuel driven airplanes, to an international conference aiming at agreements for a long-term reduction of CO_2 emissions on the global scale.

So with this process it may be possible to:

- Allowing re-design to get problems out of the system, not only to "improve" what is already going on.

- Determine the potentials of systems and sub-systems

rather than being constraint by previous structures and technologies.

- Allowing "purpose" to serve as system boundaries.

- Deal with trade-offs i.e. evaluating proposed solutions and investments with regard to their potential to serve as economically feasible stepping stones towards a vision of success rather than evaluating them as choices between evils in the short term.

- Building community by use of visions and objectives as shared mental models.

Below is a figure that shows an A-B-C-D process.

Figure 4.4: The A-B-C-D process [The Natural Step, 2004]

4.7.1 Step A: Awareness and Visioning

Successful teams are not necessarily made of similar people. But the members of successful teams always have a shared vision of success and a strategy to get there.

A prerequisite for backcasting is to know what constitutes success in the future. Traditional long-term planning is often

flawed because it rarely escapes from dealing with today's problems. Even sophisticated scenario planning is usually "polluted" with the problems of today. We cannot predict the future but we can agree upon basic principles that must apply in any sustainable society. By using backcasting from sustainability principles, targets and measures can be chosen that are steps toward sustainability, providing flexible platforms for further improvements whilst achieving a good rate of return.

The organization is assisted in that step to identify its vision according to the sustainability principles. [The Natural Step, 2004]

4.7.2 Step B: Baseline Mapping

To find out what the organization's operations look like from a sustainability perspective it is important to identify critical flows and practices in the organization with respect to the four sustainability principles. There are three general questions that the organization has to ask itself:

- What does the organization deliver? The products and services, which are delivered to customers, and what happens during the use of the products and services?

- What does it depend on? Materials, products, services, energy, transports, equipment, property, employees etc. that the operations depend on are analyzed. What happens in earlier stages in the supply-chain?

- What is left? Residues and physical by-products that arise in the process are analyzed.

Then it is asked if all of this contributes to not meeting the four sustainability principles.

In employees are involved in this way by carrying out the status analysis themselves. [The Natural Step, 2004]

4.3.3 Step C: Creative Solutions

The next step is to look for solutions free from preconceptions based upon current reality. The way to approach this is to envisage the organization as a service provider. Questions that arise might be: What utility is the customer really looking for? What needs are fulfilled by the organization? What is the organization's role in satisfying human needs? Then conceivable measures are listed in order for the organization to work towards sustainability and its vision. Planned measures must be assessed in relation to the sustainability principles. The two ways that we described before in order to reach each sustainability principle is substitution and dematerialization. There are various ways to improve the organization's efficiency. [The Natural Step, 2004]

4.3.4 Step D: Decide on Priorities

The purpose of this step is to decide on which measures should be given priority. Measures are chosen that take the organization towards the sustainable envisioned future quickly and are flexible for further improvements and optimizing financial returns. Questions that are asked in that step are [The Natural Step, 2004]:

- Is the measure a step towards the sustainability principles?

- Are we creating a flexible platform for further improvements?

- Will the measure bring good enough financial returns?

5. Sustainability Life Cycle Assessment (SLCA)

5.1 Overview

The Natural Step has developed the Sustainability Life Cycle Assessment (SLCA) tool for assessing product sustainability. The SLCA can be described as tool that provides a strategic overview of the full scope of social and ecological sustainability at the product level. It results in an analysis - using colors instead of numbers - that allows the company to see the major impact of today's product through the whole lifecycle in relation to principle requirements of sustainability.

Traditional assessments of sustainability often begin with a particular problem. This can lead to incremental efforts to be 'less bad' with insufficient consideration of strategic pathways towards full sustainability. The SLCA tool uses an alternative approach that defines system boundaries in relation to the objective of sustainability. This encourages us to consider everything relevant to sustainability and not just look for and assess the most visible or currently known impacts. The key issue is to enable designers and decision makers to focus upon the sustainable development potential of the product and thereby 'design out' unsustainable aspects throughout the whole life cycle. The question we ask is: *How can the product be developed to meet human needs in a sustainable society while reducing the risk of societal violation of the basic sustainability principles?* [The Natural Step]

5.2 How it works?

The SLCA analysis begins with an overview of the whole system, considering all issues in the lifecycle that are in conflict

with Basic Principles of Sustainability. A series of questions are completed for each life cycle stage to assess adherence to the system conditions. The results from the questions are displayed in a five by four matrix with colors assigned based on the answers. The colors provide a visual clue to where sustainability 'hotspots' occur in the product life cycle [The Natural Step]

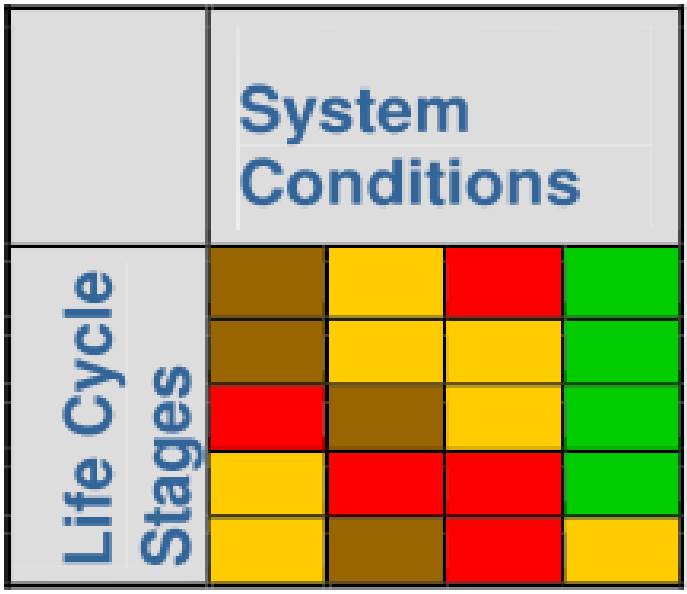


Figure 5.1: The Matrix of an SLCA [The Natural Step]

5.3 Multiple uses of the SLCA tool

The SLCA can be used for different purposes including, assessment, education and communication, depending on the needs of the user.

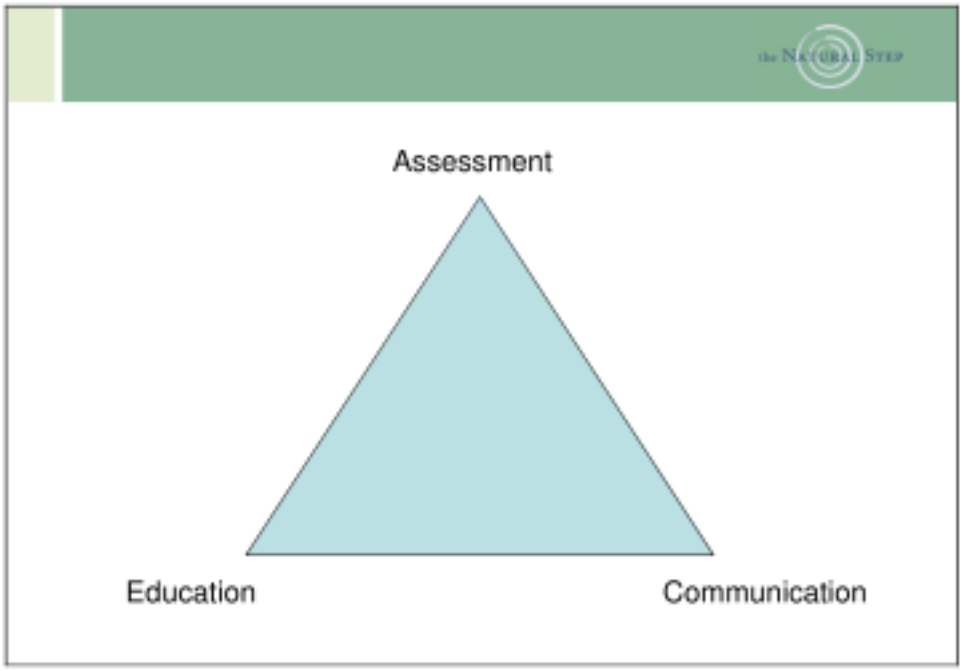


Figure 5.2: Multiple uses of SLCA [The Natural Step]

Assessment

- Assess on a product level the companies current impacts and current initiatives with respect to the TNS Framework
- The summary matrix will indicate the areas of concern and identify of areas for future action and prioritization
- The questions can be revisited after a period of time, allowing a team to see where progress has been made on addressing "don't know" areas and turning "no's" into "yes's".

Education

- The process of completing the questionnaire raises awareness amongst the participants of sustainability in general and of the impacts of their own product.
- By gathering a range of people from across the whole lifecycle of a product, the process of completing the SLCA transfers learning across the team.

Communication

- Internal communication of sustainability issues can be enhanced by visual color representation in the SLCA

summary matrix.

- The summary matrix can quickly and easily communicate the major areas of concern to people who may not have been involved in completing the questions.
- The SLCA can be used on any product, allowing separate product teams to communicate with a shared understanding after following a consistent process.

[The Natural Step]

5.4 Background: SLCA and it's relationship to TNS Framework

The Natural Step Framework is often presented as a gradual planning process called the ABCD planning methodology, that we have already described in chapter 4.7.

