UNIVERSITY OF CAMBRIDGE
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# Annex II – Detailed Methodologies

## Case study 1: Cement Sustainability Initiative

### Key facts of initiative

**Table A Key facts of the Cement Sustainability Initiative (CSI)**

| *Cement Sustainability Initiative* | Impact |
|---|---|
| *Start year* | **1999** |
| *Number of members* | **25** |
| *Number of members with reported emissions target*[1] | **11** |
| *Expected impact in 2020 of members with reported targets* | **50–100 $MtCO_2e/yr$** |
| *Possible impact in 2020 if all members delivered equivalent ambition*[2] | **60–160 $MtCO_2e/yr$** |
| *Possible impact in 2020 if Chinese cement sector followed suit* | **10–400 $MtCO_2e/yr$** |
| *Possible impact in 2020 if entire sector followed suit* | **120–540 $MtCO_2e/yr$** |

Currently, only 11 out of 25 members of the Cement Sustainability Initiative (CSI) have adopted emissions intensity targets of around 600 kgCO2e/t cement by 2020. This results in avoided emissions of up to 100 $MtCO_2e/yr$ by 2020. Under the Scale-up scenario, CSI delivers up to 160 $MtCO_2e/yr$ of avoided emissions by 2020. This scenario assumes that the 14 CSI members which currently do not have targets adopt the same 600 kgCO2e/t cement emission intensity target. Further extending the CSI initiative to the global cement sector would result in a potential of avoided emissions of up to 540 $MtCO_2e/yr$ by 2020. A large portion of the avoided emissions in this scenario could be achieved by specifically focusing on setting CSI intensity targets in the Chinese cement sector. China currently accounts for around 60% of global cement production, however only five Chinese companies are members of CSI.

### Methodology

The methodology used to calculate the company level emissions impact and potential broader sector impacts of CSI is summarised below. The data sources used in this analysis are listed in the Reference Section at the end of this document.

**Company level avoided emissions**

1. The historical cement production of each company with targets was calculated using direct emissions and emissions intensity data. The mass of cement produced is equal to the direct emissions divided by the emissions intensity. Interpolation and growth rates were used to form a complete time series of cement production per company, under high and low growth scenarios. These growth scenarios were obtained from the International Energy Agency (IEA)

[1] It should be noted that all members are required to set and report on their targets as part of the initiative. They have 3 years to set up their MRV and target process. The newer members are still in this process – the number with targets should therefore shortly increase.

[2] Impact of all CSI members setting emission intensity reduction targets at the average level of the CSI members with reported targets.

[IEA, 2014b] while company level data was obtained from companies' CDP and Corporate Social Responsibility (CSR) reports. Refer to the Reference section for further details of the data sources used.

2. A business-as-usual (BAU) emissions intensity was calculated for each company, starting with historical emission intensity data from before the company signed the CSI charter. A complete time series of BAU emissions intensity was formed by applying a high and low improvement rate. These improvement rates were obtained from the IEA projections [IEA, 2014b].
3. A CSI influenced emissions intensity was calculated for each company, starting from historical emissions intensity data from after the company signed the CSI charter. It is assumed that all companies meet their emissions intensity targets. The emissions intensity for the period between the most recent historical data point and the target year was calculated from interpolation. Following the target year:
    a. For the high emissions intensity improvement scenario, the improvement trend over the past 10 years is extrapolated.
    b. In the low emissions intensity improvement scenario, the emissions intensity was assumed to remain constant after the target year.
4. Avoided emissions from the CSI initiative per company per annum were calculated by multiplying production by the difference in the emission intensities calculated in steps 2 and 3, as summarised in equation 1. In the high emissions scenario, the high production growth rate is combined with the low emissions intensity improvement. Conversely, in the low emissions scenario, the low production growth rate is coupled with the high emissions intensity improvement.

Eq.1:

Avoided emissions = production x (BAU emissions intensity – CSI emissions intensity)

**Extended scope methodology: Scale-up scenario**

The potential impact of scaling up this initiative was investigated on several levels. Separately, we evaluated the avoided emissions impact if similar targets were adopted by all 25 CSI members, and as illustrative examples, the Chinese cement sector and the global cement sector. This was quantified by two different methods, which take into account the uncertainty around the rate at which cement companies can reduce their emissions intensity. These two methods produce a range:

- On the lower end, we assume that the initiative can be expanded to these sectors, resulting in an annual emissions intensity improvement rate over 2016–2020 (i.e. annual rate of decrease in emissions intensity) equivalent to the average improvement rate achieved by the CSI members with targets over the period from 2009–2013. This annual rate is approximately 1%, compared to a BAU improvement rate of between 0.1–0.6% [IEA, 2014b].
- On the upper end, we assume that by 2020, the other CSI members, Chinese cement sector and the global cement sector can reduce their emissions intensity to the same level as the weighted average emissions intensity in 2020 from the 11 CSI companies with targets, as calculated in step 3.

For both ends of the range, the avoided emissions is calculated by equation 1, multiplying the production volume encompassed by a larger scale initiative by the difference between the BAU emissions intensity and an expanded CSI emissions intensity, as described by the two methods above.

5. The potential avoided emissions from all CSI members is equal to the sum of avoided emissions from the 11 CSI member companies with targets as calculated in step 4, and avoided emissions from the other 14 member companies. The avoided emissions from the latter are calculated using the extended scope methodology, as described above.

