

MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

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* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
version 2.1, 21 July 2015

ADES Solar and efficient stoves in Madagascar
GS 464
monitoring period 6 (01/01/2014 - 31/12/2014)

SECTION A. General description of the project activity

A.1. Brief description of the project activity:

>> 1. The objective of this project is to locally produce and distribute solar and efficient cook stoves to people in Madagascar. The Swiss-Madagascan non-governmental organization ADES (Association pour le Développement de l'Energie Solaire) has increased its capacities since the project start in 2007 and today operates cook-stove workshops in Tuléar, Ejeda, Morondava, Morombe, Majunga and Fianarantsoa and a sales point in Antananarivo. In order to create awareness for new stove technologies and to convince people to buy a new stove, cooking demonstrations in villages and schools as well as training programs for solar cooking are conducted.

2. Installed technologies are locally produced solar and efficient cook stoves. Nine stove types are currently being disseminated: (1) solar box stove, (2) E-solar box stoves, (3) solar parabolic stove, (4) efficient wood stove OLI-b, (5) efficient wood stove OLI-45b, (6) efficient wood stove OLI-60b, (7) efficient charcoal stove OLI-c, (8) efficient charcoal stove OLI-45c, and (9) efficient charcoal stove OLI-60c.

3. Relevant dates:

Start date of the project: 27 August 2007

Start date of crediting period: 01 January 2008

Date of first stove sale: 04 January 2008

First monitoring period: 04 January 2008¹ – 22 December 2009

Second monitoring period: 23 December 2009 – 31 December 2010

Third monitoring period: 01 January 2011 – 31 December 2011

Fourth monitoring period: 01 January 2012 – 31 December 2012

Fifth monitoring period: 01 January 2013 – 31 December 2013

Sixth monitoring period: 01 January 2014 – 31 December 2014

Project is in continuous operation.

4. Total emission reductions achieved in this monitoring period are **181,996 tCO₂e**

A.2. Project Participants

>>

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Madagascar (Host)	Private Entity - ADES – Association pour le Développement de l'Energie Solaire	No
Switzerland	Private Entity	No

¹ Upon request by the Gold Standard during first issuance the start of the first monitoring period was set to be the date of first stove construction and not the start date of the crediting period as defined in the PDD.

(Annex 1)	- Foundation myclimate - the Climate Protection Partnership	
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A.3. Location of the project activity:

>> Country: Republic of Madagascar

Regions: entire country of Madagascar

Town/cities, where existing production and distribution centres are located:

- Toliara (Tuléar): 23°21'S, 43°40'E
- Ejeda: 24°21'S, 44°31'E
- Morondava: 20°17'5"S, 44°19'3"E
- Morombe: 21°44'56"S, 43°21'47"E
- Majunga: 15°42'55.09"S, 46°19'8.42"E
- Fianarantsoa: 21°27'12.07''S, 47°05'08.42''E
- Antananarivo: 18°55'18.01''S, 47°31'05.58''E

Additional production and distribution centers will be opened in other parts of Madagascar.

A.4. Technical description of the project

>> The project currently produces and disseminates 9 types of stoves.

1. Solar box stove

The box type solar stove is an easily built, insulated box. Due to incident solar radiation temperatures up to 150° C can be generated in the box which is sufficient to cook almost all meals: rice, manioc, mais, potatoes, vegetables, meat and fish. Also, bread and cakes can be baked and medical tools or water can be sterilised. The box solar stove is produced in the ADES workshops in Madagascar.



Solar box stove

2. E-solar box stove

This type of solar box stove is identical to the conventional solar box but in addition it includes PV cells and a battery so that people can cook and charge a battery at the same time. Appliances such as radio, lamps or mobile phones can be connected and charged with the solar stove.



E-solar box stove, which allows cooking and charging electric devices at the same time.

3. Solar parabolic stove

The parabolic solar stove is using a parabolic mirror. In the focus point of the mirror there is a device where the cooking pot can be put. The parabolic mirror gathers the sun rays and this process leads to high temperatures at the focal point. These temperatures are high enough to cook, bake, grill and even fry. The cooker can also be used to sterilize medical tools. The parabolic mirror is made of weather-proof shining aluminium and the base frame is made of zinc-coated steel (galvanised). The material for the mirror of parabolic solar cooker comes from Europe. The mirror parts and the frame of the stove are fabricated in Madagascar. ADES then assembles the parabolic solar stove in its workshops. The temperatures in the focus point of a parabolic-solar cooker are higher than the temperatures in the interior of the solar cooking box, which leads to a faster cooking process. The parabolic-solar cooker and the solar cooker box can be used in a complimentary manner.



Solar parabolic stove

4. Efficient wood stove OLI-b

In May 2010 a new model of an efficient wood stove called „OLI-b“ was launched. ADES locally produces this efficient rocket stove in its workshop in Madagascar (see pictures below).



New stove model: efficient wood stove “Oli-B” and its individual parts

5. Efficient wood stove OLI-45b

In 2012 a new efficient wood stove called “Oli-45b” was introduced for application in larger households and street kitchens. Upon request from its customers ADES developed a larger model of the efficient wood stove called Oli-45b for domestic application in larger households and for commercial application in street kitchens. This new model is identical to existing wood model Oli-b designed for household application but larger in size. The Oli-45b stove was especially designed to satisfy the requirements of the customers using the big cooking pots No. 45 (larger households, street kitchens in urban and rural areas).



6. Efficient wood stove OLI-60b

In 2012 a new efficient wood stove called “Oli-60b” was introduced for application mainly in school kitchens. This new model is identical to existing wood models Oli-b and Oli-45b designed for household application but again larger in size. The Oli-60b stove was especially designed to satisfy the requirements of the customers using the big cooking pots No. 60 (school kitchens).

7. Efficient charcoal stove OLI-c

In December 2010 a new charcoal stove called “OLI-c” was introduced. ADES locally produces this efficient rocket stove in its workshop in Madagascar (see pictures below).



New stove model: efficient charcoal stove “OLI-c” and its individual parts

8. Efficient charcoal stove OLI-45c (formerly OLI-G)

In May 2011 the new efficient charcoal stove called “OLI-45c” was introduced for application in larger households and street kitchens. Upon request from its customers ADES developed a larger model of the efficient charcoal stove called OLI-45c for domestic application in larger households and for commercial application in street kitchens. This new model is identical to existing charcoal model OLI-c designed for household application but larger in size. The OLI-45c stove was especially designed to satisfy the requirements of the customers using the big cooking pots No. 45 (larger households, street kitchens in urban and rural areas).



9. Efficient charcoal stove OLI-60c

In 2013 a new efficient charcoal stove called “Oli-60c” was introduced for application mainly in larger kitchens, such as in school kitchens. This new model is identical to existing charcoal models Oli-c and Oli-45c designed for household application but again larger in size. The Oli-60c stove was especially designed to satisfy the requirements of the customers using the big cooking pots No. 60 (e.g. in school kitchens).

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

>> The approved monitoring methodology applied to the project activity is included in the Gold Standard methodology for Improved Cook-stoves and Kitchen Regimes V.01.
http://www.goldstandard.org/wp-content/uploads/2011/11/GS_Methodology_Cookstove.pdf

A.6. Registration date of the project activity:

>> 23 December 2009

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

>> The start of the crediting period was on 01 January 2008.

A crediting period of 7 years with the option of renewal is chosen for the project activity

A.8. Name of responsible person(s)/entity(ies):

>>

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SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

>>

1. Starting date of operation

Start date of project activity (workshops in Tuléar and Ejeda in operation): 27 August 2007

Opening of workshop in Morondava: May 2008

Opening of workshop in Morombe: October 2010

Production start of OLI-b stoves: May 2010

Production start of OLI-c stoves: December 2010

Official opening of workshop in Fianarantsoa: July 2011

Production start for OLI-45c (formerly OLI-G) stoves: May 2011

Opening of workshop in Majunga: November 2011

Opening of ADES sales point in Antananarivo: May 2012

Opening of new sales point in Antananarivo: June 2013

Opening of new production workshop in Fianarantsoa: November 2013

2. Actual operation:

ADES continues stove production and promotion in Madagascar and is continuously expanding its activities.

Since the start of the crediting period until 31.12.2014 a total of 64,170 solar and efficient stoves have been produced and disseminated in Madagascar.