In the A-step, training is undertaken to share the framework, including the funnel metaphor representing the sustainability challenge, the process of backcasting, and the four system conditions. The SLCA tool corresponds to the B-step (baseline analysis) whereby sustainability issues can be assessed with respect to the goal of sustainability using the sustainability principles above. It helps to tell us our starting point and what we need to address from a sustainability perspective. Creating a vision within the constraints of the sustainability principles is necessary (Step C) to establish a more specific direction and set of goals to work towards. Actions are then prioritized in Step D.[The Natural Step]

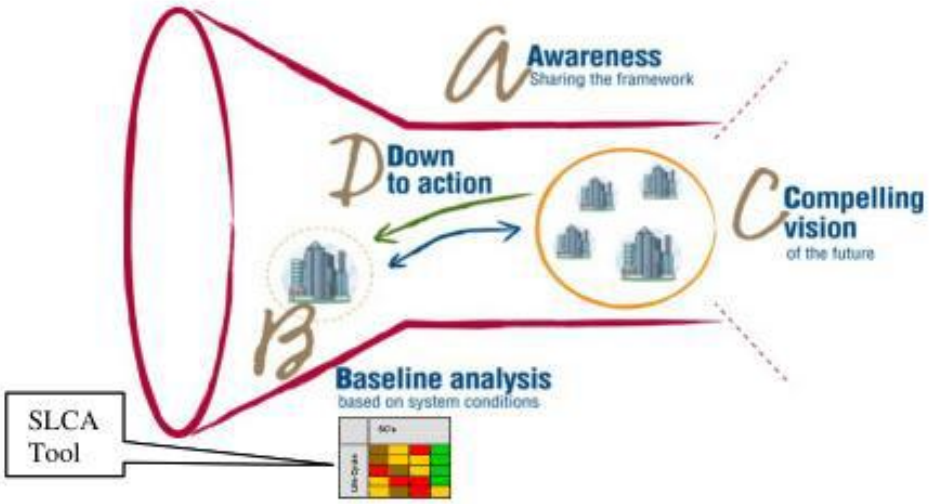


Figure 5.3: SLCA and the ABCD procedure
[The Natural Step]

5.5 LCA and SLCA

As the traditional LCA, the SLCA is a methodology to assess the sustainability of the life cycle of a product. Some phases of this methodology are based upon the standard ISO1400X for LCA. [Asaro and Spinelli, 2011]

The fundamental differences between the two methodologies are illustrated in the following table:

Approach	**Traditional LCA**	**SLCA**
Description	Detailed compilation and evaluation of materials and energy used between a system and environment	Sustainability assessment of the life cycle of a product in relation to the principles of sustainability
Degree of detail	A detailed analysis	Main overview followed by a

		detailed analysis
Sustainability issues	Consumption of resources and emission of pollutants	Economic and social problems from the complete system perspectives
Objectives	Facilitate the choice of materials and products with the lowest environmental impact in relation to their purposes	Identification of a strategic sustainable path.
Strategic perpective	The traditional approach starts from a particular environmental problem with the possibility of conducting efficiencies to be less harmful in that particular area	The SLCA intends to bring a strategic perspective in the field of Life Cycle Management using backcasting from sustainability principles. It helps to identify the gap between current reality and vision, and to develop ideas to fill it.
Applicability	Limited for entrepreneurs, usually requires specific technical skills to understand the results and implications.	The SLCA provides a simplified yet rigorous method, through answers to 140 or more questions for a specific product, to explain the purpose and results of the analysis
Scope and boundaries	It starts with the assessment of impacts that are most popular and visible	It defines the boundaries in relation to the objectives of sustainability
Social dimension	Only environmental	Using the four principles of

	aspects are evaluated	sustainability, not only the environmental, but also the social impacts are considered
Request of data, type and depth of analysis	To be effective, the analysis requires a considerable amount of detailed data	It builds on the expertise "inside of" the organization, allowing the building of a shared knowledge. This analysis can then lead to a more focused quantitative analysis.

Table 5.1: Differences between LCA and SLCA.

The SLCA does not replace the normal methods of LCA, the latter rather serve as a complement to SLCA, which can serve as a strategic guide for the whole process.

5.6 SLCA questions

The SLCA tool creates a matrix with each square representing the adherence to the system conditions against each life cycle stage. Underpinning each square is a series of questions to ascertain the key impacts of the life stage for each of the system conditions.

the NATURAL STEP

Sustainability Life Cycle Assessment Tool (SLCA)
Summary Matrix
Product name:

Welcome to the SLCA Summary Matrix. The colours have been automatically generated from the answers to the SLCA questionnaire. To see the full questionnaire, click on the **Questionnaire tab** at the bottom of the page.

	DESIGN AND DEVELOPMENT	MATERIALS (RAW AND FABRICATED)	PRODUCTION	PACKAGING, DISTRIBUTION AND RETAIL	USE & END OF LIFE
SC1: Scarce materials taken from the earth					
SC2: Substances produced by society					
SC3: Degradation of nature					
SC4: Human needs					

Key

Good	Quite Good	OK	Quite Bad	Bad	Don't Know
All answers positive. System condition met.	Mostly positive responses. System condition mostly met.	Some positive responses. System condition on the way to being met.	Mostly negative responses. System condition mostly not met.	All answers negative. System condition not met.	Insufficient knowledge to make reasonable judgment.

Figure 5.4: Unfilled SLCA matrix [The Natural Step]

By utilizing the system conditions for sustainability, the SLCA has been developed with a focus on 'designing out' unsustainable aspects throughout the whole life cycle. This is a more strategic and systematic approach, as opposed to a focus on simply minimizing the known negative impacts. It reduces the chance that by creating a 'solution' in one part of the system that problems are simply transferred somewhere else or that entirely new and unforeseen problems are being unintentionally created. It is of little use to create an assessment tool focusing on only one point in the life cycle of products if the solutions generated problems elsewhere in the rest of the supply chain.

There is an e-version of the SLCA questionnaire that has been created as an excel file. There is a set of questions for each cell of the SLCA matrix. In total there are around 140 questions. The Questions deal with both:

1. Current status with respect to sustainability principles; and
2. Actions to make progress

The questions are answered in a 'yes' or 'no' manner and are categorized 3 ways:

1) by life cycle – to provide a life cycle view of product impacts
2) by system condition – to assess how products are unsustainable from a full systems perspective
3) by 'current status' and 'progress' – to provide a full measure of where we are today by recognizing both sustainability impacts and activities already initiated to address them.

The table below gives the big picture and summarizes the areas covered by the questions for each life cycle stage.

Life Cycle stage	Life Cycle questions
1. Design and Development	• Sustainability competence of design team • Integration of sustainability in decision-making • Integration of sustainability within design development processes • Improvements to design and development processes.
2. Materials (raw and fabricated)	• Type of raw and fabricated materials • Implications for human needs • Energy use suppliers • Demands and collaboration with suppliers
3. Production	• Type of materials for processing • Implications for human needs • Energy use customer • Collaboration with supply factories to improve their product and processes
4. Packaging, distribution and retail	• Packaging material • Implications for human needs • Transportation • Demands on suppliers, strategy/actions taken for efficiency/substitution • Cooperation with retailers for promoting sustainable consumption
5. Usage and end of life	• Type of materials for use • Waste, Re-use and recycling • Implications for human needs • Energy use • Strategy/actions to improve use & end of life.

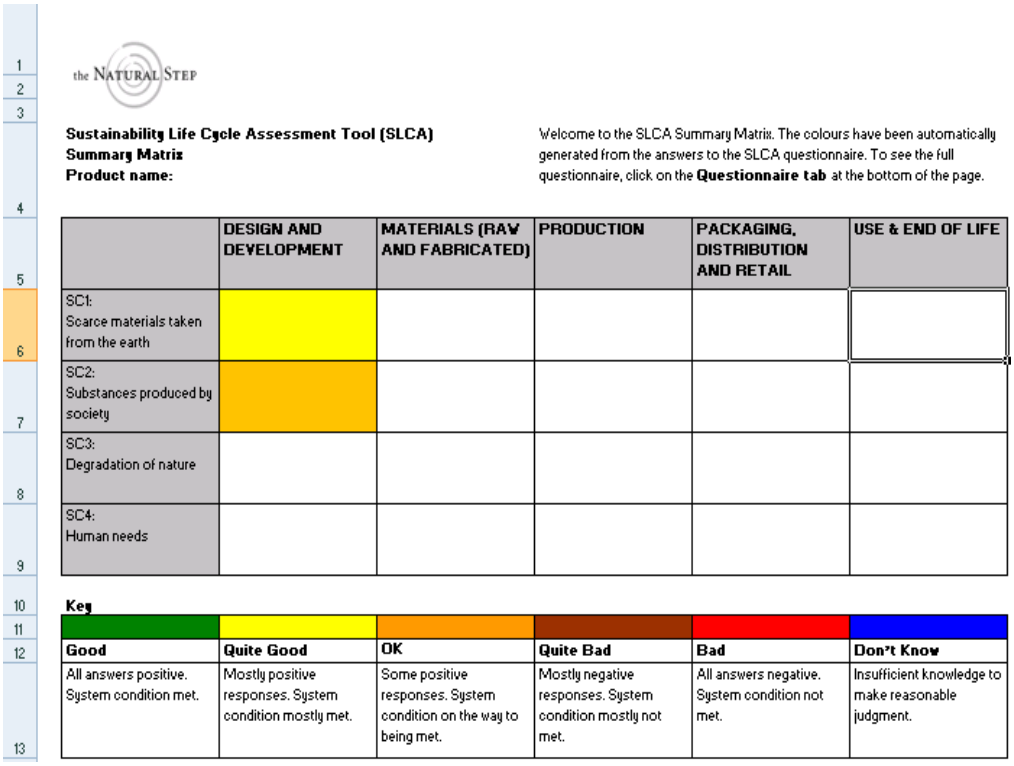
Table 5.2: Type of life cycle questions [The Natural Step]

Below there is an example of a questionnaire:

47		2	MATERIALS (RAW AND FABRICATED)		
48	SC1	2,1	Mined Materials:	Yes/No/ Don't know	Response notes and/or references to further information
49			*Current Status:*		
50		2.1.1	Are the raw and fabricated materials required to make the products completely free from virgin mined materials that are scarce* in nature (e.g. Cu, Ag, Sn, Zn, Cd, Hg etc.)?		
51		2.1.2	Are raw and fabricated materials suppliers (SC1) using renewable energy for the extraction of materials, production and/or transportation?		
52		2.1.3	Are alternatives to scarce* virgin materials being used being used and reviewed (e.g. substitution of materials)?		
53			*Activities to make progress:*		
54		2.1.4	Is the company moving towards a phase out of virgin mined materials that are scarce in nature within its materials supply?		
55		2.1.5	Does the company have clear purchasing guidelines for raw and fabricated materials suppliers (incl. production process, energy, waste and product development) relating to SC1?		
56		2.1.6	Does the company regularly audit raw and fabricated materials suppliers regarding their sustainable development practices relating to SC1?		
57		2.1.7	Does the company integrate sustainable development relating to SC1 in regular face-to-face dialogues with suppliers (e.g. in meetings to discuss price, quality and technical criteria)?		