**Extended scope to Chinese cement sector**

6. The avoided emissions from the Chinese cement sector was evaluated using the extended scope methodology as described above. The Chinese cement BAU emission intensity is assumed to be identical to that of India [IEA and WBCSD, 2013]. The production growth rate was projected by extrapolating the Chinese cement production growth rate over 2000–2014 forward to 2020.

**Extended scope to global cement sector: Available Potential**

7. The avoided emissions of the global cement sector is equal to the sum of avoided emissions from the 11 CSI member companies with targets as calculated in step 4, and avoided emissions from the remaining production. The avoided emissions from the latter are calculated using the extended scope methodology as described above.

## Input assumptions

The key assumptions used to quantify the emissions impact of CSI and potential scaling up this initiative are:

- The percentage of global production from CSI members is assumed to remain at the current level of 30% [CSI, 2015] until 2020.
- China's cement production growth rate is assumed to be decreasing according to the production trends over 2000–2014 [National Bureau of Statistics of China, 2014].
- The Chinese BAU emissions intensity is assumed to be identical to that of India. This is characterised by a high emissions intensity in 1996 of 1120 kg$CO_2$/t cement, falling to 719 kg$CO_2$/t cement in 2010 [IEA and WBCSD, 2013]. This is valid as the primary energy carrier in China and India for non-metallic minerals production is coal [IEA, 2014a] and both India and China have relatively modern plants.
- The high and low cement production rates used 2.5% and 2.1%, respectively. These were calculated using projected production figures under a low and high demand scenario [IEA, 2014b].
- The BAU emissions intensity improvement rate were obtained from [IEA, 2014b]. The low improvement rate used was -0.1% per annum, which was used in IEA's 6DS low demand scenario. The high improvement rate used was -0.6% per annum, which was used in IEA's 4DS high demand scenario.

## Data sources used

This analysis is based on the following data sources:

- Company level data was obtained from CDP disclosures and the company reports [CDP, 2014j, 2014h, 2014i, 2014f, 2014g, 2014k; Cemex, 2014; CIMPOR, 2013; CRH, 2014; Heidelberg, 2012, 2014; Holcim, 2014; Italcementi, 2014; Lafarge, 2014; SCG, 2014; Taiheiyo, 2014; Titan, 2014, Votorantim, 2013a, 2013b]
- Historical Chinese cement production data was obtained from the Chinese Statistical Yearbook [National Bureau of Statistics of China, 2014].
- Global cement historical production data was obtained from the US Geological Survey [USGS].

# Case study 2: en.lighten

## Key facts of initiative

**Table B Key facts of UNEP/GEF en.lighten**

| en.lighten | Impact |
|---|---|
| *Start year* | **2009** |
| *Number of participating countries* | **73** |
| *Number of participating countries which have already set legally binding phase-out targets before 2020* | **39** |
| *Expected impact in 2020 by participating countries with binding targets* | **Approx. 60 $MtCO_2e/yr$** |
| *Possible impact in 2020 if all participating countries set targets for a ban on sales in 2016* | **Approx. 80 $MtCO_2e/yr$** |
| *Possible impact in 2020 if all developing countries ban the sale of incandescents in 2016* | **Approx. 340 $MtCO_2e/yr$** |
| *Possible impact in 2020 if the world bans the sale of incandescents in 2016* | **Approx. 640 $MtCO_2e/yr$** |

En.lighten has 73 member countries under the current target scenario. 39 of these countries have committed themselves to ban the sale of inefficient lighting before 2020. Taken together, this market transition could result in an estimated 60 $MtCO_2e/yr$ in avoided emissions by 2020. The most ambitious members, 23 of them, will ban incandescent lighting by 2016. Under the Scale-up scenario it is assumed that all 73 members adopt 2016 as target year for the ban, resulting in avoided emissions of around 80 $MtCO_2e/yr$ in 2020. If the whole world were to follow the 2016 commitment (ca. 120 additional countries) to ban inefficient lighting, the potential avoided emissions would be as high as 640 $MtCO_2e/yr$ by 2020, with 340 $MtCO_2e/yr$ coming from developing countries alone.

## Methodology

**Reproduction of en.lighten assessment**

1. In a first step, a calculation tool was set up to reproduce the results from en.lighten's own assessment study [UNEP/GEF en.lighten initiative, 2014]. This was done by using the en.lighten data[3] on current lamp stock per country, differentiated by lamp type and sector (residential, commercial and outside), as well as operation hours and wattages for the different lamp types. This data is available for 120 different countries (developing and developed).

**Target Scenario**

1. For the current target scenario, the energy consumption from lighting was determined in 2010 and 2020, before and after transition to efficient lighting options. From this information an estimate of possible energy savings was carried out which were then used to estimate emission savings achievable through the move to efficient lighting.
2. To determine the energy consumption from lighting in 2010 the following calculation steps were done:

[3] lighting assessment tool v1.6.1_beta - http://learning.enlighten-initiative.org/Tools.aspx

a. **Before transition (2010):** Using the en.lighten data on current lamp stock per country, bulb type and sector (residential, commercial and outside), as well as operation hours and wattages for the different lamp types the energy consumption was calculated before transition to efficient lighting.
b. **After transition (2010):** The participating countries were grouped together based on the policies in place to support the phase-out of inefficient lighting. The following policy categories were defined:
    i. Ban of incandescents without support campaign to increase the uptake of LEDs
    ii. Ban of incandescents supported by a campaign to increase the uptake of LEDs
    iii. Ban of incandescents and halogen lamps supported by a campaign to increase the uptake of LEDs
    iv. No ban in place

    For each policy category replacement tables were defined to be able to estimate the lighting composition within a country after transition. These tables provide estimations of the share of incandescent lamps that will be replaced by halogen tungsten lamps, compact fluorescent lamps or LEDs. This distribution varies according to policy category.

c. **Theoretical energy savings (2010):** the theoretical energy savings were calculated based on an immediate transition, which does not consider the rate at which replacement will take place.