Total stove sales since project start according to stove type:

Year	Box	E-Box	OLI-45b	OLI-45c	OLI-60b	OLI-60c	OLI-b	OLI-c	Parabolic	School Box	Yoyo	Total
2008	1459	0	0	0	0	0	0	0	67	0	117	1643
2009	620	0	0	0	0	0	0	0	14	0	0	634
2010	1462	0	0	0	0	0	619	168	26	0	0	2275
2011	1346	0	0	234	0	0	1124	3824	111	0	0	6639
2012	1651	13	78	728	45	0	1310	6976	160	11	0	10972
2013	1473	227	111	625	58	30	2044	12286	114	3	0	16971
2014	621	336	113	831	63	155	3847	18967	99	4	0	25036
Total	8632	576	302	2418	166	185	8944	42221	591	18	117	64170

Comment: Please note that the above table includes also stoves that are not counted for emission reduction calculations.

Total stove sales since project start according cluster:

Year	Charcoal	Solar + OLI-b	Solar + OLI-c	Wood	Total
2008	768	2	5	868	1643
2009	429	1	1	203	634
2010	1208	327	80	660	2275
2011	3946	163	1273	1257	6639
2012	7963	250	1305	1454	10972
2013	13601	405	963	2002	16971
2014	20493	361	425	3757	25036
Total	48408	1509	4052	10201	64170

Comment: Please note that the above table includes also stoves that are not counted for emission reduction calculations.

In the year 2014 there are especially the following activities to be highlighted:

1. Kettle now also produced locally

As planned ADES could further develop the local kettle workshop. The kettles used for efficient stoves are now produced locally. This increases value creation in Madagascar and creates more employment.



2. Centre in Fianarantsoa now fully operational

The new workshop in Fianarantsoa officially opened in late 2013 could enter into full operation in 2014. The centre provides employment for 37 workers, has a structured production line, and operates kilns with a capacity to burn up to 600 stove at a time.



3. Software solution “SalesForce” - a trustful tool

Introduced in 2012 this new system called “Sales Force” has proven to be an efficient and reliable tool for sales administration and calculation of emissions reductions. Verification of vintage 2013 has shown the accurateness of this system. See Annex 3 for algorithm and source code applied.

3. Impact on applicability of methodology

No events occurred during this monitoring period, which impact the applicability of the monitoring methodology.

B.2. Revision of the monitoring plan

>> No revision of the monitoring plan was done during this monitoring period.

B.3. Request for deviation applied to this monitoring period

>>No request for deviation from the monitoring plan was submitted during this monitoring period.

B.4. Notification or request of approval of changes

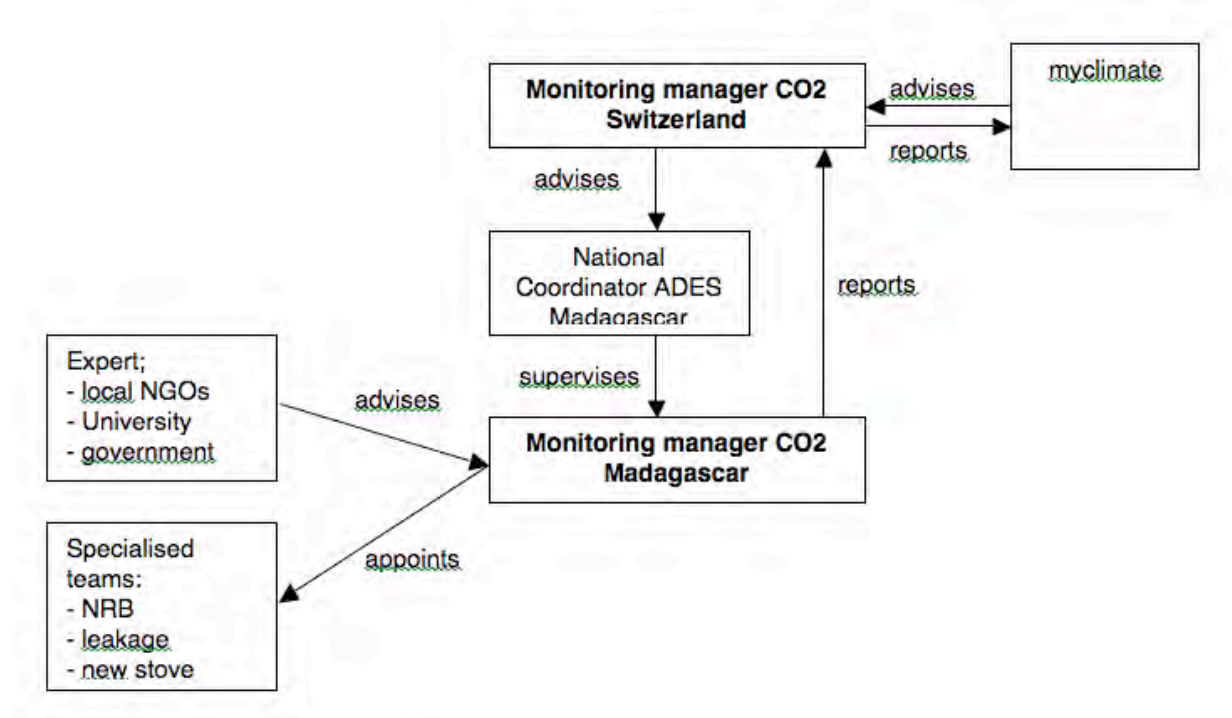
>> No request for design change was submitted to the Gold Standard during this monitoring period.

The PDD had been revised in 2012 due to a design change for the extension of the project area to the entire country. The latest version of the PDD is V6.1 dating 19.06.2012.

SECTION C. Description of the monitoring system

>> A description of the monitoring system (organizational structure, responsibilities of personnel etc.) can be found in the latest monitoring manual V07 provided as a separate document.

Monitoring set-up:



Personnel & Qualifications:

Monitoring Manager CO2 Switzerland:

Mr. Hans Peter Frei, Engineer HTL, Auditor: ISO 9001: 2008 & ISO 14000

Monitoring Manager CO2 Madagascar:

Mr. Andriamfidy Razafimanarantsoa (Fidy),

University degree,

Long-term professional experience in surveys, interviews, data collection and analysis of results.

Deputy Monitoring Manager CO2 Madagascar:

Mr. Ramilson Faralahy,

Secondary degree,

University degree,

Animation and surveys professional experiences

Monitoring assistant manager CO2 Madagascar :

Mme ETIANNE Noëline Alpène :

University degree on Management & Finance,

Health animator consultant with PSI-Madagascar,

Animation and surveys professional experiences with Canadian Red Cross.

Responsibilities and quality assurance:

A monitoring manual has been compiled, where all necessary steps and procedures (organization, responsibilities, and tasks) are described in details for all monitoring activities. This manual is applied for all activities and allows for quality assurance at the different levels.

The ADES monitoring manager CO2 in Madagascar is responsible for all monitoring activities in the entire project area and is not involved in sales activities to guarantee an independent appraisal. For Kitchen Surveys, Kitchen Tests and other surveys paper records are kept with the ADES monitoring manager CO2 in Tuléar, Madagascar. Surveys are conducted by the monitoring manager CO2 in collaboration with a representative from the corresponding production center. The monitoring manager CO2 conducts household visits, fills in the questionnaires and transforms paper data into electronic data. The electronic data from the monitoring activities is then submitted to the ADES monitoring manager CO2 in Switzerland, where it is checked on its accuracy and consistency. Final check and statistical analysis of the monitoring data is conducted by myclimate.

This organizational separation of data generation and data analysis combined with a two level data check guarantees for accurate and consistent results. The Project Database and the Customer Database are compiled and managed by myclimate.

The monitoring manager CO2 Madagascar conducts plausibility checks during data generation and preparation. Results that cannot be reconstructed are not considered and if required additional surveys or tests are conducted. Moreover, the monitoring manager CO2 Madagascar crosschecks data (especially sales reports) with other data available at the different production and distribution centers during monitoring visits. Delivery and stock lists for materials used also help to verify sales figures.

Monitoring and sales data is transferred to the monitoring manager CO2 Switzerland, who is also the responsible person for logistics. He thus can compare figures of delivered materials with the number of stoves sold. Final plausibility check is conducted during data analysis at myclimate.