Figure 5.5: SLCA example of questions [The Natural Step]

From the answers a color-code is automatically allocated to each cell and this builds to reveal a completed matrix showing where there are 'red' problem areas through to 'green' areas where they are doing well (see below).



the NATURAL STEP

Sustainability Life Cycle Assessment Tool (SLCA)
Summary Matrix
Product name:

Welcome to the SLCA Summary Matrix. The colours have been automatically generated from the answers to the SLCA questionnaire. To see the full questionnaire, click on the **Questionnaire tab** at the bottom of the page.

	DESIGN AND DEVELOPMENT	MATERIALS (RAW AND FABRICATED)	PRODUCTION	PACKAGING, DISTRIBUTION AND RETAIL	USE & END OF LIFE
SC1: Scarce materials taken from the earth					
SC2: Substances produced by society					
SC3: Degradation of nature					
SC4: Human needs					

Key

Good	Quite Good	OK	Quite Bad	Bad	Don't Know
All answers positive. System condition met.	Mostly positive responses. System condition mostly met.	Some positive responses. System condition on the way to being met.	Mostly negative responses. System condition mostly not met.	All answers negative. System condition not met.	Insufficient knowledge to make reasonable judgment.

Figure 5.6: Filling an SLCA matrix [The Natural Step]

6. Application of the Framework into Illy Coffee

The methodology is applied in organizations or communities. People anyway compose an organization, so in either case we are referring to a community of people.

In this thesis we consider a company in the coffee production area as a case, namely Illy coffee. This company is a subsystem of the system 'society in the biosphere' (compared to level 1 of the FSSD). In order to move society towards sustainability it is necessary that organizations embedded in the larger system, 'society in the biosphere', operate in a sustainable way and offer products that consumers can use in a sustainable manner. Illy is available worldwide in 140 countries and it's headquarters are in Trieste, Italy.

Two direct contacts were held with Illy coffee, one in Trieste, Italy and one in Rio de Janeiro, during the UN Conference on Sustainable Development, where CEO Mr. Andrea Illy gave a talk on the sustainability of the products of Illy coffee. Also there was extensive contact and exchange of information also through email and phone.

Apart from the contacts made with Illy, many documents were read from the company's performance on sustainability issues and environmental management, including the sustainability value report and the environmental statement of Illy coffee.

The purpose of the meeting and all other contacts made with Illy coffee together with the documents read was to understand the actions that Illy coffee is taking towards sustainability, to share the framework of The Natural Step with Illy and try to evaluate their performance according to the framework. In that way there has been built a good connection between Illy and The Natural Step, and a good foundation for future collaboration.

The methodology was applied in two ways. Firstly through connecting all the information collected from the contacts and

the documents about sustainability with the five levels of the framework (see explanation in chapter 4). Then a complete Sustainability Life Cycle Analysis was performed (see explanation in chapter 5).

The two ways of application are analyzed in chapter 6.1 and 6.2. Special attention has been given to the recovery of energy from waste that is created throughout the life cycle of coffee, produced from Illy coffee. This part is analyzed in paragraph 6.4.

6.1 Application of the five levels to Illy coffee

Analyzing the sustainability value report of Illy coffee and other documents related to the eco-friendly performance of Illy, as well as by direct contacts made with the company, useful information and elements were collected regarding their sustainability performance. These elements were then grouped and allocated to the 5 levels of the framework.

The purpose of this grouping was then to evaluate the sustainability performance of Illy qualitatively according to the five level framework.

This work is a more qualitative assessment compared with the assessment that follows on paragraph 6.2 (Sustainability Life Cycle Assessment).

The results are as follows:

Level 1: System

- Hierarchy of stakeholders (consumers at the top, etc.)
- Mechanisms for the sustainability strategy and governance:
    1. Sustainability committee that has the role of supporting for the elaboration of corporate plans and assessment of sustainability in processes and objectives and also giving proposals to the strategic committee and the communication of corporate principles of

sustainability. It is chaired by Anna Adriani, director of Global PR and Responsibility
2. Strategic committee that has the role of analyzing and approving policies and strategies

- Broad governance and monitoring systems in place to ensure the sustainable development of the business
- Comprehensive environmental management system capable of maintaining a certified environmentally friendly worksite
- Sustainability committee.

Level 2: Success

- Illy coffee mission
- Aim to be the benchmark for coffee culture and excellence, and the world's most innovative coffee company, offering the finest products, preparation systems and places of consumption.
- Grow and become the world's high-end coffee segment leader, creating value for our stakeholders
- Ethics and Quality as founding values
- Pursuit of perfection
- Creating sustainable value to share with all its stakeholders in both the short and the long term.
- In order to be excellent, a product has to be sustainable

Level 3: Strategy

- Strategic Plan that includes special sections dedicated to sustainability projects
- Passion for excellence (love for the beautiful and well-made)
- Ethics (building long-term value through sustainability, transparency and human development, promoting social growth and respecting the environment)
- Transparency in word and deed
- Fairness in management
- Compliance with regulations

- Protection of the rights and interests of the shareholders and all stakeholders
- Responsible behavior in all functional areas
- Creation of sustainable value for the customers and stakeholders by providing products, solutions and services in line with expectations, and at the highest levels of excellence and quality.
- Innovation means riding the waves of technology: computer science, microelectronics, and molecular biology.
- The creation of social value through the concept of growth
- Long-term relationships with the best coffee growers in the world, which guarantees quality, as well as an increase in the product's value.
- Constantly improving its quality standards from all points of view: production, processes, and customer service.
- Improve the customer's satisfaction level.
- Product eco-innovation (ensuring the non-polluting materials, maximizing component recycling, cutting consumption, becoming more aware of waste)
- 4C Strategy (Care, Customer, Cash, inCrease)
- Staff Training and Development (eg. spreading the Code of Ethics, Sha-zam Execution, Oltre project, workshops, The Kaizen Project)
- Each new staff member is required to attend a special course administered by the Prevention and Protection Service.
- Training to deal with emergencies and to practice first aid and fire fighting.
- Monitoring all changes that occur with respect to safety regulations
- Ethics is the compass that shows what direction the company should take to create sustainable economic value to share with its stakeholders.
- The company works in communities that benefit from the employment opportunities created on the field
- Purchasing 100% of its raw materials from its origin.
- Commitment to the environment
- Illy regularly monitors each phase of the raw materials, from the coffee's growth in the plantations through shipping, and also the consumption of all the raw materials it uses

- Waste management is closely monitored during all production phases.
- Illy designs and implements solutions to make product disposal as environmentally efficient as possible. The approach is based on the concepts of prevention and minimization, reuse and recycle (from the best till the least good)
- All packaging and related materials produced by Illy coffee are recyclable.
- Agricultural techniques with low environmental impact (water consumption, water treatment, nitrogen fertilization and employment of chemicals)

Level 4: Actions

- University of coffee
- Ernesto Illy foundation
- Investments made in technology and research and development, though relationship with strategic partners and first and foremost, through the professionalism and expertise of the people working in the company.
- Innovations (e.g. Iperespresso, illy issimo, illycrema, illy Monoarabica, packaging)
- Aroma Lab
- Numerous scientific studies
- Active participation in numerous scientific conferences
- Active participation in various COST actions
- Donations granted to socially useful institutions
- Samples of green coffee are inspected in Illy coffee Labs
- Samples of roasted coffee are inspected in Illy coffee Labs
- Sophisticated systems to monitor and control the production process phases
- Pressurization technology
- Analysis and Quality Labs
- Espressamente Illy (franchise formula)
- Artisti del Gusto Illy (special baristas for whom Illy coffee has set up and international network to enhance and improve their professionalism)
- Relationships with the media

- Zero industrial incident projects has aimed at creating sensitivity among all workers, and disseminating their cultural attitude of becoming more responsible and aware at workplace safety.
- Appropriate individual protection devices (e.g. anti-incident shoes, protective gloves)
- "Exchange", its internal journal to share information on the company's projects and activities, showing the company's determination to protect the environment.
- "Un coffee con i manager" has the main goal of improving the relationship among employees and managers in a casual atmosphere.
- "Made in Illy": Some of the company's employees share their skills and experience and volunteer in organizing parties.
- Free guidance service to children of the employees.
- Company supporting some of the monthly charges of some nurseries and pre-schools for the children of the workers.
- Canteen, conventions, and other time saving services.
- Illy coffee supports the artist communities by contributing to national and international events and directly promoting cultural and artistic projects. (e.g. Galleria Illy, illy SustainArt, illywords)
- Illy supports local development projects with a clear economic, social and environmental impact.
- Illy invests in research and innovation to improve the knowledge on coffee and the living and production conditions of coffee growers.
- Illy coffee supports all costs relating to certification and inspection on farms.
- Purchase of the best productions from the growers, by paying them more than the average market price in order to acknowledge the quality of their production and to encourage constant improvement of a consistent product.
- Process to obtain the certification (identification of KPIs, on field tracks, evaluation questionnaires for producers, best practices for producers, analysis of risk-countries and monitoring and then improvement review)
- Fair income for coffee growers (calculation of minimum fair price according to variables and international stock market standards)