3. In a next step to determine the energy consumption from lighting in 2020 the following calculation steps were done.
    a. **Progress factor:** To receive a rough estimate of energy consumption on country level from lighting in 2020, a progress factor was approximated, based on the projected population growth as well as the progress towards electrification. For this the electrification levels of the countries were extracted from en.lighten's assessment tool and assumptions were made on how electrification levels will progress in different country groups from 2010 to 2020.
    b. **Before transition (2020):** To determine the energy consumption from lighting before transition in 2020, the value for 2010, calculated in step 2a., was multiplied with the progress factor determined in step 3a.
    c. **After transition (2020):** to determine the energy consumption from lighting before transition in 2020 the value for 2010, calculated in step 2b. was multiplied with the scale up factor determined under step 3a.
    d. **Theoretical energy savings (2020):** the theoretical energy savings were calculated based on this immediate transition, which does not consider the rate at which replacement will take place.

**Current Target scenario**

4. The following approach was used to estimate the **energy savings** in 2020 for the Current Target scenario
    a. Target years for the phase-out of incandescent lamps were obtained based on the policy categories and information collected from the countries participating in the initiative. Where there is currently little activity in banning incandescent lamps, the

target year was set to after 2020, meaning that these countries do not contribute to the impact assessed in the Current Target scenario.
   b. Using a weighted average life time for the different bulb types, as well as the operation hours, the share of the stock that will be replaced by 2020 was estimated. This was based on the start of replacement from the target year for incandescent phase-out onwards.
   c. This share was then multiplied with the theoretical energy savings in 2020 from step 3d. to determine more accurate energy savings.
5. Estimating the **Mt$CO_2$ emission** connected to these energy savings
   a. Using IEA Emission factors for the different countries/regions, the energy savings calculated in step 4c. were translated into Mt$CO_2$ for each country of the participating countries in the Global Efficient Lighting Partnership Programme.

**Scale-up scenario**

1. For the Scale-up scenario it was assumed that all countries participating in the Global Efficient Lighting Partnership Programme set phase-out targets for the year 2020, countries which were previously grouped into the policy category “No ban in place” were included in the policy category "Ban of incandescents supported by a campaign to increase the uptake of LEDs”. Thus these countries also contribute to the impact of the initiative under this scenario.
2. Steps 4b-5a of the Current Target scenario were repeated for the Scale-up scenario.

**Available Potential**

1. To estimate the analytical potential that lies within the case if the entire world were to transition to efficient lighting options an approximation was used, as stock composition data is not available for all countries in the world.
2. A conversion factor was defined based on the ratio in electricity consumption in 2010 for the 120 countries included in en.lighten’s lighting assessment tool v1.6.1_beta and electricity consumption provided by IEA energy balances for the indicator “world”.
3. This conversion factor was then applied to the results received in the assessment for all 120 countries listed in the tool to receive an approximation for emission savings achievable if the world were to phase-out inefficient lighting technologies by 2016.
4. Other assumptions made to determine the assessment results are the same as for the Scale-up scenario

## Limitations

- The bulb stock composition used for the different countries is greatly simplified and represents only an approximation. It has been developed by en.lighten based on available country and global statistics supplemented by a few in-country stock taking. The bulb stock information is differentiated in to 5 cases, to represent different situations in countries. Similarly other lamp properties, like lamp life, operation hours and wattages represent approximations made in en.lighten’s assessment. More information can be found in the methodology description of the initiatives own assessment [UNEP/GEF en.lighten initiative, 2014]
- Rebound Effect: We are aware of the debate on the impact of the rebound effect over energy savings. The American Council for an Energy-Efficient Economy [ACEEE, 2012, 2012]

made an assessment of a range of rebound effect studies and concluded that the total rebound effect, both direct and indirect, is about 20%. The IEA also investigated the rebound effect in the World Energy Outlook 2012. The report notes that depending on the country or the consumption sector at stake, the direct rebound effect generally ranges from 0-10%, and that estimates of the indirect rebound effect vary widely. Accounting for this, the IEA estimates the overall rebound effect to be 9% [IEA, 2012]. We understand that uncertainty remains on the extent of the rebound effect and that studies have estimated numbers higher than 20%. Given that our calculations are high-level estimates and the large amount of uncertainty in the magnitude of the rebound effect we have not considered it in our analysis.

- The change in electricity consumption from 2010 to 2020 was approximated with a simplified approach based on population development as well as progress towards electrification to receive an indication for possible energy savings.