In 2012 ADES has introduced a new system called “SalesForce”, which allows tracking all data during production and sale of the solar and efficient stoves. Every stove tracked by a unique number is linked to customer data. In 2013 SalesForce was further developed to include also calculation of stove days and stove years, which serve as the basis for emission reduction calculation. Since 2013, calculation of stove years is no more done in Excel but in SalesForce. This allows a more accurate calculation of stove years since now specific adjustment factor can be applied for each cluster and stove type (see Annex 3 for algorithm and source code applied).

All stove sales are carefully documented and recorded in the salesforce database, a customer relation management system that is filled by the sales managers and overviewed by the manager CO2 Madagascar. The manager CO2 Madagascar is responsible for all monitoring activities in Madagascar. Furthermore, also stoves sold to other organizations are listed in the sales record and marked accordingly with “not counted”. For these stoves no emission reductions are counted (see Project Database). This careful tracking of stove sales is a strict measure to avoid double counting.

Initially, the numbering of stoves was done in every production/distribution center separately starting with the number one. In 2009 the production center in Tuléar was closed for some months and thus stoves produced in Ejeda were transported to Tuléar for sale. In order to allow for traceability in the production process, these stoves received a different stove number starting with an “E” (for Ejeda) followed by the actual stove number. In order to avoid confusion, from 2010 on all stoves are numbered according to the new numbering system always indicating the stoves’ production/distribution center with the Initials such as “T” for Tuléar, “E” for Ejeda, “M” for Morondava, “MB” for Morombe, and “MG” for Majunga (see Monitoring Manual for details).

The new efficient wood and charcoal stoves are manufactured in Tuléar and are numbered starting with the initials of the stove type OLI-b (b for bois, which means wood in French) followed by a number, and OLI-c (c for charbon, which means charcoal in French) followed by a number.

The larger models for the efficient wood and charcoal stove are named as follows: OLI-45b followed by a number, OLI-45c followed by a number (formerly OLI-G followed by a number), OLI-60b followed by a number, OLI-60c followed by a number.

From 2010 on a certified independent auditor from Antananarivo, Madagascar, verifies the stove sales figures together with the financial audit of ADES Madagascar. This allows for crosschecking stove sales from a financial point of view.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	EF _{bl.bio,co2}
Data unit:	tCO ₂ /t biomass
Description:	CO ₂ emission factor arising from use of wood-fuel in baseline scenario
Source of data used:	Default IPCC values for wood / wood waste are applied Default IPCC values for charcoal are applied 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
Value(s) :	1.7472 tCO ₂ /t wood (=112.0 tCO ₂ /TJ * 0.0156 TJ/ t) 3.3040 tCO ₂ /t charcoal (=112.0 tCO ₂ /TJ * 0.0295 TJ/ t)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculation
Additional comment:	See project database, spreadsheet “ER_per_stove”

Data / Parameter:	EF _{pl.bio,co2}
Data unit:	tCO ₂ /t biomass
Description:	CO ₂ emission factor arising from use of wood-fuel in project scenario
Source of data used:	Default IPCC values for wood / wood waste are applied Default IPCC values for charcoal are applied 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
Value(s) :	1.7472 tCO ₂ /t wood (=112.0 tCO ₂ /TJ * 0.0156 TJ/ t) 3.3040 tCO ₂ /t charcoal (=112.0 tCO ₂ /TJ * 0.0295 TJ/ t)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emissions calculations
Additional comment:	See project database, spreadsheet “ER_per_stove”

Data / Parameter:	EF _{af,co2}
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Data unit:	tCO ₂ /t _{fuel}
Description:	CO ₂ emission factor arising from use of alternative fuel
Source of data used:	Default IPCC values for Liquefied Petroleum Gases are applied 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tables 1.2/1.4
Value(s) :	0.8136 tCO ₂ /t LPG (=17.2 tCO ₂ /TJ * 0.0473 TJ/ t), LPG
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculations
Additional comment:	Currently not applied

Data / Parameter:	EF _{bl.bio.non-co2}
Data unit:	tCO ₂ /t _{biomass}
Description:	Non-CO ₂ emission factor arising from use of wood-fuel in baseline scenario
Source of data used:	Default IPCC values for CH ₄ and N ₂ O emissions for wood / wood waste are applied Default IPCC values for CH ₄ and N ₂ O emissions for charcoal are applied The following GWP100 are applied: 25 for CH ₄ , 298 for N ₂ O 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.5
Value(s) :	0.1356 tCO ₂ e/t wood 0.1563 tCO ₂ e/t charcoal
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculation
Additional comment:	See project database, spreadsheet “ER_per_stove”

Data / Parameter:	EF _{pl.bio.non-co2}
Data unit:	tCO ₂ /t _{biomass}
Description:	Non-CO ₂ emission factor arising from use of wood-fuel in project scenario
Source of data used:	Default IPCC values for CH ₄ and N ₂ O emissions for wood / wood waste are applied Default IPCC values for CH ₄ and N ₂ O emissions for charcoal are applied The following GWP100 are applied: 25 for CH ₄ , 298 for N ₂ O 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.5
Value(s) :	0.1356 tCO ₂ e/t wood 0.1563 tCO ₂ e/t charcoal
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emissions calculation
Additional comment:	See project database, spreadsheet “ER_per_stove”

Data / Parameter:	EF _{af.non-co2}
Data unit:	tCO ₂ /t _{fuel}
Description:	Non-CO ₂ emission factor arising from use of alternative fuel
Source of data used:	Default IPCC values for CH ₄ and N ₂ O emissions for Liquefied Petroleum Gases are applied The following GWP100 are applied: 25 for CH ₄ , 298 for N ₂ O

	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.5
Value(s) :	0.0064 tCO ₂ e/t LPG
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculation
Additional comment:	Currently not applied

Data / Parameter:	EF _{bio,prod,co2}
Data unit:	tCO ₂ /t fuel
Description:	CO ₂ emission factor arising from production of wood-fuel
Source of data used:	There are no IPCC default values available. Therefore, country-specific values are applied. Girard, P., Rousset, P, Vergnet, A., Rasamindisa, A., 1998. Comparing forestry wood species for the charcoal supply of Antananarivo city, Madagascar, Boiling Point, Issue 40, Household energy and health. (http://www.hedon.info/BP40_ComparingForestryWoodSpeciesForTheCharcoalSupply?bl=y) -> Mean of mentioned emission factors
Value(s) :	3.0400 tCO ₂ e/t charcoal 0 tCO ₂ e/t wood
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emissions calculation
Additional comment:	See project database, spreadsheet “ER_per_stove”

Data / Parameter:	EF _{af,prod,co2}
Data unit:	tCO ₂ /t fuel
Description:	Non-CO ₂ emission factor arising from production of alternative fuel
Source of data used:	n.a.
Value(s) :	0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculation
Additional comment:	Currently not applied

Data / Parameter:	EF _{bio,prod,non-co2}
Data unit:	tCO ₂ /t biomass
Description:	Non-CO ₂ emission factor arising from production of wood-fuel
Source of data used:	Calculation with factor from “Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (Table 1-14 on Page 1.46 of the Reference Manual)”
Value(s) :	0.6195 tCO ₂ e/t charcoal 0 tCO ₂ e/t wood Only methane emissions during charcoal production are reflected (no N ₂ O) Wood is not produced but collected.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emissions calculation
Additional comment:	See project database, spreadsheet “ER_per_stove”

Data / Parameter:	EF _{af,prod,non-co2}
Data unit:	tCO ₂ /t _{fuel}
Description:	Non-CO ₂ emission factor arising from production of alternative fuel
Source of data used:	n.a.
Value(s) :	0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculation
Additional comment:	Currently not applied

Data / Parameter:	B _{bl,i,y}
Data unit:	t _{biomass} /stove year
Description:	Mass of woody biomass combusted in the baseline in year y
Source of data used:	Kitchen Test
Value(s) :	Wood cluster: 5.001 t wood/stove year Charcoal cluster: 1.909 t charcoal /stove year
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions calculation
Additional comment:	Fixed baseline applied. Repetition of KT for the wood cluster revealed that the original values for baseline consumption are no more representative/conservative for the project area. Therefore, a lower value obtained from paired KT for baseline and project fuel consumption conducted in January 2012 is applied.