- Minimize any direct impact arising from production, in terms of both energy efficiency and sustainable waste management.
- Illy promotes low environmental impact farming practices with green coffee suppliers.
- Minimizing use of synthetic products.
- Actions taken to reduce waste, increase savings and improve energy efficiency, have enabled the company to limit consumption of its main resources.
- A system to recover the thermal energy emanating from the roasting plant's chimneys, which is used to heat most of the plant and produce domestic water.
- A large photovoltaic system was built as a renewable source of energy.
- Advanced, computerized systems for watering the green areas are optimizing water used for irrigation.
- Numerous procedures for improving waster management, such as identifying different types of waste in order to improve separation for collection purposes, placing waste separator bins inside the plant and offices, and training staff on waste management.
- The jute sacks of coffee are placed in containers in such a way as to prevent mold, condensation and unpleasant odors.
- Iperespresso capsules plastic recycled.
- Improvements regarding Illy coffee espresso machines.

Level 5: Tools

- Sustainability Manifesto
- Code of Ethics
- Awarding of Italian and international certifications and standards:
    - For Quality:
        Quality management system
        Product conformity
        HACCP
        IFS Food Certificate
        BRC Food Certificate
        Laboratories

- For Environment:
  - Environmental Management System
  - EMAS Regulation
- For the supply chain:
  - Responsible Supply Chain Process

- Website
- Social networks
- Compliance with International Labor Organizations (ILO) principles
- Monitoring of its supplies to ensure compliance with national labor regulations with the certification of the manager in charge of the Supply Chain Process.
- Numbers to show their sustainability performance.
- Key performance Indicators (KPIs) specific to each country along its supply chain. (About product risks, ethical risks, work risks and environmental risks)
- Award for growers in Brazil in order to encourage a mechanism of identification of the best producers and to promote quality.
- Improvement goals that Illy has set for itself, and is committed to maintaining and disclosing in the future.
- Sustainable value report.

6.2 SLCA of Illy coffee

The product unit for the assessment was the 3kg coffee can.

The process of doing the Sustainability Life Cycle Assessment for Illy coffee was as follows:

The answers were first filled, after having one formal meeting and several other communications with managers of Illy coffee, and analyzing the documents provided by Illy coffee.
More specifically, all the answers referring to the current status were found at the value report of Illy coffee, which can be found on the internet (http://valuereport.illy.com/), except those that required information regarding their suppliers. These last answers along with the other ones regarding

activities to make progress were filled with a certain level of uncertainty according to personal perception created from the contacts made with Illy coffee.
After that, the answers were sent to Illy coffee to revise them and correct them.

The answers are grouped in the 5 stages of the life cycle: Raw Materials (Table 1), Illy Production (Table 2), Packaging and Distribution (Table 3), Consumer Use (Table 4), End of Life (Table 5).

For confidentiality purposes the answers are not shown publically. They are only given to the examination committee.

Raw Materials

SUSTAINABILITY PRINCIPLE 1: Mined material		
No.	Full question	Yes/No
	Current Status	
1.1.1	Are the raw materials required to make Illy products free from mined materials that are scarce in nature* (e.g. Cu, Ag, Sn, Cd, Hg…)?	
1.1.2	Are Illy raw materials free from virgin mined materials (i.e. based on renewable resources and or post-consumers waste)?	
1.1.3	Are the suppliers using fossil-fuel free energy for its extraction, production and/or transportation?	
	Activities to make progress	
1.1.4	Does Illy integrate in its own product development and R&D attempts to move towards a phase out of raw materials that are scarce mined materials?	
1.1.5	Does Illy have purchasing guidelines for suppliers (incl. Production process, energy, waste and product development) relating to SP1 (mined materials that are scarce in nature and fossil energy)?	
1.1.6	Does Illy regularly audit suppliers or discuss issues in regular face-to-face meetings regarding their sustainable development practice related to SP1?	
1.1.7	Does Illy integrate in its own product development and R&D attempts to move towards a phase in of mined materials that are less energy intensive to produce?	

SUSTAINABILITY PRINCIPLE 2: Substances produced by society		
	Current Status	
1.2.1	Are the raw materials required to make Illy products free from man-made substances that accumulate in nature?	
1.2.2	Are all your raw materials free from virgin man-made substances (i.e. based on renewable resources and or post-consumers waste)?	
1.2.3	Do illy suppliers power their operation (e.g. production and transportation) with energy sources that do not generate and/or depend on man-made substances that risk systematically increasing in concentration in nature?	
	Activities to make progress	
1.2.4	Does Illy integrate in its own product development and R&D attempts to move towards a phase out of raw materials that are man-made substances that accumulate in nature?	
1.2.5	Does Illy have purchasing guidelines for suppliers (incl. Production process, energy, waste and product development) relating to SP2 (man-made substances that accumulate in nature)?	
1.2.6	Does Illy regularly audit suppliers regarding their sustainable development practice related to SP2?	
1.2.7	Does Illy integrate sustainable development relating to SP2 in regular face-to-face dialogues with suppliers (e.g. meeting to discuss price, quality and technical criteria)?	

SUSTAINABILITY PRINCIPLE 3: Physical Degradation		
	Current Status	
1.3.1	Is there no physical degradation of nature linked to the extraction, manufacturing & transportation of our raw materials? (e.g. cause no systematic degradation to nature e.g. through heating water, water extraction, strip mining, monocultures…) ?	
1.3.2	Do the raw materials that are sourced from nature to make Illy products come from sustainably managed ecosystems?	
1.3.3	Do Illy suppliers power their operations with energy sources that do not systematically degrade nature by physical means?	
	Activities to make progress	
1.3.4	Does Illy integrate in its own development and R&D attempts to move towards a phase in of raw materials from sustainably managed ecosystems?	
1.3.5	Does Illy have purchasing guidelines for suppliers (incl. Production process, energy, waste and product development) relating to SP3 (physical degradation of nature)?	
1.3.6	Does Illy regularly audit suppliers regarding their sustainable development practice related to SP3?	
1.3.7	Does Illy integrate sustainable development relating to SP3 in regular face-to-face dialogues with suppliers (e.g. meeting to discuss price, quality and technical criteria)?	

SUSTAINABILITY PRINCIPLE 4: Human needs		
	Current Status	
1.4.1	Do none of Illy raw material suppliers contribute to violating basic human needs?	
1.4.2	Do working conditions of most suppliers comply with the highest international labor standards (including no significant health risks)?	
1.4.3	Do most suppliers support the local community for the long term (general public and future generation)?	
	Activities to make progress	
1.4.4	Does Illy have a code of conduct integrated into all purchasing guidelines to help meet SP4 (not contributing to violating basic human needs)?	
1.4.5	Does Illy provide guidance and incentives to encourage raw material suppliers meet SP4?	
1.4.6	Does Illy regularly audit suppliers or discuss issues in regular face-to-face meetings regarding their sustainable development practice related to SP4?	
1.4.7	Does Illy integrate in its own development and R&D attempts to move towards raw materials that are less hazardous to health?	

Table 6.1: Raw materials answers

Illy Production

SUSTAINABILITY PRINCIPLE 1: Mined material		
No.	Full question	Yes/No
	Current Status	
2.1.1	Are the production process and facilities required to synthesize Illy products completely free from materials and waste containing mined materials that are scarce in nature (e.g. Cu, Ag, Sn, Cd, Hg…)?	
2.1.2	Is all equipment built from recyclable and abundant materials (i.e. not from scarce mined materials)?	
2.1.3	Are the production processes and facilities powered with fossil-fuel free energy sources?	
	Activities to make progress	
2.1.4	Does Illy integrate in its own product development and R&D attempts to move towards production processes that phase out scarce mined materials ?	
2.1.5	Does Illy have clear targets for, and is production managed and monitored, to systematically minimize the need for scarce mined materials and increase energy efficiency?	
2.1.6	Does Illy have targets and are clear actions being taken to improve systems in use for waste recycling, reuse and wastewater treatment and to minimize waste to landfill (in order to avoid the dispersion of scarce mined materials in nature)?	
2.1.7	Does Illy integrate in its own product development and R&D attempts to move towards production processes that are less energy intensive?	

SUSTAINABILITY PRINCIPLE 2: Substances produced by society		
	Current Status	
2.2.1	Are the production process and facilities required to synthesize Illy products completely free from man-made substances that risk systematically increasing in concentration in nature?	
2.2.2	Are all waste streams and emissions recyclable, recycled or reused (i.e. closed loop)?	
2.2.3	Is all equipment able to be recycled or reused at the end of life to avoid dispersion of man-made substances specified in 2.2.1	
	Activities to make progress	
2.2.4	Does Illy integrate in its own product development and R&D attempts to move towards a production process that phase out man-made substances that accumulate in nature?	
2.2.5	Does Illy have clear targets, and is production managed and monitored, to systematically minimize the need for materials referred in 2.2.1 and help achieve 2.2.2?	
2.2.6	Does Illy have targets and are clear actions being taken to improve systems in use for waste recycling, reuse and wastewater treatment and to minimize waste to landfill and increase energy efficiency (to prevent generating man-made substances that risk systematically increasing in concentration in nature)?	
2.2.7	Does Illy integrate in its own product development and R&D attempts to move towards production processes that are less demanding in man-made substances that risk building up in nature?	