## Input assumptions

6. Replacement matrixes were slightly adapted from the en.lighten matrix (can be found here: [UNEP/GEF en.lighten initiative, 2014]) for the different country policy scenarios
    a. Ban of incandescents without support campaign to increase the uptake of LEDs
    b. Ban of incandescents supported by a campaign to increase the uptake of LEDs
    c. Ban of incandescents and halogen lamps supported by a campaign to increase the uptake of LEDs
    d. No ban in place
7. Assumption were made on progress towards electrification from 2010 to 2020, following country groupings
8. Assumptions on $CO_2$ factors per region (if not available for the individual countries) were made
9. Scaling-up to receive an estimation for the world was made based on the projected energy consumption (based on data from IEA energy balances)

## Data sources used

- Population current and growth projection was based on data provided by the UN for both sexes combined, as of 1 July with an assumption for a medium fertility rate [United Nations 2013]
- IEA emission factors and electricity consumption retrieved for the year 2010 from IEA energy balances.
- Bulb stock information, bulb wattages, operation hours; lamp life based and lighting consumption values were taken from the lighting assessment tool v1.6.1_beta - http://learning.enlighten-initiative.org/Tools.aspx
- En.lighten's second generation on-grid country lighting assessments [UNEP/GEF en.lighten initiative, 2014]
- Information on target year and bulb type bans for specific countries and country groups were provided by the initiative

# Case study 3: Tropical Forest Alliance 2020

## Key facts of initiative

**Table C Key facts of the Tropical Forest Alliance 2020**

| Tropical Forest Alliance 2020 | Impact |
|---|---|
| *Start year* | **2012** |
| *Number of direct private sector members* | **16** |
| *Number of members with a zero net deforestation target for palm oil* | **8** |
| *Current annual emissions savings of members with targets* | **20 $MtCO_2e/yr$** |
| *Expected impact in 2020 if all palm oil handled by members was sources sustainably* | **20-200 $MtCO_2e/yr$** |
| *Expected impact in 2020 if all global palm oil was sourced sustainably* | **50-460 $MtCO_2e/yr$** |

Of the 16 private sector members of the TFA 2020, 8 have set the goal of zero for palm oil handled within their supply chains. Under the current scenario the efforts of these 8 members can be connected to around 20 $MtCO_2e/yr$ avoided emissions in 2020. This analysis assumes that certification of palm oil steers cultivation and expansion away from high carbon value virgin forest and peatland towards low carbon value forest types, leading to less emissions than under business-as-usual development[4]. If all members were to source their palm oil sustainably, avoided emissions could grow almost ten-fold to potentially 200 $MtCO_2e/yr$ in 2020. Moreover, if all of future produced palm oil, including from companies who are not members of TFA 2020, were to be sourced sustainably, the avoided emissions could reach an estimated 460 $MtCO_2e$ by the same year.

## Methodology

**Step 1: Emissions resulting from increase in palm oil production**

1. For the commodity palm oil (oil, palm fruit), historic data on area harvested (1990-2013) was exported from FAOSTAT[5] for the major producing countries within the tropical belt:
    a. Indonesia (45% share in production in 2013 among tropical countries) and Malaysia (36% share among tropical countries)
2. The area values were extended from 2013–2020 through two scenarios:
    a. **Minimum scenario:** For the minimum range the observed trend from the previous 10 years was carried onwards up to 2020, which resulted in an average annual increase in area harvested of 5% in Indonesia and 2.6% increase in Malaysia
    b. **Maximum scenario:** For the maximum range the annual growth rate provided by FAOSTAT which was 9% for Indonesia and around 3.4% for Malaysia was used.
3. This allowed for determining the minimum and maximum values for additional area harvested. This represents the increase in area effected by palm oil due to the increase in its production volume over the years. To determine the additional area harvested the following was done under the minimum and maximum scenarios:

[4] See the limitations to the analysis for details on this assumption

[5] FAOSTAT, 2015: http://faostat3.fao.org/download/Q/QC/E

   a. **Minimum scenario**: The additional area harvested per year was calculated by the difference in area harvested in two consecutive years under minimum scenario 2a.
   b. **Maximum scenario:** In this case additional area harvested per year was calculated by the difference in area harvested in two following years under maximum scenario 2b.
4. Determination of emissions $MtCO_2e$ that can be attributed to palm oil under the **Baseline scenario:**
   a. Using the typical expansion patterns observed for the commodity, together with carbon content values for the different types of forest that the commodity enters, the $MtCO_2e$ were estimated.
5. Determination of $MtCO_2e$ that can be attributed to palm oil under the **Certification scenario:**
   a. In this scenario, it was assumed that with 100% sustainable certification of the commodity, the expansion into certain types of land – namely virgin forest, peatland and high carbon value forest – will not take place, as the certification scheme will include forest management options. This "certification expansion" was used together with the carbon content values from the baseline scenario to determine the $MtCO_2e$ under the certification scenario.
   b. For the maximum scenario under certification it was further assumed that a halt in deforestation is gradually achieved by 2020.
6. Assumptions:

**Table D Assumed expansion patterns (same patters for Indonesia and Malaysia)**[6]

| Forest Type | Expansion pattern | |
|---|---|---|
| | **Baseline** | **Certification** |
| Area share of peat | 4% | 0% |
| Area share of shrubs/grass and deforested (previously converted) land | 55% | 75% |
| Area share of virgin forest | 37% | 0% |
| Area share secondary forest | 4% | 25% |

**Table E Estimated emission factors (same patters for Indonesia and Malaysia)**[7]

| Forest Type | Emission factor [$tCO_2/ha$] | |
|---|---|---|
| | **min** | **max** |
| Peat | 226 | 776 |
| Shrubs/grass and deforested (previously converted) land | 110 | 132 |
| Virgin forest | 381 | 693 |
| Secondary forest | 183 | 381 |

7. A range of $MtCO_2e$ emissions was determined for the baseline as well as the certification scenario, arising from the minimum and maximum scenarios for the additional area harvested together with the emission factor assumptions. In the maximum scenario for certification emissions become 0 as it is assumed that net zero deforestation is achieved.