Data / Parameter:	$\Delta B_{90\%}$
Data unit:	t _{biomass} /stove year
Description:	Lower bound of the 90% confidence interval of woody biomass savings per stove year
Source of data used:	Kitchen Test 2008 for charcoal cluster Kitchen Test 2012 for wood cluster
Value(s) :	Wood cluster: 2.365 t wood/stove year Charcoal cluster: 0.9021 t charcoal /stove year
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emissions calculation
Additional comment:	Fixed baseline applied. Repetition of KT for the wood cluster revealed that the original values for baseline consumption are no more representative/conservative for the project area. Therefore, a lower value obtained from paired KT for baseline and project fuel consumption conducted in January 2012 is applied.

References:

- Revised PDD V06.1: 1206_ADES_GS_VER_PDD_V6_1.pdf, pp. 55-57
- Project Database: 150512_ADES_Project_Database_2014_V02.xlsx

D.2. Data and parameters monitored

>> Since a fixed baseline is applied only project parameters but no baseline parameters are monitored.

Data / Parameter:	Total Sales Record
Data unit:	Number of stoves sold
Description:	Number of stoves sold per cluster
Measured /Calculated /Default:	Measured
Source of data:	ADES Salesforce database
Value(s) of monitored parameter:	See table below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Calculation of stove years
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Continuously
Calculation method (if applicable):	The Total Sales Record now available in Salesforce is continuously populated with all sales of all stove types since the crediting start date 01.01.2008. The Total Sales Record for this monitoring period contains sales from 04 January 2008 to 31 December 2014.
QA/QC procedures applied:	Third party financial audit of stove sales activities

Stoves counted for emission reductions according to stove type:

Year	Box	OLI-45b	OLI-45c	OLI-b	OLI-c	Parabolic	Total
2008	1384	0	0	0	0	54	1438
2009	617	0	0	0	0	13	630
2010	1408	0	0	567	160	21	2156
2011	1337	0	227	1105	3724	110	6503
2012	1590	74	658	1239	6574	144	10279
2013	1319	94	532	1821	11495	105	15366
2014	594	91	682	3585	17247	86	22285
Total	8249	259	2099	8317	39200	533	58657

Stoves counted for emission reductions according to cluster:

Year	Charcoal	Solar + OLI-b	Solar + OLI-c	Wood	Total
2008	630	2	4	802	1438
2009	425	1	1	203	630
2010	1182	253	75	646	2156
2011	3859	162	1241	1241	6503
2012	7439	249	1231	1360	10279
2013	12436	195	846	1889	15366
2014	18230	338	266	3451	22285
Total	44201	1200	3664	9592	58657

For this monitoring period a total of 58,657 solar and efficient stoves are counted.

Stoves not counted for emission reductions:

In the total sales record a total of 5,513 solar and efficient stoves are not counted for emission reduction calculations for this monitoring period. There are several reasons, why stoves are not counted:

Reason	Quantity
Blue Ventures	268
Broken	12
Institution	335
New model	945
Outside project area	308
Secondary stoves	3627
Yoyo	18
Total	5513

References:

- Project Database: 150512_ADES_Project_Database_2014_V02.xlsx

Data / Parameter:	1) $X_{nr,pj,y}$
Data unit:	Fraction
Description:	Non-renewability of woody biomass fuel in the project in year y
Measured /Calculated /Default:	Default
Source of data:	CDM default value for Madagascar: http://cdm.unfccc.int/DNA/fNRB/index.html
Value(s) of monitored parameter:	72.0%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emissions and project emissions calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	fixed
Calculation method (if applicable):	Default value
QA/QC procedures applied:	Official CDM default value

Data / Parameter:	2) $B_{pj,y}$
Data unit:	t biomass/stove year
Description:	Mass of woody biomass combusted in the project in year y
Measured /Calculated /Default:	Measured
Source of data:	Kitchen Test
Value(s) of monitored parameter:	Wood cluster: 2.499 t wood/stove year Charcoal cluster: 0.929 t charcoal /stove year
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emissions calculations

Leakage emission calculations)	
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Calibrated balance
Measuring/ Reading/ Recording frequency:	If needed, every two years Repetition of the Kitchen Test in order to control fuel savings is conducted in case Kitchen Surveys reveal that parameters of the type measured by the Kitchen Test may have changed significantly. This parameter is not updated, but adjustment factors are applied for stove aging and stove usage.
Calculation method (if applicable):	n.a.
QA/QC procedures applied:	Calibrated measuring equipment and random sampling of cluster population

Data / Parameter:	3) $AF_{pi,y}$
Data unit:	t fuel /stove year
Description:	Mass of alternative fuel i combusted in the project in year y
Measured /Calculated /Default:	Measured
Source of data:	Kitchen Test
Value(s) of monitored parameter:	n.a.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emissions calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Calibrated balance
Measuring/ Reading/ Recording frequency:	If needed, every two years This parameter is assessed with the help of a Kitchen Test in case Kitchen Surveys reveal the use of alternative fuels. Kitchen Surveys conducted in 2014 did not provide any indication for the use of alternative fuels, thus there is no need to conduct a Kitchen Test to measure this parameter.
Calculation method (if applicable):	n.a.
QA/QC procedures applied:	Calibrated measuring equipment and random sampling of cluster population

Data / Parameter:	4) $Usage_{z,y}$
Data unit:	Fraction
Description:	Percentage of stoves of age z remaining in use in year y
Measured /Calculated /Default:	Calculated

Source of data:	Usage survey
Value(s) of monitored parameter:	See below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emissions
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Every two years
Calculation method (if applicable):	Survey of stoves sold in the first year in order to establish the drop-off rate in stove usage over time.
QA/QC procedures applied:	Random sampling of cluster population

This parameter is monitored every two years with Usage Surveys of stoves sold in the first year of distribution in order to establish the drop-off rate in stove usage over time.

The following usage surveys have been conducted so far:

Stove type	Year of introduction	Completed usage surveys
Solar stoves	2008	2010, 2012, 2014
Oli-b	2010	2012, 2014
Oli-45b	2012	Same as Oli-b
Oli-c	2011	2013
Oli-45c	2011	2013

Other stove types are not yet counted for ER and KT have not yet been conducted.

The following drop-off rates are applied for the different stove types.

Solar stoves:

Stove application	Drop-off rate	Adjustment factor
First year of operation	0%	1
Second year of operation (after 1 year in use)	6.0%	0.94
Third year of operation (after 2 years in use)	12.0%	0.88
Fourth year of operation (after 3 years in use)	18.0%	0.82
Fifth year of operation (after 4 years in use)	24.0%	0.76
Sixth year of operation (after 5 years in use)	30.0%	0.70
Seventh year of operation (after 6 years in use)	36.0%	0.64

Adjustment factor to reflect stove usage of solar stoves

For Oli-b stoves:

Stove application	Drop-off rate	Adjustment factor
First year of operation	0%	1

Second year of operation (after 1 year in use)	16.9%	0.831
Third year of operation (after 2 years in use)	33.9%	0.661
Fourth year of operation (after 3 years in use)	50.8%	0.492
Fifth year of operation (after 4 years in use)	67.8%	0.322
Sixth year of operation (after 5 years in use)	84.7%	0.153

Adjustment factor to reflect stove usage of Oli-b stoves

For Oli-45b stoves (same as for Oli-b):

Stove application	Drop-off rate	Adjustment factor
First year of operation	0%	1
Second year of operation (after 1 year in use)	16.9%	0.831
Third year of operation (after 2 years in use)	33.9%	0.661
Fourth year of operation (after 3 years in use)	50.8%	0.492
Fifth year of operation (after 4 years in use)	67.8%	0.322
Sixth year of operation (after 5 years in use)	84.7%	0.153

Adjustment factor to reflect stove usage of Oli-45b stoves

For Oli-c:

Stove application	Drop-off rate	Adjustment factor
First year of operation	0%	1
Second year of operation (after 1 year in use)	1.7%	0.983
Third year of operation (after 2 years in use)	3.4%	0.964
Fourth year of operation (after 3 years in use)	5.1%	0.949
Fifth year of operation (after 4 years in use)	6.8%	0.932
Sixth year of operation (after 5 years in use)	8.5%	0.915

Adjustment factor to reflect stove usage of Oli-c stoves

For Oli-45c:

Stove application	Drop-off rate	Adjustment factor
First year of operation	0%	1
Second year of operation (after 1 year in use)	1.0%	0.990
Third year of operation (after 2 years in use)	2.0%	0.980

Fourth year of operation (after 3 years in use)	2.9%	0.971
Fifth year of operation (after 4 years in use)	3.9%	0.961
Sixth year of operation (after 5 years in use)	4.9%	0.951

Adjustment factor to reflect stove usage of Oli-45c stoves

References:

- Usage Survey Report 2014: 150226_ADES_usage_survey_report_2014_V01.pdf

Data / Parameter:	5) Age_z
Data unit:	Fraction
Description:	Adjustment to values of $B_{pi,y}$ and $AF_{pi,i,y}$ for stoves of age x
Measured /Calculated /Default:	Measured
Source of data:	Aging-Stove Kitchen Test
Value(s) of monitored parameter:	See below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Calibrated balance
Measuring/ Reading/ Recording frequency:	Every two years
Calculation method (if applicable):	Aging-Stove Kitchen Test is undertaken for sales made in the first year to measure fuel reduction performance in successive years of stoves of Age x, Age y,...
QA/QC procedures applied:	Calibrated measuring equipment and random sampling of cluster population

The Aging-Stove Kitchen Test is conducted every two years using a questionnaire to interview households and measure fuel consumption of stoves sold in the first year. The results from the Aging-Stove Kitchen Test are used to determine the fuel saving performance of the stoves over successive years. This is to find out, if stoves after being in use for several years still provide the same fuel savings as in the first year.