SUSTAINABILITY PRINCIPLE 3: Physical Degradation		
	Current Status	
2.3.1	Does Illy production process and facilities avoid systematically degrading nature by physical means (e.g. avoided effects on groundwater tables, wetlands, deforestation, encouraging urban sprawl…)?	
2.3.2	Are well-functioning systems in place for recycling and reuse of natural resources during the production process?	
2.3.3	Is Illy production process powered with energy sources that do not systematically degrade nature by physical means?	
	Activities to make progress	
2.3.4	Does Illy have clear targets and are actions (in product development and R&D) being taken to allow alternative renewable materials from sustainably managed ecosystem?	
2.3.5	Does Illy have clear targets, and is production managed and monitored, to systematically minimize the degradation of nature by physical means (natural resources and ecosystems)?	
2.3.6	Does Illy have clear targets and are actions being taken to minimize waste to landfill?	
2.3.7	Do Illy production facilities have clear targets and are actions being taken for energy efficiency (to not systematically degrade nature by physical means)?	

SUSTAINABILITY PRINCIPLE 4: Human needs		
	Current Status	
2.4.1	Do none of Illy raw material suppliers contribute to violating basic human needs?	
2.4.2	Do working conditions of most suppliers comply with the highest international labor standards (including no significant health risks)?	
2.4.3	Do most suppliers support the local community for the long term (general public and future generation)?	
	Activities to make progress	
2.4.4	Does Illy have a code of conduct integrated into all purchasing guidelines to help meet SP4?	
2.4.5	Does Illy provide guidance and incentives to encourage raw material suppliers meet SP4?	
2.4.6	Does Illy regularly audit suppliers or discuss issues in regular face-to-face meetings regarding their sustainable development practice related to SP4?	
2.4.7	Does Illy integrate in its own development and R&D attempts to move towards the use in it production process of materials that are less hazardous to health?	

Table 6.2: Illy Production answers

Packaging and Distribution

SUSTAINABILITY PRINCIPLE 1: Mined material		
No.	Full question	Yes/No
	Current Status	
3.1.1	Are all materials requirements (packaging, logistic, transportation) completely free from mined materials that are scarce in nature?	
3.1.2	Are all Illy packaging, transportation and warehousing equipment free from scarce mined materials?	
3.1.3	Are all energy requirements (packaging, logistic, transportation) powered with fossil-fuel free energy?	
	Activities to make progress	
3.1.4	Does Illy have targets and is action being taken to phase out the use of scarce mined materials?	
3.1.5	Does Illy have targets and is action being taken to favor transportation and warehousing that are less energy intensive?	
3.1.6	Does Illy have clear purchasing guidelines for the packaging, warehousing and transport suppliers relating to SP1?	
3.1.7	Does Illy have targets and are actions being taken to change to fossil fuel free transportation?	

SUSTAINABILITY PRINCIPLE 2: Substances produced by society		
	Current Status	
3.2.1	Is all Illy packaging, logistics and transportation (PLT) completely free from emissions or waste streams that systematically build-up within nature?	
3.2.2	Are most man-made substances used in PLT recyclable, recycled or re-used?	
3.2.3	Is transportation of Illy products powered with energy sources that do not generate and/or depend on man-made substances that risk systematically increasing in concentration in nature?	
	Activities to make progress	
3.2.4	Does Illy have clear purchasing guidelines for the packaging, warehousing and transportation suppliers relating to SP2?	
3.2.5	Does Illy integrate in its product development and R&D attempts to move towards a PLT processes that phase out man-made substances that risk accumulating in nature?	
3.2.6	Does Illy have targets and is transportation and warehousing managed and monitored to systematically increase efficiency?	
3.2.7	Does Illy have targets for PLT to change to energy sources that do not generate and/or depend on man-made substances that risk systematically increasing in concentration in nature?	

SUSTAINABILITY PRINCIPLE 3: Physical Degradation		
	Current Status	
3.3.1	Is there no physical degradation to nature (natural resources and ecosystems) linked to our PLT operations?	
3.3.2	Are all PLT materials required from nature taken from sustainably managed ecosystems?	
3.3.3	Are all PLT materials from recycled sources (meaning no extraction so no physical degradation)?	
	Activities to make progress	
3.3.4	Does Illy have clear purchasing guidelines for the packaging, warehousing and transportation suppliers relating to SP3?	
3.3.5	Does Illy have targets and is packaging, managed and monitored to phase out the systematic physical degradation of nature?	
3.3.6	Does Illy have targets and is transportation and warehousing managed and monitored to systematically reduce the physical degradation of nature?	
3.3.7	Does Illy PLT have clear targets and are actions being taken for energy efficiency (to not systematically degrade nature by physical means)?	

SUSTAINABILITY PRINCIPLE 4: Human needs		
	Current Status	
3.4.1	Are all aspects of the human needs of all PLT workers met and not undermined in any way?	
3.4.2	Do working conditions of all PLT workers comply with the highest international labor standards (including no significant health risks)?	
3.4.3	Do the PLT operations enable all aspects of the human needs of the surrounding community to be met, and not undermine them in any way (e.g. through capacity building, avoiding social dislocation, providing infrastructure, avoiding odor…)?	
	Activities to make progress	
3.4.4	Do all PLT workers have regular training and appropriate skill levels in sustainable development?	
3.4.5	Does Illy have clear targets and are actions being taken to interact in a constructive manner with the local community?	
3.4.6	Does Illy have Health and Safety policies with targets in place, regular auditing and has there been a consistent decrease in H&S incidents?	
3.4.7	Does Illy regularly audit suppliers for packaging and/or transport regarding SP4 (basic human needs)?	

Table 6.3: Packaging and Distribution answers

Consumer Use

SUSTAINABILITY PRINCIPLE 1: Mined material		
No.	Full question	Yes/No
	Current Status	
4.1.1	Is the use and maintenance of the final product completely free from mined materials that are scarce in nature?	
4.1.2	Is leakage of scarce mined materials from the final product completely eliminated during the use phase?	
4.1.3	Is no energy used during the use phase or, if necessary, is it fossil-fuel free energy?	
	Activities to make progress	
4.1.4	Does Illy have targets and are actions being taken to improve product use attributes from a sustainability perspective relating to SP1?	
4.1.5	Does Illy have targets and are actions in product development and R&D being taken to help reduce the use of scarce mined materials in the use and/or maintenance of the final product?	
4.1.6	Is Illy helping adjust the component lifetime of the final product to be fit for purpose? (i.e. not lasting 100 of years if not needed)?	
4.1.7	Does Illy have targets and are actions being taken in product development and R&D to help reduce the use of fossil energy in the use and/or maintenance of the final product?	

SUSTAINABILITY PRINCIPLE 2: Substances produced by society		
	Current Status	
4.2.1	Is the use and maintenance of the final product completely free from man-made substances that could systematically build up in nature?	
4.2.2	Is the final designed product used in a closed-loop manner?	
4.2.3	Is leakage of man-made substances from the final product completely eliminated during the use phase?	
	Activities to make progress	
4.2.4	Does Illy have targets and are actions being taken to improve product use attributes from a sustainability perspective relating to SP2?	
4.2.5	Does Illy have targets and are actions in product development and R&D being taken to help reduce the use of man made substances (that could systematically build up in nature) in the use and/or maintenance of the final product?	
4.2.6	Is Illy helping adjust the component lifetime of the final product to be fit for purpose? (i.e. not lasting 100 of years if not needed)?	
4.2.7	Does Illy have targets and are actions being taken in product development and R&D to help reduce the use of energy sources that do not generate and/or depend on man-made substances that risk systematically increasing in concentration in nature during the use and/or maintenance of the final product?	

SUSTAINABILITY PRINCIPLE 3: Physical Degradation		
	Current Status	
4.3.1	Does the use of the final product in any way physically degrade nature (natural resources and ecosystem)?	
4.3.2	Is the final designed product used in a closed-loop manner?	
4.3.3	Does the maintenance of the final product not in any way physically degrade nature (natural resources and ecosystem)?	
	Activities to make progress	
4.3.4	Does Illy have targets and are actions being taken to improve product use attributes from a sustainability perspective relating to SP3?	
4.3.5	Is Illy helping adjust the final product towards a phase-out of systematically degrading nature by physical means (natural resources and ecosystem)?	
4.3.6	Is the use and maintenance of the final product powered with energy sources that do not systematically degrade nature by physical means?	
4.3.7	Is Illy helping adjust the component lifetime of the final product to be fit for purpose? (i.e. not lasting 100 of years if not needed)?	

SUSTAINABILITY PRINCIPLE 4: Human needs		
	Current Status	
4.4.1	Does the use of the final product not undermine people's (user, and community) capacity to meet their needs?	
4.4.2	Is increased use of materials in the use phase justified only by utility needs (i.e. package, shoe….)?	
4.4.3	Are all-significant health risks relating to the use of the final product eliminated?	
	Activities to make progress	
4.4.4	Does Illy have targets and are actions being taken to improve product use attributes from a sustainability perspective relating to SP4?	
4.4.5	Does Illy help provide information to consumers regarding the footprint of the final products and are actions being taken to raise awareness of the sustainability attributes of the final products?	
4.4.6	Does the use of the products interact in a constructive manner with the local community?	
4.4.7	Is Illy helping adjust the component lifetime of the final product to be fit for purpose? (i.e. not lasting 100 of years if not needed)?	