[6] Based on Agus et al. (2013): Historical $CO_2$ Emissions from Land Use and Land Use Change from the oil palm Industry in Indonesia, Malaysia and Papua New Guinea.

[7] Based on Agus et al. (2013): Historical $CO_2$ Emissions from Land Use and Land Use Change from the oil palm Industry in Indonesia, Malaysia and Papua New Guinea.

**Table F Determined Emissions in 2020 under the baseline and certification scenario**

| Forest Type | Emissions in 2020 [$MtCO_2/a$] | |
|---|---|---|
| | min | max |
| Indonesia baseline | 90 | 400 |
| Indonesia certification | 50 | 0 |
| Malaysia baseline | 30 | 70 |
| Malaysia certification | 10 | 0 |

**Step 2: Private sector impact**

**Current Target scenario**

1. In order to determine the impact, the volume (t) of palm oil handled by TFA 2020 private sector members, together with the share of certified palm oil, was collected. Currently private sector members of the TFA 2020 hold roughly 45% of the market.
2. It was assumed that the shares the different members hold in the market in 2013 remain the same. Based on these shares an estimation was made for the volume of palm oil the members handle in 2020.
3. Using the 2020 emissions determined under Step 1 calculations, together with production values of palm oil in 2020, emission factors were determined in $tCO_2/t$ (palm oil) for the baseline scenario, as well as for the certification scenario
4. Using these emissions factors, the emissions caused by the palm oil handled by the companies were determined
    a. The share of uncertified palm oil was multiplied with the baseline scenario emission factor and the share of certified palm oil was multiplied by the certification scenario emission factor

**Scale-up scenario**

1. Under the Scale-up Scenario it was assumed that all member companies reach the most ambitious target and all palm oil handled by the member companies is sustainably sourced.
2. The achievable emission reductions were estimated by following the baseline scenario development to determine emissions as well as the certification scenario to calculate emissions when all palm oil is handled sustainably.
3. The resulting difference is estimated to be the possible avoided emissions.

**Available Potential**

1. For the Available Potential the two emission factors were applied to all palm oil produced in 2020 to estimate possible emission reductions, if this palm oil were to be sourced sustainably and were not to expand into virgin forest.

## Limitations

- For the impact analysis of the TFA 2020 the emphasis was put on palm oil as the main commodity addressed by the initiative over the last years (see also [Cole and Teebken, 2015]). In addition, the focus was put on Indonesia and Malaysia as the major producing countries of palm oil not only within the tropical belt, but worldwide. These two countries alone account for well over 80% of global palm oil production [WWF, 2013; FAOSTAT], making them a suitable selection for analysis.

- Volume handled by companies in 2020 is based on the 2013 shares and not the companies own growth projections.
- Where expansion patterns were based on specific regions, it was assumed that the same patterns applied to the entire country/region.
- The simplification was made that deforestation *decreases* due to certification and avoided emissions can be estimated based on a forest management component within certification. For this analysis the focus lies only on deforestation emissions. In this case the emission reductions resulting from a decrease in deforestation can only be claimed if the entire sector would be certified or if governments would manage to effectively ban deforestation, thereby steering oil palm plantation area expansion towards non-forested land.
- The simplification was made that the increase in palm oil production and its expansion are the only factors considered to drive deforestation for this analysis.
- Certification has several benefits and contributes positively to a more sustainable palm oil production. While it can be used to claim that no deforestation takes place due to the companies' palm oil operations, it cannot be simply claimed that overall deforestation *decreases* due to certification. Also certification does not lead that easily to emission reductions. Under RSPO direct production chain emission reductions can be claimed, for instance reductions from palm oil biodiesel compared to the fossil reference. However for this analysis the focus lies only on deforestation emissions. In this case the emission reductions resulting from a decrease in deforestation can only be claimed if the entire sector would be certified or if governments would manage to effectively ban deforestation, thereby steering oil palm plantation area expansion towards non-forested land. Otherwise one would only see a move towards expansion into low carbon value land by the companies sourcing sustainably and the remaining market would continue expanding into (virgin) forest area. Currently TFA 2020 members hold a market share of around 45% in palm oil production, leaving the rest of the market to conventional sourcing.

  This so called 'waterbed effect' means that while sourcing sustainably can be seen as no longer contributing to deforestation from a company perspective, emission reductions cannot be that easily claimed, as a company moving towards low carbon value land can result in other companies further driving deforestation through their sourcing and production practices. Increasing membership and taking up efforts in steering expansion towards low carbon value forest and land type on a global scale could help address and eventually overcome this issue.

## Input assumptions

- Production volumes/area harvested can be extended to 2020 by trending historic developments
- Expansion patterns for palm oil (based on literature and expert estimates)
- Maximum and minimum emission factors/carbon content for different types of forest (peat, deforested, virgin, secondary forest) were based in part on different countries and regions.
- Assumed that emission factors/carbon content in Malaysia is similar to Indonesia
- It was assumed that a rough emission factor for "handled palm oil" can be estimated as $tCO_2/t$ production in 2020 for the baseline and certification scenario