Stove type	Year of introduction	Completed Aging-Stove KT
Solar wood cluster	2008	2010, 2012, 2014
Solar charcoal cluster	2008	2010, 2012, 2014
Oli-b	2010	2012, 2014
Oli-45b	2012	Same as Oli-b
Oli-c	2011	2013
Oli-45c	2011	2013

Other stove types are not yet counted for ER and KT have not yet been conducted.

The following aging effects were determined with Aging-Stove KT:

For solar stoves in the charcoal cluster:

Stove age	Stove performance: charcoal cluster
0-1	98.7%
1-2	96.1%
2-3	93.5%
3-4	90.9%
4-5	88.3%
5-6	85.7%
6-7	83.1%

Adjustment factors for aging of solar stoves in charcoal cluster

The Aging-Stove Kitchen Test 2014 with solar stoves in the wood cluster revealed no aging effects with regard to stove performance. On the contrary, stove performance was better compared to previous years. However, no adjustment factor is applied in order to follow a conservative approach.

The Aging-Stove Kitchen Test 2014 with Oli-b stoves revealed no aging effects with regard to stove performance. It can be concluded that stove performance of Oli-b does not decrease over time.

Oli-45b stove are counted as the smaller model Oli-b. Thus no separate Aging-Stove KT is conducted for this stove model. Thus the same aging effects as for Oli-b are applied.

The Aging-Stove Kitchen Test 2013 with Oli-c stoves revealed no aging effects with regard to stove performance. It can be concluded that stove performance of Oli-c does not decrease in the first two years of stove operation.

The Aging-Stove Kitchen Test 2013 with Oli-45c stoves revealed a small aging effect with regard to stove performance. However, since Oli-45c stoves are included in the charcoal cluster and fuel savings with aged stoves are still higher than in the existing charcoal cluster, no adjustment is needed. This is conservative.

Data / Parameter:	6) New Stove $B_{pj,i,y}$ and $AF_{pj,i,y}$
Data unit:	Fraction
Description:	Adjustment to values of $B_{pj,i,y}$ and $AF_{pj,i,y}$ for new stove models
Measured /Calculated /Default:	Measured
Source of data:	New-Stove Kitchen Test
Value(s) of monitored parameter:	See below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emissions calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Calibrated balance
Measuring/ Reading/	When new stove model is introduced

Recording frequency:	
Calculation method (if applicable):	A New-Stove Kitchen Test is to measure fuel consumption of new stove models and designs introduced by the project
QA/QC procedures applied:	Calibrated measuring equipment and random sampling of cluster population

No New-Stove Kitchen Test was conducted in 2014. All KT Results and adjustment factors are available in the latest Customer Database.

Data / Parameter:	7) Similar new project activity in the project area
Data unit:	Number of new project activities
Description:	Similar new project activity in the project area
Measured /Calculated /Default:	Reported
Source of data:	Different sources
Value(s) of monitored parameter:	There is one new activity to be mentioned. An update an existing activities is also found below.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Avoid double counting
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	ADES will report and monitor any similar new project activity in the project area in order to avoid double counting
QA/QC procedures applied:	n.a.

Activities by Blue Ventures:

As already reported in the previous monitoring reports, Blue Ventures (www.blueventures.org) is a British non-governmental marine conservation organization that operates since 2001 an information and education centre in Andavadoaka, a fishermen settlement about 120 km north of Tuléar, in Madagascar. The main goal of this organization is conserving the coral reef in southwest Madagascar. Deforestation in the inland also poses a threat to the reef and thus needs to be combated. For this reason, Blue Ventures buys solar and efficient cook stoves from ADES and distributes them to the local population. Blue Ventures is a client of ADES. Emissions reductions from stoves sold to Blue Ventures are not counted for this project.

Activities by GIZ (Gesellschaft für internationale Zusammenarbeit, Deutschland):

As already mentioned in previous monitoring reports, GIZ together with local producers develops efficient stoves in the region of Tuléar, Majunga and Diégo Suarez. As ADES heard from different sources, the project faces problems with stove quality and thus manufacturer are not able to sell the efficient stoves.

Activities by WWF Madagascar:

WWF Madagascar has joined up with ADES to distribute efficient and solar stoves in Madagascar. There are currently no own cook stove activities by WWF Madagascar.

Activities by Japan International Cooperation Agency (JICA):

This governmental agency supported the production of improved cook stove in the area of Bongolava. The product called Kamado is an artisanal product and can be used with charcoal and fuel wood. As ADES heard from different sources, this project is not very successful up to now. The stove is produced by hand and thus production scale is very small. As it was only for one region, supply is not secured and the population does not show big interested because of the stove quality. The latest update from JICA is from March 2013².

Other Gold Standard or CDM Activities:

There is a registered CDM PoA (Ref. 7359 PoA for the reduction of emission from non-renewable fuel from cooking at household level) with CPAs in the central highlands of Madagascar. The project does not include solar or efficient stoves, but is described as follows: “Replace non-renewable fuel with renewable fuel for cooking for households that voluntarily want to take part in the CPA project through the lease or buying of an ethanol or biogas stove, household water purifying kit or buying water from community based water purification systems from the project participant or from the project implementer.” Our project and the PoA do not share the same technologies. Thus, there is no danger for any double counting.

References:

- Project Database: 150512_ADES_Project_Database_2014_V02.xlsx
- PDD V6.1: 1206_ADES_GS_VER_PDD_V6_1.pdf

Data / Parameter:	8) Incentive scheme to surrender charcoal baseline stove
Data unit:	Number of stoves sold at discount
Description:	Number of efficient charcoal stoves sold at discount
Measured /Calculated /Default:	Calculated
Source of data:	ADES financial records
Value(s) of monitored parameter:	1,569
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Leakage emissions calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	Number of efficient charcoal stoves (Oli-c and Oli-45c) sold at a discount of 20% granted to households that hand in the baseline charcoal stove.
QA/QC procedures applied:	n.a.

In 2014 the number of clients that handed in their baseline stove (Oli-c and Oli-45c) in order to profit from a 20%-discount amounted to 1,569. This means around 9% of clients that purchased an efficient charcoal stove took advantage of the incentive scheme. This is comparable to figures achieved in previous years. These numbers show that the clients are accepting the incentive scheme. ADES will try to promote the discount model even more intensively and expects to further increase the return rate in the coming years.

² <http://www.jica.go.jp/madagascar/french/office/topics/press130308.html>

Data / Parameter:	9) F_{var}
Data unit:	Fraction
Description:	Adjustment factor for seasonal and weekly variation of biomass fuel consumption
Measured /Calculated /Default:	Calculated
Source of data:	Kitchen Survey Report 2014
Value(s) of monitored parameter:	1. Wood cluster: 99.9% 2. Charcoal cluster: 100% 3. Solar+oli-b: cluster: 100% 4. Solar+oli-c cluster: 100%
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline and project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Annually
Calculation method (if applicable):	n.a.
QA/QC procedures applied:	n.a.