Table 6.4: Consumer Use answers

End of Life

SUSTAINABILITY PRINCIPLE 1: Mined material		
No.	Full question	Yes/No
	Current Status	
5.1.1	Does the end of the life of the final product release absolutely no scarce mined materials into nature?	
5.1.2	Are all the operations related to the end of life (transport, incineration, landfill) of the final product completely free of scarce mined material?	
5.1.3	Are all the operations related to the end of life of the final product powered by fossil-fuel free energy?	
	Activities to make progress	
5.1.4	Does Illy have targets and are actions being taken to help develop systems for reuse and increase percentage of weight of the final product being reused (and therefore eliminating the need to extract raw materials from earths' crust)?	
5.1.5	Are there well-functioning systems in place in society for reuse and recycling of final product?	
5.1.6	Does Illy current process for substances development support and improve the final product end of life regarding SP1?	
5.1.7	Does Illy R&D's processes for future development take into account the end of life of the final product regarding SP1?	

SUSTAINABILITY PRINCIPLE 2: Substances produced by society		
	Current Status	
5.2.1	Does the end of the life of the final product release absolutely no man-made substances that could systematically build-up in nature?	
5.2.2	Are all the operations related to the end of life (transport, incineration, landfill) of the final product completely free of man-made substances that could systematically build-up in nature?	
5.2.3	Is the final product being designed to fit in a closed-loop society?	
	Activities to make progress	
5.2.4	Does Illy have targets and are actions being taken to help develop systems for reuse and increase percentage of weight of the final product being reused (and therefore eliminating the need to produce more man-made substances and their dispersion in biosphere)?	
5.2.5	Are there well-functioning systems in place in society for reuse and recycling of final product?	
5.2.6	Does Illy current process for substances development support and improve the final product end of life regarding SP2?	
5.2.7	Does Illy R&D's processes for future development take into account the end of life of the final product regarding SP2?	

SUSTAINABILITY PRINCIPLE 3: Physical Degradation		
	Current Status	
5.3.1	Is the end of the life of the final product completely free of physical degradation to nature?	
5.3.2	Are all the operations related to the end of life (transport, incineration, landfill) of the final product completely free of physical degradation to nature?	
5.3.3	Are all the operations related to the end of life of the final product powered by energy that does not physically degrade nature?	
	Activities to make progress	
5.3.4	Does Illy have targets and are actions being taken to help develop systems for reuse and increase percentage of weight of the final product being reused (and therefore eliminating physical degradation of nature by not having to mine substances for example)?	
5.3.5	Are there well-functioning systems in place in society for reuse and recycling of final product?	
5.3.6	Does Illy current process for substances development support and improve the final product end of life regarding SP3?	
5.3.7	Does Illy R&D's processes for future development take into account the end of life of the final product regarding SP3?	

SUSTAINABILITY PRINCIPLE 4: Human needs		
	Current Status	
5.4.1	Does the end of life of the final product not undermine people's (workers and community) capacity to meet their needs in any way?	
5.4.2	Does the end of life of the final product not undermine workers' health in any way?	
5.4.3	Does the end of life of the final product not undermine the local community's health in any way?	
	Activities to make progress	
5.4.4	Are significant health risks of the final product disposal being monitored?	
5.4.5	Is the disposal of the final product having less of a negative impact on the community over time?	
5.4.6	Does Illy current process for substances development support and improve the final product end of life regarding SP4?	
5.4.7	Does Illy R&D's processes for future development take into account the end of life of the final product regarding SP4?	

Table 6.5: End of Life answers

The matrix then was created and each cell was assigned a color according to the number of "yes" or "no" answers for each combination of the 5 stages of the life cycle of coffee with the 4 sustainability principles.

	1. Raw Materials	2. Production	3. Packaging, distribution & retail	4. Use	5. End of Life
Sustainability Principle 1	6	3	2	5	2
Sustainability Principle 2	6	4	4	4	4
Sustainability Principle 3	6	5	4	5	2
Sustainability Principle 4	7	6	7	5	7

7 yes / NA
6 yes / NA
5 yes / NA
4 yes / NA
3 yes / NA
2 yes / NA
1 yes / NA
0 yes / NA

Figure 6.1: Filled matrix according to Illy coffee answers

We can also show the results in a diagram.

According to sustainability principles we have the following results:

Sustainability Principle 1: **18** yes answers
Sustainability Principle 2: **22** yes answers
Sustainability Principle 3: **22** yes answers
Sustainability Principle 4: **32** yes answers

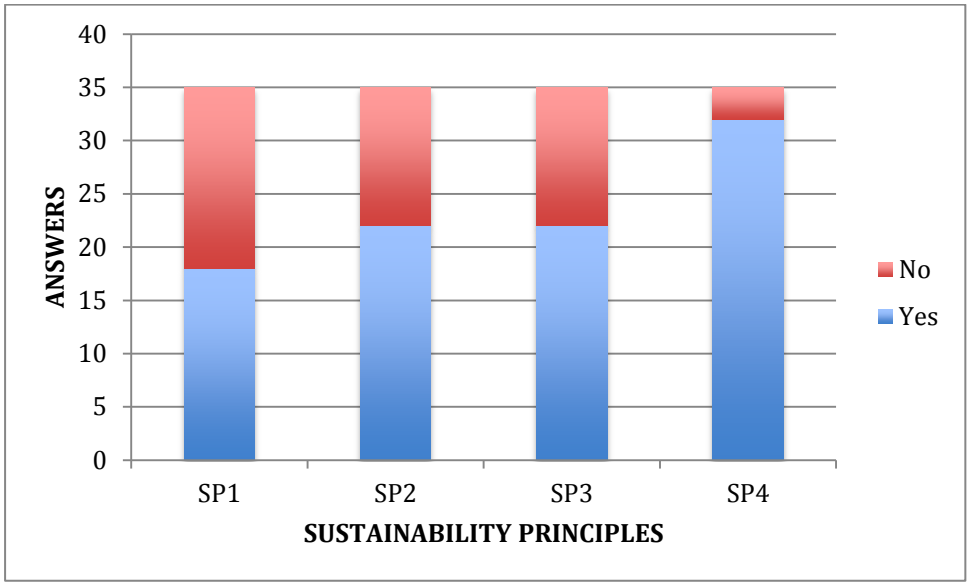


Figure 6.2: Answers according to Sustainability Principles

According to the stage of their value chain:

Raw Materials: **25** yes answers
Production: **18** yes answers
Packaging & Distribution: **17** yes answers
Use: **19** yes answers
End of Life: **15** yes answers

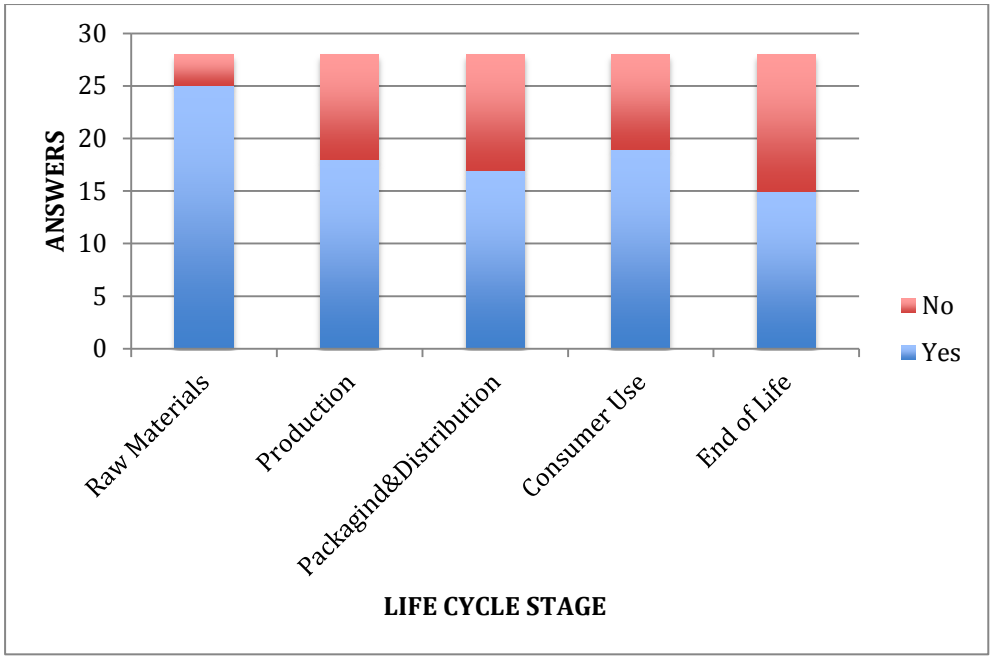


Figure 6.3: Answers according to life cycle stages

6.3 Bioenergy of Illy coffee

Illy coffee has been implementing an action to recover heat from waste created during the production of coffee. That brings with it a great possibility for Illy coffee to move towards become independent from outer sources of energy. At the moment Illy coffee is recovering around 1% from the smokestack (roasting plant) for heat recovery. The total consumption of Illy coffee in TOE (Tons of oil equivalent) for the year 2010 were:

Electrical Energy (TOE)	2461
Natural Gas (TOE)	1384
Total TOE	**3845**

Table 6.6: Total energy consumption of Illy coffee

The electrical energy consumed in the year 2010 was totally 9845 MWh, and the total consumption of natural gas was 1688350 Mc.

The production process of Illy coffee is made into roasting, packaging and sale of coffee blends. The manufacture of tin plated cans is made through the phases of pressing, forming and welding. The waste is collected indiscriminately from the production line.