## Data sources used

- [Agus et al., 2013]
- Annual Communication of Progress (ACOP) Reports to the Roundtable on Sustainable Palm Oil (RSPO):
    - ACOP 2013/2014 - McDonald's Corporation [McDonald's, 2014]
    - ACOP 2013/2014 - Cargill Incorporated [Cargill Incorporated, 2014]
    - ACOP 2014 - [Wilmar, 2014]
- CDP, 2015: https://www.cdp.net/en-US/Pages/HomePage.aspx
    - CDP Forests 2014 Information Request Marks and Spencer Group plc [CDP, 2014d]
    - CDP Forests 2014 Information Request Marfrig Alimentos S.A. [CDP, 2014c]
    - CDP Forests 2014 Information Request Nestlé [CDP, 2014e]
- FAOSTAT, 2015: http://faostat3.fao.org/download/Q/QC/E
- Roundtable on Sustainable Palm Oil (2014): Impact Report 2014 [RSPO, 2014]
- Sustainability report:
    - M&S Plan A Report 2014 [M&S Marks and Spencer Group, 2014]
- Union of Concerned Scientists:
    - Palm Oil Scorecard: Company Profiles [Union of Concerned Scientists, 2014]
    - Donuts, Deodorant, Deforestation. Scoring America's Top Brands on Their Palm Oil Commitments. [Calen May-Tobin and Lael Goodman, 2014]
- WWF (2013): Palm Oil Buyers Scorecard – Measuring the Progress of Palm Oil Buyers [WWF, 2013].

# Case study 4: WWF Climate Savers

## Key facts of initiative

**Table G Key facts of WWF Climate Savers**

| WWF Climate Savers | Impact |
|---|---|
| *Start year* | **2000** |
| *Number of members* | **28** |
| *Number of members with emissions target* | **28** |
| *Expected impact in 2020 of members with targets* | **10–32 $MtCO_2e/yr$** |
| *Expected impact in 2020 if membership double* | **16–60 $MtCO_2e/yr$** |
| *Possible impact in 2020 if industry peers follow suit* | **1,000–1,300 $MtCO_2e/yr$** |

Under the current target scenario, the initiative's 28 members have committed to ambitious emission reduction targets of between 15-40% of emission reductions in their supply chains and operations. This results in overall avoided emissions of up to 32 $MtCO_2e/yr$ mitigated by 2020. If 28 additional companies would join the initiative, membership would double. With similarly ambitious emission reduction targets for these members, the initiative could increase its impact in 2020 to around 60 $MtCO_2e/yr$. Finally, if the average emission reduction targets were to be applied to all industry sector peers of Climate Saver companies the avoided emissions could be raised up to 1,300 $MtCO_2e/yr$ by 2020.

## Methodology

**Current Target scenario**

For the WWF Climate Savers analysis a slight distinction was made between members that joined prior to 2011 and were thus already included in the analysis performed by Ecofys in 2011 [Ecofys, 2012], here after referred to existing members and the so called "new members" that joined after 2011 and were therefore not part of the Ecofys' first impact assessment.

In general, where possible only scope 1 & 2 emissions were used.

**Company level avoided emissions –new members**

1. From the WWF Climate Savers website the following data was collected for each new member:
   a. Year joined
   b. Base year for the target
   c. Commitment period end (= target year)
   d. Reduction target
2. In a next step historical emissions (where possible only scope 1&2 emissions) and revenue data were collected for each member company from CDP reports, annual/sustainability reports and other official communications.
3. Using this information the final emissions were estimated starting from the year the company joined the initiatives up to the target year. Where necessary the final emissions were extended to 2020.
   a. Based on the base year emissions the absolute emissions for the target year were calculated using the reduction target set as part of the Climate Saver Agreement

   b. For the years between last available actual emissions and the target year the emissions were linearly interpolated.
   c. If the target year was before 2020, the final emissions were extended in two ways to account for uncertainty:
      i. By keeping the final emissions constant between target year and 2020 (const. scenario).
      ii. By continuing the previously observed trend in emission reductions until 2020 (trend scenario).
4. The following steps were taken to approximate the Business-as-usual (BAU) development from which to estimate the achieved avoided emissions:
   a. Where data availability allowed a BAU scenario was created using specific emissions based on revenue, following methodology 3 as described in [Ecofys, 2012].
   b. After the last available year of such determined BAU emissions they were extended using the same approach as for the final emissions:
      i. By keeping the BAU emissions constant between last available year and 2020 (const. scenario).
      ii. By continuing the previous trend in BAU emissions until 2020 (trend scenario)
   c. Where no information on revenue and emissions in a specific year were available the emissions from the base year were used as the starting point for the BAU which was then kept constant up to 2020
5. This data was then used to determine the avoided emissions achieved:
   a. The **maximum** avoided emissions were calculated by subtracting the lowest final emissions from the highest BAU emission for each year
   b. The **minimum** avoided emissions were calculated by subtracting the highest final emission value from the lowest BAU emissions for each year.

**Company level avoided emissions –existing members**

1. Data on BAU emissions and final emissions was extracted from the 2011 analysis file
2. Where data gaps existed up to 2020 the gaps were filled using the same approach as for new members, for both BAU and final emissions:
   a. By keeping the emissions constant between last available year and 2020 (const. scenario)
   b. By continuing the previous trend in emissions until 2020 (trend scenario)
3. The avoided emissions from the existing members were determined as for new members:
   a. The **maximum** avoided emissions were calculated by subtracting the lowest final emissions from the highest BAU emission for each year
   b. The **minimum** avoided emissions were calculated by subtracting the highest final emission value from the lowest BAU emissions for each year.

**Current Target scenario**

1. The overall impact of the initiative was then calculated as the sum of the minimum values for new and existing members in 2020 and similar for the maximum values to receive the minimum value of the range and the maximum value of the range respectively.