Data / Parameter:	LE_v (wood)
Data unit:	Fraction
Description:	Percentage of saved wood used for another purpose
Measured /Calculated /Default:	Calculated
Source of data:	Kitchen Survey 2014/Leakage Survey 2014
Value(s) of monitored parameter:	0% The Kitchen Surveys showed that 0% of households use saved wood for other purposes. The leakage survey showed that the project activity has no influence on the price or on the supply of wood fuel.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Leakage emissions calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Every two years (updated in 2014)
Calculation method (if applicable):	Retailers on the market are asked if the supply of wood has risen in the last months or years as consequence of stove appliance
QA/QC procedures applied:	n.a.

Data / Parameter:	LE_v (charcoal)
Data unit:	Fraction
Description:	Percentage of saved charcoal used for another purpose
Measured /Calculated /Default:	Calculated
Source of data:	Kitchen Survey 2014/Leakage Survey 2014
Value(s) of monitored parameter:	0% The Kitchen Surveys showed that 0% of households use saved charcoal for other purposes. The leakage survey showed that the project activity has no influence on the price or on the supply of charcoal.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Leakage emissions calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Every two years (updated in 2014)
Calculation method (if applicable):	Retailers on the market are asked if the supply of charcoal has risen in the last months or years as consequence of stove appliance
QA/QC procedures applied:	n.a.

Sustainable Development Indicators:

Data / Parameter:	SD 1) Jobs created by ADES
Data unit:	Number of jobs
Description:	Number of jobs created by ADES in Madagascar
Measured /Calculated /Default:	Measured
Source of data:	ADES records (contracts with employees)
Value(s) of monitored parameter:	See below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	n.a.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Every two years
Calculation method (if applicable):	n.a.
QA/QC procedures applied:	n.a.

Since the project start in 2007, ADES has continuously increased its activities and also the number of employees from 22 in 2007 to 150 by the end of 2014 (see Table below). ADES offers positions for a variety of qualifications: director, management, secretary, education & training, carpenter, sales

animator, CO₂-monitoring, gardener, driver, guard. All positions listed below are offered to local employees.

Location	2007	2008	2009	2010	2011	2012	2013	2014
Coordination	-	5	8	11	25	34	36	42
Tuléar	15	16	15	20	12	11	11	13
Ejeda	7	8	8	9	11	13	12	12
Morondava	-	8	9	9	11	10	10	12
Andavadoaka	-	6	5	-	-	-	-	-
Morombe	-	-	-	4	5	6	5	6
Majunga	-	-	-	-	5	12	13	13
Fianarantsoa	-	-	-	-	-	-	35	42
Antananarivo	-	-	-	-	-	-	10	10
Total	22	43	45	53	69	86	132	150

Number of local persons employed by ADES in Madagascar

References:

– Jobs created by ADES: ADES_employees_2014.xlsx

Data / Parameter:	SD 2) Schools visited by ADES
Data unit:	Number of schools
Description:	Number of schools visited by ADES in Madagascar
Measured /Calculated /Default:	Measured
Source of data:	ADES records
Value(s) of monitored parameter:	See below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	n.a.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Every two years
Calculation method (if applicable):	n.a.
QA/QC procedures applied:	n.a.

In order to create awareness for the problem of deforestation and for new, clean and more efficient stove technologies cooking demonstrations and animations in schools are performed. In the year 2014 a total of 69 school visits with 6'365 pupils and teachers were conducted thereby reaching out to 65 different schools with 6'310 unique participants.

Location	Number of schools visited	Number of school visits	Number of attendees	Number unique participants
Toliara	28	30	2258	2258
Majunga	27	27	975	975
Ejeda	3	4	214	159
Morondava	5	6	2722	2722
Morombe	1	1	130	130
Fianarantsoa	1	1	66	66
Total	65	69	6365	6310

Number of schools visited and number of people reached by these activities in 2014

A visit card is signed for every school visit, which mentions the number of attendees.

References:

- Schools visited by ADES: 150209_list_schools_visited_2014.xlsx

Data / Parameter:	SD 3) Expenses for wood and charcoal
Data unit:	Hours or Ariary (local currency)/month
Description:	Time or money households spend on fuel acquisition
Measured /Calculated /Default:	Measured
Source of data:	Kitchen surveys
Value(s) of monitored parameter:	See below
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	n.a.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	n.a.
Measuring/ Reading/ Recording frequency:	Every two years
Calculation method (if applicable):	n.a.
QA/QC procedures applied:	n.a.

Charcoal cluster

From the Kitchen Surveys conducted in 2014 we know that all households purchase charcoal and that on average they spend now using the project stove between 8,876 – 8,782 Ariary per month (approximately EUR 2.80). Conservatively estimated a household spends around 106,512 Ariary per year (EUR 35.30) on charcoal. From the Kitchen Surveys conducted in 2014 we also know fuel expenses in the baseline: They spent between 15,322 - 15,341 Ariary per month (approx. EUR 4.80) or around 184,092 Ar. per year (approx. EUR 58). A household annually saves around 77,580 Ariary (EUR 24.50) due to the fuel savings from the project stove.

Wood cluster

The Kitchen Surveys 2014 showed that some households purchase fuelwood and others collect fuel. Households that purchase fuel wood spent on average around 22,046 Ariary per month (EUR 6.95) prior to using the project stove and now spend on average 10,357 Ariary (EUR 3.30) per month. A household saves around 11,689 Ariary (EUR 3.70) per month or 140,268 Ar. per year (EUR 44) due to the fuel savings from the project stove. Households that collect fuel wood spent on average around 15 hours per week and now spend only around 4 hours per week since using the project stove. This results in time savings of 11 hours per week or 572 hours per year.

References:

- Kitchen Survey Report 2014: 150310_ADES_KS_report_2014_V01_EN.pdf

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

>> The general formula for calculating baseline emissions is

$$\begin{aligned} BE_y = & X_{nrb,bl,y} * B_{bl,y} * EF_{bl,bio,CO_2} + \sum (AF_{bl,i,y} * EF_{af,CO_2,i}) \\ & + \sum (B_{bl,y} * EF_{bl,bio,non-co_2,i}) + \sum (AF_{bl,i,y} * EF_{af,i,non-co_2 \text{ gas } i}) \\ & + X_{nrb} * B_{bl,y} * EF_{bio,prod,co_2} + \sum (AF_{bl,i,y} * EF_{af,prod,co_2,i}) + \sum (B_{bl,y} * \\ & EF_{bio,prod,non-co_2 \text{ gas } i}) + \sum (AF_{bl,i,y} * EF_{af,i,prod,non-co_2 \text{ gas } i}) \end{aligned}$$

Since Kitchen Tests were performed with paired samples (that is baseline and project fuel consumption in the same households) it is “legitimate to derive a value for emission reduction for each individual kitchen in the sample tested. That is, the values of BE and PE are not found for each cluster, but instead are found for each kitchen, giving an emission reduction value for each kitchen” (see applied methodology, p 19).

Therefore, baseline emissions are not calculated separately. See E.4 for formula of emission reduction calculation applied.

E.2. Project emissions calculation

>> The general formula for calculating project emissions is

$$\begin{aligned} PE_y = & X_{nrb,pj,y} * B_{pj,y} * EF_{pj,bio,CO_2} + \sum (AF_{pj,i,y} * EF_{af,CO_2,i}) \\ & + \sum (B_{pj,y} * EF_{pj,bio,non-co_2,i}) + \sum (AF_{pj,i,y} * EF_{af,i,non-co_2 \text{ gas } i}) \\ & + X_{nrb} * B_{pj,y} * EF_{bio,prod,co_2} + \sum (AF_{pj,i,y} * EF_{af,prod,co_2,i}) + \sum (B_{pj,y} * \\ & EF_{bio,prod,non-co_2 \text{ gas } i}) + \sum (AF_{pj,i,y} * EF_{af,i,prod,non-co_2 \text{ gas } i}) \end{aligned}$$

Since Kitchen Tests were performed with paired samples (that is baseline and project fuel consumption in the same households) it is “legitimate to derive a value for emission reduction for each individual kitchen in the sample tested. That is, the values of BE and PE are not found for each cluster, but instead are found for each kitchen, giving an emission reduction value for each kitchen” (see applied methodology, p 19).

Therefore, project emissions are not calculated separately. See E.4 for formula of emission reduction calculation applied.

E.3. Leakage calculation

>> The formula for calculating leakage is

$$\sum LE_{i,y} = LE_y (\text{charcoal}) + LE_y (\text{wood})$$

Based on the monitoring conducted no leakage effect for charcoal and wood clusters was identified.