After the production line of Illy coffee there is the following total waste was collected in 2010:

TYPE OF WASTE	AMOUNT in kg. (2010)
Parchment	320.200
Ink H	190
Toner	260
Workshop liquid H	890
Copper	2.842
Emulsions and solutions for machinery containing halogens H	1.000
Tin plate wastage	-
Used mineral oils H	990
Emulsions H	490
Grease H	19.510
Paper and cardboard	229.363
Plastic packaging (capsule)	13.040
Plastic packaging (polyester)	-
Plastic packaging (extensible film)	15.790
Wooden pallets	9.760
Tin plate cans	605.700
Polycoupled (150105)	16.880
Polycoupled (150106)	21.220
Packaging textile	191.920 (13.260 + 178.660)
Packaging solvent H	280
Rags H	1.470
E.S.E paper	31.580

Hazardous obsolete equipment H	330
Obsolete equipment	880
Organic waste	98.110
Batteries	-
BSE glycol ethylene H	720
Wood	3.030
Aluminum	-
Scrap	25.890
Cables	150
Various insulating materials	60
Medical waste products	-
Pulp mill	15.524
Glass	-
Solid urban waste	124.180 (4.780 + 119.400)
Sludge	8.000
Trench sludge	3.000

Table 6.7: List of waste production of Illy coffee [2011 Illycaffe SpA Environmental Statement]

(H: Hazardous)

Out of this list of waste, the last 5 types of waste (Pulp mill, glass, solid urban waste, sludge and trench sludge) are similar to municipal and not arising from the production line of Illy coffee.

The green color indicates waste that was then recovered and the red color indicates waste that was then disposed.

The purpose of listing the different waste collected after the production of Illy coffee was to analyze the potential of recovering energy from the biomass and then discuss it's connection to the sustainability of Illy coffee.

Biomass involves all products and residues from plant or animal sources, which can be used as fuel for the production of energy, like fire wood, plant and forestry wastes (pruning,

straw, sawdust, seeds), animal waste (manure, trash fish), municipal waste and residues from food and agricultural industries.

The following table shows an average potential energy recovery of wooden pallets and wood collected from Illy coffee production.

Waste type	Energy content (kWh/kg)	Amount (kg)	Energy recovery (kWh)
Wooden pallets	5	9.760	48.800
Wood	4,5	3.030	13.635

Table 6.8: Energy recovery from waste [http://www.sludgefacts.org/Ref87_2.pdf, http://www.resel.tuc.gr/images/stories/docs/19.cea-biomass.pdf]

Energy can be recovered also from other waste sources. However, some of them are recycled (e.g. paper) and for other we don't have sufficient information to have a reasonable estimation of energy recovery. Therefore that could be considered as the minimum energy that can be recovered from the waste of Illy coffee production.

So the total energy recovery from wooden pallets and wood can be estimated at: 48.800 + 13.635 = 62.435 kWh thermal energy. If the efficiency of thermal electricity conversion is considered to be around 40%, then the equivalent of 62435 kWh thermal energy is: 62435 * 0,4 = 24.974 kWh electrical energy.

7. Discussion of Results

There is a lot of information that can be extracted from each analysis made and its results.

From the qualitative analysis made, which is analyzed in paragraph 6.2, we can come to the conclusion that Illy coffee is surely a company that considers sustainability an essential aspect of their work. It shows that the tools that they use are not used in an abstract way but on the contrary, they are used in a strategic way. And their strategy is then reflected on their actions. They have a clear vision of success, that the company becomes a promoter of beauty, that the product has to be sustainable in order to be excellent or that ethics and quality are essential values. And also they have mechanisms, monitoring and environmental management systems, so they are conscious of a systems perspective that is defining their contribution for sustainability. That is in contrast to maybe many other companies, who are using the tools as their strategy and they are never exploring these higher levels.

From the standpoint of the Framework for Strategic Sustainable Development, which was described extensively in chapter 4, we could say that what is missing is clearly defined principles for success as far as sustainability is concerned. Having these principles as its guideline for their strategies would give them an even higher perspective and order in their actions.

Based on the Sustainability Life Cycle Assessment we can identify some general patterns:

- The overall sustainability performance of Illy coffee is very good when this is compared to the current situation in the world as far as sustainability is concerned. The number of "yes" answers is far exceeding the "no" answers. It reflects also the qualitative assessment (paragraph 6.1) and proves that Illy coffee is on a right path towards sustainability, yet

it is still far from full sustainability, which would mean that at least all the parts of the matrix would be colored dark green. All answers would then be "yes". Those are the minimal conditions in order a business or human activity to be sustainable in the long run, in a sustainable society.

- The far highest score, according to sustainability principles, is the one about the Human needs (32 "yes" answers and only 3 "no" answers). That is a very high performance and it shows that Illy coffee is considering the needs of humans throughout the whole life cycle of their product as a top priority. That reflects also the big emphasis that is given on ethics and quality as founding values and part of their definition of success.

- The far highest score according to life cycle stages is identified at the stage of the raw materials (25 "yes" answers and only 3 "no" answers). This reflects the good communication of Illy coffee with its coffee growers and producers, that is based on a personal trusting relationship. It also reflects the massive job on monitoring and mobilizing the entire coffee supply chain.

- The End of Life stage of the life cycle seems to be the most critical, especially when it comes to Sustainability Principle 1 and 3, where we have totally only 4 out of 14 "yes" answers, even though Sustainability Principle 4 is totally met (7 "yes" answers). When looking at SPs 1 - 3 , we can identify a gap between the current situation of how society is treating waste (e.g. question 5.1.1) and what is Illy coffee doing (e.g. question 5.1.6). So it seems that Illy is taking into account the end of life of it's product in it's research and action, but society is not meeting SPs 1-3 when it comes to the end of life of products of Illy coffee.

- The most critical Sustainability Principle when it comes to Illy coffee is SP1 (only 18 "yes" answers out of 35), although not in a big difference from SP2 and SP3 that both have 22 "yes" answers. There is though an interesting observation to be made. SP1 is showing big differences throughout the life cycle. Production, Packaging and End of Life are not doing well, whereas Raw materials and Consumer's use are doing

very well. The reason why raw materials is showing such a good result as far as SP1 is concerned is because the coffee is considered, whereas during the production and packaging other raw materials enter, which are not in direct influence from Illy coffee and violate SP1. Almost the same issue is reflected when it comes to the Consumer's use. There are many "yes" answers because the questions are directly connected with Illy actions (for example question 4.1.2)

- Sustainability Principle 2 on the other hand, although it is reaching a higher score in comparison with SP1, except from the raw materials stage, it has the same score throughout all other stages. There is again a gap between the current situation and the actions being taken by Illy coffee.

- The "no" answers are for the vast majority difficult one's, in the sense that they might depend on other supply chains or energy aspects. So there are elements throughout Illy coffee life cycle that are not depending entirely or directly from Illy coffee and they lack a sustainability perspective with regard to the 4 Sustainability Principles.

The opportunities to advance further and increasingly towards full sustainability lies for Illy mostly on influencing in an effective way processes out of their direct impact throughout the whole life cycle of the production of coffee. The same strategy of creating a strong relationship with coffee growers could possibly be implemented in other stages of the life cycle, and thus choosing ways to move towards energy systems or disposal opportunities that are not violating the 4 Sustainability Principles.

What can be clearly seen also through this assessment is the need of more consultative mechanisms between businesses, between business and government and between all stakeholders, as mentioned in chapter 1. Businesses need fairness, because they have difficulty dealing with differing regulations.

So Illy is a good example of an enlightened business that could constitute a leading force to establish effective global institutions that will be good for business.

Areas of improvement

The SLCA is a good tool for having a general understanding of how sustainable is a product during all the stages of the life cycle. There are a few points though to be mentioned.

- The full implementation process and SLCA analysis would include the generation and implementation of solutions to advance towards a fully sustainable product, and the monitoring on solutions implementation.

- Furthermore, the analysis shall be extended to the entire line of products, not just the 3Kg cans.

- The analysis is centered to a product, therefore it does not necessarily show how much is business investing in terms of resources for sustainability or how well it is doing in it's practices or performance.

- Also the questions are simply answered with a "yes" or "no" and therefore there is not a weight factor for each question. For example the question about dependence from fossil fuel energy would not be so relevant as a question about the dependence from mined materials that are scarce in nature for a business. That is just because there could be a specific business that is dependent on fossil fuels but not using but a limited amount of energy and on the other hand extensively extracting mined materials from the earth's crust that are scarce in nature. Both answer would be "no" but the outcome is not the same. Therefore what can be measured is not so much the actual situation of the business but it's direction in terms of sustainability of its product.

- Another point is again showing how SLCA is looking more on the direction. For the same question of the SLCA,

two businesses could have the same results but their impact would be very different. For example a business that is moving strongly towards non fossil fuel energy but still hasn't achieved it will be shown equally to another business that doesn't care about moving into non fossil-fuel energy. In both cases the answer would be "no".

These were some of the points to be mentioned about the adequacy of SLCA. This doesn't mean at all that the tool is ineffective. Rather, in spite of areas that could be improved, the tool has to remain fundamentally simple and profound and it has to be centered to direction in terms of the sustainability of a product, given a vision of full sustainability when it's principles are met.

Bioenergy

The minimum potential energy recovery from Illy coffee production that can be then consumed by the industry is 24.974 kWh. The total electricity consumption for Illy coffee in 2010 was 9.845 MWh. So, if energy were recovered from the two wastes, it would amount to around 0,25% of the total electricity consumption.

The cost of electricity in Italy is 0,2031 (prices of May 2012). The energy recovery then of 24.974 kWh would create savings of around 5.070 Euro for one year.

Apart from the economical aspect, there is of course an environmental benefit. The use of biomass for energy recovery would contribute to the decrease of CO_2 emission. The use of pallets or wood would decrease the forestry waste from Illy production.