**Scale-up scenario**

1. In order to determine the potential for scale-up within the initiative a selection of 28 additional members was made. These members belong to similar industry subsectors as current members. They are also of the relevant size and visibility typically targeted by WWF Climate Savers.
2. As of 2015 WWF Climate Savers members are required to set emission reduction targets in line with science. To account for this each member was assigned to a sector as described in [CDP et al., 2015]. Based on the sectoral decarbonisation pathways described in this methodology the members were given reduction targets appropriate to their sector.
3. To determine the BAU development, to scenarios were used:
    a. By keeping the emissions reported in 2013 constant between up to 2020 (const. scenario).
    b. By assuming an annual emissions growth of 1.68% (growth scenario), which is in line with global emissions growth projections [UNEP, 2011].
4. The range of potentially avoided emissions from these additional members were then determined:
    a. The **maximum** avoided emissions were calculated by subtracting the targeted final emissions in 2020 from the growth scenario BAU emissions in 2020
    b. The **minimum** avoided emissions were calculated by subtracting the targeted final emissions in 2020 from the constant scenario BAU emissions in 2020.

**Available Potential**

5. In a last step the overall potential savings were estimated if industry peers of WWF Climate Savers members followed suit and achieved comparable emission savings. This analysis uses the data and values from the Current Target scenario.
    a. The members were grouped into different subsectors and the BAU emissions trend/const. in 2020 as well as the final emissions trend/const. in 2020 were summed within each subsector.
    b. For the trend and const. scenario the percentage (%) of avoided emissions was then determined within each subsector.
    c. Using the subsector emissions for scope 1&2 of the top 2000 emitters in 2008[8] the emissions for the subsectors were determined in 2020
        - $Emissions_{2020} = Emissions_{2008} * (1 + Annual\ Emissions\ Growth)^{(2020-2008)}$
        - Annual Emissions Growth was assumed to be 1.68% as for the Scale-up scenario.
    d. Using the previously calculated % avoided emissions the potential emissions savings within each subsector were calculated for the trend and const. scenario
    e. The potential emissions savings were then summed for the const. scenario to determine the range minimum and the trend scenario for the range maximum of total potential emission savings

[8] Information was obtained from previous Ecofys work.

## Limitations

- The baseline was determined at best using specific emissions based on turnover. However, under the Climate Saver Agreement the WWF and company decide on a baseline which may differ from the one chosen in this analysis.
- Data gaps were addressed through linear interpolation between data points.
- Targets set before 2020 were extended to 2020 through the use of a “constant” and a “trending” scenario, however member companies will decide to set a target for 2020 by using one of the methodologies recommended under the Science Based Target Initiative[9] to set new targets in line with science.

## Input assumptions

- Inflation rate was assumed to be 2%/yr
- Autonomous annual energy efficiency improvement was set to 1%/yr
- Where “years joined” were missing the year was set to 2011
- Annual emissions growth = 1.68% (following [UNEP, 2011])
- Linear intra/extrapolation was used for bridging data gaps

## Data sources used

- WWF Climate Savers website and communication/fact sheets[10]
- Company sustainability and annual report series (2010–2014): [Vanke, 2011; WWF and Vanke, 2015; SKF, 2014; Swisscom, 2013, 2011, ; SwissPost, 2014; Volvo Group, 2014; Coop Group, 2014b; Novelis, 2012b, 2014b; Resolute Forest Products, 2012; Volvo Group, 2015; Coop Group, 2011b, 2010, 2011a, 2013, 2014a; Lego Group, 2014b, 2009, 2014a; Novelis, 2013, 2014a, 2012a; Resolute Forest Products, 2013; Sony, 2013, 2014, 2010]
- Company CDP reports: [CDP, 2012a, 2013, 2014b, 2012b]
- Ecofys reports: [Ecofys, 2012; WWF and Ecofys, 2015]

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[9] http://sciencebasedtargets.org/

[10] http://climatesavers.org/

# Case study 5: Refrigerants, Naturally!

## Key facts of initiative

**Table H Key facts of Refrigerants, Naturally!**

| *Refrigerants, Naturally!* | Impact |
|---|---|
| *Start year* | **2004** |
| *Number of members* | **4** |
| *Expected impact in 2020* | **0.0–0.7 $MtCO_2e/yr$** |
| *Expected impact in 2030* | **0.2–1.4 $MtCO_2e/yr$** |
| *Possible impact in 2030 if entire stand-alone refrigeration sector followed suit* | **0.9–7.9 $MtCO_2e/yr$** |
| *Possible impact in 2030 if all refrigeration units using HFCs follow suit* | **240–320 $MtCO_2e/yr$** |

RefNat!'s moderate avoided emissions are due to the fact that emissions mostly occur at the equipment's end of life, 8–14 years after purchase. Current targets set by the 4 member companies in RefNat! to replace F-gas based refrigerants with natural refrigerants in stand-alone refrigeration units result in a maximum of 1.4 $MtCO_2e/yr$ by 2030. If the targets of RefNat! would extend to the whole stand-alone commercial refrigeration sector, avoided emissions would go up to 8 $MtCO_2e/yr$ by 2030. This scenario assumes that the global stock of stand-alone commercial refrigeration units using F-gas refrigerants are phased-out at the same rate as the member companies of RefNat!. Scaling up the RefNat! initiative to all refrigeration units (i.e. including domestic refrigeration, condensing units and full supermarket systems), not just stand-alone units, and using F-gas refrigerants would result in avoided emissions of up to 320 $MtCO_2e/yr$ by 2030.