Leakage therefore is:

$$\sum LE_{2010} = LE_{2010} (\text{charcoal}) + LE_{2010} (\text{wood}) = 0 + 0 = 0$$

E.4. Emission reductions calculation / table

>> The general formula for calculating emission reductions is

$$ER_y = \sum BE_{i,y} - \sum PE_{i,y} - \sum LE_{i,y}$$

Since Kitchen Tests were performed with paired samples (that is baseline and project fuel consumption in the same households) it is “legitimate to derive a value for emission reduction for each individual kitchen in the sample tested. That is, the values of BE and PE are not found for each cluster, but instead are found for each kitchen, giving an emission reduction value for each kitchen.” Moreover, “it is legitimate to derive emission reduction values on a per Unit basis directly from the KT tests, and modify the mode of calculation of project emission reductions [...] accordingly, in cases where this results in the most transparent and clear mode of calculation [...]” (see applied methodology, p 19).

1) Thus, in a first step emission reductions are calculated for a SINGLE KITCHEN resulting in a value for emission reductions per STOVE YEAR for each cluster (see Project Database in the spreadsheet “ER per stove”). Baseline and project emissions are not separately calculated, but the formulae are modified to deliver directly the emission reductions per stove year.

$$ER_{\text{stove year}} = X_{\text{nrb},y} * (B_{\text{bl},y} * EF_{\text{bl,bio},\text{CO}_2} - B_{\text{pj},y} * EF_{\text{pj,bio},\text{CO}_2}) + (AF_{\text{bl},i,y} * EF_{\text{af},\text{CO}_2,i} - AF_{\text{pj},i,y} * EF_{\text{af},\text{CO}_2,i}) + (B_{\text{bl},y} * EF_{\text{bl,bio},\text{non-co}_2,i} - B_{\text{pj},y} * EF_{\text{pj,bio},\text{non-co}_2,i}) + X_{\text{nrb},y} * (B_{\text{bl},y} * EF_{\text{bio,prod},\text{co}_2} - B_{\text{pj},y} * EF_{\text{bio,prod},\text{co}_2}) + (AF_{\text{bl},i,y} * EF_{\text{af,prod},\text{co}_2,i} - AF_{\text{pj},i,y} * EF_{\text{af,prod},\text{co}_2,i}) + (B_{\text{bl},y} * EF_{\text{bio,prod},\text{non-co}_2 \text{ gas},i} - B_{\text{pj},y} * EF_{\text{bio,prod},\text{non-co}_2 \text{ gas},i}) + (AF_{\text{bl},i,y} * EF_{\text{af,i,prod},\text{non-co}_2 \text{ gas},i} - AF_{\text{pj},i,y} * EF_{\text{af,i,prod},\text{non-co}_2 \text{ gas},i}) - LE_{i,y}$$

This formula can further be simplified since no alternative fuels are used and since identical emission factors for biomass combustion are used in the baseline and in the project case:

$$ER_{\text{stove year}} = X_{\text{nrb},y} * (B_{\text{bl},y} - B_{\text{pj},y}) * EF_{\text{bio},\text{CO}_2} + 0 + (B_{\text{bl},y} - B_{\text{pj},y}) * EF_{\text{bio},\text{non-co}_2,i} + X_{\text{nrb},y} * (B_{\text{bl},y} - B_{\text{pj},y}) * EF_{\text{bio,prod},\text{co}_2} + 0 + (B_{\text{bl},y} - B_{\text{pj},y}) * EF_{\text{bio,prod},\text{non-co}_2 \text{ gas},i} + 0 - LE_{i,y}$$

Since for fuel savings ($B_{\text{bl},y} - B_{\text{pj},y}$) the lower bound of the 90% confidence interval needs to be applied ($\Delta B_{90\%}$) and an adjustment factor for seasonal and weekly variations (F_{var}) is considered in the calculations, the formula is modified as shown below:

$$ER_{\text{stove year}} = X_{\text{nrb},y} * (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio},\text{CO}_2} + 0 + (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio},\text{non-co}_2,i} + X_{\text{nrb},y} * (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio,prod},\text{co}_2} + 0 + (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio,prod},\text{non-co}_2 \text{ gas},i} + 0 - LE_{i,y}$$

For the charcoal cluster the formula applied is:

$$ER_{\text{stove year}} (\text{charcoal}) = X_{\text{nrb},y} * (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio},\text{CO}_2} + 0 + (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio},\text{non-co}_2,i} + X_{\text{nrb},y} * (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio,prod},\text{co}_2} + 0 + (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio,prod},\text{non-co}_2 \text{ gas},i} + 0 - LE_{i,y}$$

$$ER_{\text{stove year 2014}} (\text{charcoal}) = 72.00\% * (0.9021*1) * 3.3040 + 0 + (0.9021*1) * 0.1563 + 72.00\% * (0.9021*1) * 3.0400 + (0.9021*1) * 0.6195 + 0 - 0$$

For the wood cluster the formula can be further simplified since there are no emissions during production of the fuel. Thus the formula applied is:

$$ER_{\text{stove year}} (\text{wood}) = X_{\text{nrb},y} * (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio},\text{CO}_2} + 0 + (\Delta B_{90\%} * F_{\text{var}}) * EF_{\text{bio},\text{non-co}_2,i} + 0 + 0 + 0 + 0 - LE_{i,y}$$

$$ER_{\text{stove year 2014}} (\text{wood}) = 72.00\% * (2.3650*0.999) * 1.7472 + 0 + (2.3650*0.999) * 0.1356 + 0 + 0 + 0 + 0 - 0$$

For the combined application solar+OLI-b an adjustment factor is applied to the emission factors of the wood cluster. KT for combined application of solar+OLI-b stove showed that households save more fuel than with only one stove (see KT Report 2011 and Customer Database). Thus, the formula applied is:

$$ER_{\text{stove year2013 (solar+OLI-b)}} = ER_{\text{stove year2014 (wood)}} * 1.18$$

For the combined application solar+OLI-c an adjustment factor is applied to the emission factors of the charcoal cluster. KT for combined application of solar+OLI-c stove showed that households save more fuel than with only one stove (see KT Report 2011 and Customer Database). Thus, the formula applied is:

$$ER_{\text{stove year2013 (solar+OLI-c)}} = ER_{\text{stove year2014 (charcoal)}} * 1.319$$

Cluster	Emissions reductions tCO ₂ e per stove year (lower bound 90% confidence interval and including seasonal/weekly variation)
Wood	3.29 tCO ₂ e
Charcoal	4.82 tCO ₂ e
Solar+OLI-b	3.89 tCO ₂ e
Solar+OLI-c	6.36 tCO ₂ e

Emission reduction per stove year for each cluster

Adjustment factors other than for lower bound of 90% confidence level and for seasonal/weekly variations in fuel use are not reflected in the emission factor above. Other adjustment factors for emission reductions such as drop-off rate and frequency of stove application are considered when calculating number of stove years.

2) In a second step, emission reductions are calculated separately for each cluster by multiplying the number of stove years (including the drop-off rate and adjustment factor for frequency of stove application) with the values for emission reductions per stove years (including lower bound of 90% confidence level and seasonal/weekly variations in fuel consumption).

For every stove, the number of stove days is calculated by counting the number of days from the sale date or start of monitoring period until the end of the monitoring period. This is done within the Salesforce software, which was accordingly programed (see Annex 3 for information on algorithm and source code).

The adjustment factor for the drop-off rate and for frequency of stove application is considered in the following way: For every stove being in operation for the second, third, fourth, fifth year, etc., the stove days in the respective operational year is multiplied with an adjustment factor. This provides for every stove the corrected number of stove days in its second, third, fourth, etc. year of operation.

Since OLI-c stoves are included in the charcoal cluster, an adjustment factor of 0.96 is applied to the stove days in order to reflect slightly lower fuel savings. For combined application of OLI-c and solar stoves this adjustment factor for lower fuel savings of OLI-c stoves is not applied, because separate KT have been conducted for the combined application and thus already subsume this effect.

Stove years of a specific year are then calculated by adding up all corrected/adjusted stove days of all stoves sold in a specific year.