But the percentage of recovery is very low, and it would mean that waste is sorted during the production phase, so that the use of it for recovery of energy would be possible. That doesn't happen in the case of Illy coffee. Apart from the waste is collected indiscriminately from all the phases of the production.

This shows that Illy coffee is a very responsible company as far as the treatment of waste is concerned, therefore using the biomass for energy recovery would produce no significant results. The amount of waste that is been recovered, instead of deposed is very positive.
It would be preferable for Illy coffee to continue using part of the biomass for fertilizers and direct it's efforts on becoming more independent from fossil fuels by moving into renewable energy and by continuing to gain heat from the smokestack.

8. Conclusion

A Strategic Sustainable Development approach is very useful when studying sustainability. By providing a strict, principled-based definition of a sustainable society, and providing strategic guidelines to move towards that society, a Strategic Sustainable Development approach avoids many of the pitfalls that can hamper other sustainability initiatives (for example a lack of a clear vision of success). By acknowledging that full sustainability requires a strategic, stepwise progression, an SSD approach can also empower individuals to act in the face of an overwhelming sustainability challenge.

Illy coffee is an example of a company that has proved to be a leader in embedding sustainability in its strategies, however far it still is to full sustainability, according to the FSSD.
It has more precisely shown that:

- It is using the tools for presenting its sustainability performance in a strategic way, with a vision of success and a definition of the system in which it is working. The outcomes of the thesis could make the company more conscious of this, as well as the importance of being guided by sustainability principles
- It has a good sustainability performance of its product throughout the life cycle. SLCA has shown to be an overarching practical tool to examine the sustainability of the whole life cycle of a product and a strong force towards helping businesses move decisively towards sustainability.
- It is quite efficient in managing its waste, although there is still space for more progress. Biomass has shown to be of little gain, if recovered for heating or electricity purposes.

However, the whole FSSD, as efficient as it is, could become a unifying framework only when it touches the concept of values, which is so central to any decision-making. If we want scientific and technological improvement to coincide with a decrease of environmental problems and a brave movement towards a

sustainable future, we should have a clear vision of prosperity and of the fundamental unity of humankind. That is an area that has to be acknowledged strongly and further addressed, because if we consider the needs of people (described as the 4th sustainability principle in the FSSD), what we basically need in the end is a common set of values that will move society to a deeply unified body. A business should address that question and ask itself how the concepts of sustainable development, prosperity, and values are connected to each other and to the business itself. A business should see itself as a leader in utilizing the capacities that have been created by the people and so much rejected by the old systems which are in place nowadays, towards building a new system based on the concepts mentioned before. In such a system, a business is a community of people, who are conscious of and inspired by the guidance that:

"All men have been created to carry forward an ever-advancing civilization"[1]

1. Baha'u'llah, "Gleanings from the Writings of Baha'u'llah", p.214

BIBLIOGRAPHY

1. J. Segalas, et al., 2009, *"Introducing Sustainable Development in Engineering Education",* ch1: Introduction p.1, < http://www.sefi.be/wp-content/abstracts2009/Segalas.pdf>

2. Bahai International Community, 1992, *"Sustainable Development and the Human Spirit"* based on the statement *"The Most Vital Challenge"* presented to the Plenary of the United Nations Conference on Environment and Development (UNCED, Earth Summit '92), <http://www.bic.org/statements/sustainable-development-and-human-spirit>

3. United Nations Environment Programme, 2007, *"Global Environment Outlook 4, ch1: Environment for Development"*, UN Documents <http://www.unep.org/geo/geo4.asp>

4. G. Robiati, 2004, *"Economy for a new world order",* George Ronald publishing trust

5. A. Dahl, 2002, *"The Challenge of Sustainable Development and Prosperity"*, European Baha'i Business Forum Publications <http://www.ebbf.org/publications/english/publications013.html>

6. United Nations World Commission on Environment and Development, 1987, *"One Common Future"*, UN Documents <http://www.un-documents.net/ocf-ov.htm>

7. Henrik Ny, 2006, *"Strategic Life Cycle Modelling for Sustainable Product Development"*, Blekinge Institute of Technology Licentiate Dissertation Series No. 2006:08 (ISSN 1650-2140 / ISBN 91-7295-094-5)

8. Allenby, Brad, 2006, "The ontologies of industrial ecology", *"Progress in Industrial Ecology - An International Journal",* Vol. 3, Nos. 1/2, 2006, p.28-40

9. Schmidt-Bleek, 2001, *"The Story of Factor10 and MIPS", < http://www.factor10-institute.org/files/MIPS_History.pdf>*

10. Wackernagel, 1994, *"Ecological footprint and appropriated carrying capacity: A tool for planning toward sustainability"*, phD Thesis, British Colombia University <https://circle.ubc.ca/bitstream/handle/2429/7132/ubc_1994-954027.pdf?sequence=1>

11. Lindfors et al., 1995, *"Nordic Guidelines on Life-cycle Assessment and Technical Reports",* Publication Nord 1995:020 (ISBN 92-912-0692-X) <http://www.norden.org/en/publications/publikationer/1995-020>

12. G.Pauli, 1998, *"Zero Emissions Research and Initiatives",* <http://zeri.org>

13. T.Lindhqvist, 2000, *"Extended Producer Responsibility in Cleaner Production"*, pHD Thesis Lund University published as AFR-Report 300 (ISSN 1102-6944 / ISBN 91-88902-13-7) <http://www.lub.lu.se/luft/diss/tec355.pdf>

14. Institute for the Environment and Sustainability - European Commission, 2010, *"Life Cycle Thinking and Assessment"*, <http://lct.jrc.ec.europa.eu/>

15. The European Commission's Directory of Environment, 2012, *"Sustainable Development"*, <http://ec.europa.eu/environment/eussd/escp_en.htm>

16. The European Commission's Directory of Environment, 2012, *"Integrated product policy",* <http://ec.europa.eu/environment/ipp/integratedpp.htm>

17. The European Commission's Directory of Environment, 2012, *"Sustainable use of Natural Resources",* <http://ec.europa.eu/environment/natres/index.htm>

18. United Nations Environment Programe and SETAC, 2009, *"Life Cycle Management: How business uses it to decrease footprint, create opportunities and make value chains more sustainable"*, Power Editing, Ireland

<http://www.unep.fr/shared/publications/pdf/DTIx0889xPA-LifeCycleManagement.pdf>

19. J.B. Guinee et al., 2011, "Life Cycle Assessment: Past, Present, and Future", *"Environ.Sci.Technol.",* vol.45, p.90-96

20. J.Bare et al., 2006, "Development of the method and US normalization database for life cycle impact assessment and sustainability metrics*", "Environ.Sci.Technol."*, vol.40, p. 5108-5115

21. The European Commission's Directory of Environment, 2012, *"Life cycle costing",*
< http://ec.europa.eu/environment/gpp/lcc.htm >

22. G.Rebitzer, D.Hunkeler, 2003, "Life cycle costing in LCM: ambitions, opportunities, and limitations*", "The International Journal of Life cycle Assessment",* vol.8, no.5, p.253-256

23. Zackrisson et al., 2000, *"Environmental management systems - Paper tiger or powerful tool"*, IVF Research Publication 00828 <http://www.swerea.se/Global/Swerea%20IVF/Dokument/skr00828.pdf>

24. Frankl and Rubik, 2000, *"Life cycle assessment in industry and business: Adoption patterns, applications and implications"*, Springer Publications

25. Broman et al., 2000, "Simplicity without reduction: Thinking Upstream Towards the Sustainable Society*", "Interfaces",* vol.30, n.3 ABI/INFORM Global pg. 13

26. K.H. Robèrt, 2002, *"The Natural Step story: Seeding a quiet revolution"*, New Society Publishers

27. R. Heijungs et al., 2010, *"*Life cycle assessment and sustainability analysis of products, materials and technologies. Towards a scientific framework for sustainability life cycle analysis*", "Polymer Degradation and Stability"*, vol.95, n.3 p.422-428

28. The Natural Step, 2004, *"A guide to The Natural Step framework",* <http://www.ruralsustainability.org/files/TNSFrameworkGuidebook1.pdf>

29. K.H. Dreborg, 1996, paper "The Essence of Backcasting", *"Futures",* Volume 28, Issue 9, pg. 813-828

30. K.H. Robèrt, 2000, "Tools and concepts for sustainable development, how do they relate to a framework for sustainable development, and to each other?", *"Journal of cleaner production",* vol.8, n.3, p.243-254

31. C.Folke, 2004, "Traditional knowledge in Social-Ecological Systems*", "Ecology and Society"*, vol.9, n.3, p.7 < http://www.ecologyandsociety.org/vol9/iss3/art7/>

32. K.H. Robert et al., 2002, "Strategic sustainable development - selection, design and synergies of applied tools", *"Journal of Cleaner Production"*, vol.10, p.197-214

33. L.Schipper , F.Johnson, 1993, *"Energy use in Sweden: An international perspective",* International Energy Studies Group, Lawrence Berkeley Laboratory, Berkeley (California) <http://www.osti.gov/bridge/servlets/purl/10129190-tBCYNi/native/10129190.pdf>

34. The Natural Step, 2004, *"Sustainability Life Cycle Analysis (SLCA): Assessing the sustainability of products"*, <http://www.thenaturalstep.org/sites/all/files/TNS-SLCA-tool_0.pdf>

35. I.Asaro, M.Spinelli, 2011, *"Case Study SLCA:Biomattone Equilibrium",* Politecnico di Milano < http://ebookbrowse.com/case-study-slca-biomattone-equilibrium-pdf-d312521543>