## Methodology

The methodology used to calculate the company level emissions impact and potential broader sector impacts is summarised below.

**Current Target scenario**

1. For each company, the total number of refrigeration units in use and growth rates are used to calculate the historical and projected number of refrigeration units over time, from 2004 to 2030.
2. The number of new refrigeration units purchased in a year *t* is the sum of:
   a. The difference between the total number of refrigeration units in year *t* and *t*-1. This is the number of new units purchased due to growth.
   b. The number of units at the end of life in year *t*-1. This is calculated assuming a uniform distribution of refrigeration unit age, and a unit lifetime of 8–14 years.
   - Due to the range in unit lifetime, the number of new refrigeration units purchased and all further calculations are a range.
3. A first estimate of the number of HFC-free units purchased is formed by multiplying the number of new refrigeration units purchased in a year by the deployment rate of HFC-free units.
4. Next, this estimate of the number of HFC-free units purchased each year up to 2013 is normalised by company figures available in the public domain. After 2013 (the last historical

data point), the number of HFC-free units purchased is linearly extrapolated until it is equal to the total number of new units purchased (evaluated in step 2).

5. The number of HFC units purchased is the difference between the total number of new units purchased (evaluated in step 2) and the number of HFC-free units purchased (evaluated in step 4).
6. The number of HFC units to be disposed each year is calculated by the following:
   a. It is assumed that prior to joining the initiative, all refrigeration units purchased use the refrigerant HFC-134a. The number of HFC units disposed in the years up to the year of joining the initiative + the 8/14 year lifetime of the units is equal to total the number of refrigeration units at the end of life in that year.
   b. In the following years, the number of HFC units at the end of life is equal to the number of HFC units purchased in year *t*–8 or year *t*–14.
7. The avoided emissions impact of Refrigerants, Naturally! on a company level is calculated by taking the difference between:
   a. GHG emissions without the initiative. First, it is assumed that all refrigeration units at the end of life (calculated in step 2b) are HFC units. The mass of HFC-134a emitted per year is calculated by multiplying the number of units by the mass of refrigerant per unit and then by the percentage of refrigeration units with HFC refrigerants that are not recycled or destroyed at the end of life. Finally, the mass of HFC-134a emitted is converted to units of $CO_2$e by applying the HFC-134a Global Warming Potential (GWP).
   b. GHG emissions with the initiative. The emissions of the HFC units disposed each year (evaluated in step 6) is calculated in a similar manner as step 7a.

**Scale-up scenario**

8. The avoided emissions impact of extending the initiative to all commercial, stand-alone refrigeration units is calculated by:
   a. Evaluating the percentage of stand-alone refrigeration units covered by the current members of the initiative.
   b. Dividing the avoided emissions impact of the initiative's members by the percentage share calculated in step 8a.

**Available Potential**

9. The avoided emissions impact of extending the initiative to all refrigeration units using HFC refrigerants is calculated by:
   a. Evaluating the % of BAU GHG emissions abated by the 4 members of the initiative
   b. Multiplying the projected HFC emissions by the percentage calculated in step 9a.

## Input assumptions

Due to limited data availability, the following assumptions were used in this analysis:

- Unilever's deployment rate of HFC-free units [Unilever, 2014] is representative of the deployment rate of the other companies.
- The age of refrigeration units in use is uniformly distributed, with a lifetime of between 8–14 years [IPCC and TEAP, 2006].

- The growth rate in the number of refrigeration units is assumed to be 3% for all companies. This is the weighted average growth rate for commercial refrigeration in OECD and non-OECD regions [IPCC and TEAP, 2006].
- The proportion of units in OECD and non-OECD countries is the same for all companies [IPCC and TEAP, 2006].
- The HFC recycling or destruction rate is assumed to be 50% in OECD countries and 25% in non-OECD countries [UNEP, 2009].
- For all refrigeration units, it is assumed that the synthetic refrigerant HFC-134a, with a GWP of 1,430 [IPCC, 2007], is replaced with a natural refrigerant with GWP of 0. This assumption is valid as HFC-134a is the most common HFC refrigerant used in these type of refrigeration units [IPCC and TEAP, 2006] and the natural refrigerants used to displace HFCs, e.g. $CO_2$, has a GWP of 1, which is significantly lower than 1,430.
- The leakage of refrigerant during operation is negligible. The only emission of GHGs occurs during the disposal phase [IPCC and TEAP, 2006].
- The number of PepsiCo refrigeration units on the market is assumed to be proportional to the number of Coca-Cola refrigeration units when weighted by the ratio of revenues [Coca-Cola, 2013; PepsiCo, 2014].
- Before joining the initiative, all refrigeration units purchased use HFC-134a as a refrigerant.
- The HFC-134a refrigerant mass per refrigeration unit is between 0.2–1 kg [IPCC and TEAP, 2006].

### Data sources used

This analysis is based on the following data sources:

- Company level data was obtained from CDP disclosures and the company reports: [CDP, 2014a; Coca-Cola, 2011,, 2013, 2014; CDP, 2014l; Unilever, 2012, 2014, ; Jacob, 2014; Red Bull, 2014; PepsiCo, 2014; Refrigerants, Naturally!, n.d.].
- The US EPA database was used for global HFC emissions projections [US EPA, 2014].
- Global refrigeration data and characteristics of stand-alone refrigeration units were obtained from the *IPCC/TEAP Special Report*: *Safeguarding the Ozone Layer and the Global Climate System* (2005).

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