Year	2014	
	Stove years	ERs (tCO ₂ e)
WOOD Cluster	6'068	19'965
CHARCOAL Cluster	31'211	150'438
Solar+OLI-b	401	1'562
Solar+OLI-c	1'577	10'031
Leakage	-	-
TOTAL	39'257	181'996

References

– Project Database: 150512_ADES_Project_Database_2014_V02.xlsx

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

>>

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO₂e)	93,945	181,996

E.6. Remarks on difference from estimated value in the PDD

>> Projected overall emission reductions in the PDD are lower than actual emission reductions achieved by the project in the monitoring period. This is due to the following reasons:

- In the original PDD higher fuel savings and higher ER of combined application of solar and efficient stoves was not considered for ER forecast. Combined application results in 18% - 30% higher savings than single stove usage.
- The project is the continuous dissemination of solar and efficient stoves and stove sales are projected to increase over time. If expected number of stove sales is higher than planned, then this also has implications on emission reductions. In the PDD it was forecasted to sell 48,069 stoves by the end of 2014. The MR reports that by end of 2014 a total of 58,657 stoves have been sold and are counted for ER. Thus, around 22% more stoves have been sold than assumed in the PDD.
- In the PDD a very conservative drop-off rate of 10% was applied. Actual annual drop-off rate for the most commonly used project stove (Oli-c) is only around 2%.
- The NRB fraction used for ER forecast in the PDD (49%) was considerably lower than the currently applied NRB fraction, which is the CDM default value (72%). This contributes to an increase in ER of around 32%.

Annex 1

Appended Files

No.	Reference	Description	File name
1	Detailed Customer Database	Results and sample from baseline Kitchen Surveys and Kitchen Tests	150212_ADES_customer_database_2014_V01.xlsx
2	Project Database	Outcome of baseline Kitchen Surveys and Kitchen Test and clustering, and ER calculations	150512_ADES_Project_Database_2014_V02.xlsx
3	Total Sales Record	Total Sales Record is available in the SalesForce Database	SalesForce Database
4	Monitoring Manual	Monitoring Manual V07	130314_ADES_monitoring_manual_french_V07.pdf

Annex 2

References

No.	Ref. to Chapter	Description	File name
1	PDD	PDD, version 6.1, dated 19.06.2012	1206_ADES_GS_VER_PDD_V6_1.pdf
2	SD 2: Schools visited by ADES	List of schools visited in 2014	150209_list_schools_visited_2014.xlsx
3	SD 1: Jobs created by ADES	Number of jobs created by ADES in 2014	ADES_employees_2014.xlsx
4	Kitchen Test Report 2014	Kitchen Test Report conducted in 2014	150226_ADES_Aging_KT_Oli-b_report_2014.pdf 150226_ADES_Aging_KT_solar_report_2014.pdf
5	Kitchen Survey	Kitchen Survey Reports 2014	150310_ADES_KS_report_2014_V01_EN.pdf
6	Stove Usage	Usage Survey Report 2014	150226_ADES_usage_survey_report_2014_V01.pdf
7	Leakage	Leakage Survey 2014	150211_ADES_Leakage_survey_report_2014.pdf

Annex 3

Algorithm and source code for salesforce

Algorithm

Below is an explanation of the algorithm used for the calculation of the stove days, i. e. the number of days that the stove was used during the monitoring period.

1. All the stoves that were sold to clients or resellers are retrieved from the database, except:
 - a. Yoyo, OLI-60b, OLI-60c, FS+ and Box GM (solar oven for schools).
 - b. Stoves that were sold to or through Blue Ventures.
 - c. Stoves sold to institutions.
 - d. Stoves sold outside of project region, i. e. Madagascar, e. g. Comoros or Switzerland.
2. If the client has exactly one stove, the stove days are calculated and after the application of the corresponding adjustment factors they are assigned to the Wood or Charcoal cluster. The following adjustment factors are applied:
 - a. Aging AF depending on the stove type and its age, i. e. the older the stove, the lower the AF.
 - b. Drop-off AF depending on the stove type and its age, i. e. the older the stove, the lower the AF.
 - c. AF that is applied to all OLI-c stoves.
 - d. AF that is applied to all solar stoves that are used in the highlands of Madagascar (regions of Antananarivo, Antsirabe, Fianarantsoa and Tsiroanomandidy).

Example: An OLI-c that was bought in June 2012 is calculated for the monitoring year 2013. For the period January 2013 until June 2013, the aging and drop-off adjustment factors for one-year-old stoves are applied. For the period June 2013 until December 2013, the aging and drop-off adjustment factors for two-year-old stoves are applied. The OLI-c AF is applied to the resulting stove days.

This application of adjustment factors is the same for the steps below.

3. If the client is in a “Solar + OLI” cluster and has exactly two stoves, the stove days are calculated as follows:
 - a. If the stoves were bought at the same time, the stove days are calculated and assigned to the corresponding “Solar + OLI” cluster.
 - b. If one of the stoves was bought earlier, the days of its sole usage are calculated and assigned to the wood or charcoal cluster. Then the days for the combined usage are calculated and assigned to the corresponding “Solar + OLI” cluster.
4. If the client is in a “Solar + OLI” cluster and has more than two stoves, the newest solar and the newest OLI stove are identified and used for the calculation as above (the other stoves are not counted).
5. If the client is not in a “Solar + OLI” cluster and has two or three stoves, only the newest is counted.
6. If the client has more than three stoves, he is considered as a reseller, and every stove is counted (obviously the same applies for stoves sold to resellers):
 - a. The stove days for OLI-b, OLI-45b and eventually OLI-60b are assigned to the wood cluster.
 - b. All other stoves are assigned to the charcoal cluster.

All stoves that were sold to resellers are counted for the CO₂ ER calculation only thirty (30) days after their delivery to the reseller. Example: A reseller buys stoves on the 1st of June 2012. For the calculation of the CO₂ ER, those stoves are counted from the 1st of July 2012 on. The thirty days is an average number of days that the reseller needs to sell the stoves to clients. But

this does **not** apply for stoves that were sold to clients who count as resellers! This is based on the assumption that a client who buys a couple of stoves will directly use them or give them to someone to use (otherwise he/she would make a contract as reseller to get the stoves cheaper).

7. After the stove days for every stove have been calculated and assigned to the corresponding cluster, the stove years are calculated by dividing the stove years through 365. The emission reductions are then calculated by multiplying the stove years by the emission factors of the corresponding cluster.

Source Code

```

/*
 * Class for the calculation of the stove days (number of days that the stoves were in use during monitoring period)
 */
public class CO2ERCalc {
    //Constants
    public static final Integer CLIENT_MAX_STOVE_CNT = 3;           //A client with more than 3 products is considered as reseller
    public static final Integer FIRST_MONITORING_YEAR = 2008;      //First year that was monitored
    public static final Decimal AF_OLIB_WEIGHTING = 0.697;        //Weighting of OLI-b stoves in Solar + OLI-b cluster in highlands
    public static final Decimal AF_OLIC_WEIGHTING = 0.716;        //Weighting of OLI-c stoves in Solar + OLI-c cluster in highlands

    //Adjustment factors used for calculation of stove days
    private Decimal AF_OLI_C;                                     //Adjustment factor for every OLI-c stove
    private Decimal AF_SOLAR_IN_HIGHLANDS;                       //Adjustment factor for solar stove used in highlands
    private Map<String,List<Decimal>> AF_AGING_SOLAR;             //Divided in Wood and Charcoal clusters
    private Map<String,List<Decimal>> AF_AGING_OLI;               //Divided per type: OLI-b, OLI-c, OLI-45b, ...
    private Map<String,List<Decimal>> AF_DROPOFF;                 //Divided per type: Solar, OLI-b, OLI-c, ...
    private Map<String,Decimal> ERclusterMap;                    //Emission reductions per cluster

    private List<Client_c> clients;                               //List of clients with bought stoves
    private List<Sale_c> resellerSales;                           //List of resellers with bought/sold stoves
    private Date monitoringPeriodStart;                           //Start date of the monitoring period
    private Date monitoringPeriodEnd;                             //End date of the monitoring period
    private Map<String,Decimal> mapStoveDays;                     //Map containing the stove days per cluster
    private String allClientSalesQuery;                           //Query to get ALL client sales from database
    private String allResellerSalesQuery;                         //Query to get ALL reseller sales from database
    private String clientSalesQuery;                              //Query to get client sales from database
    private String resellerSalesQuery;                            //Query to get reseller sales from database
    private Map<String,Map<String,Integer>> stoveTypeCnt;         //Counter for stoves per year and type
    private Map<String,Map<String,Integer>> stoveClusterCnt;      //Counter for stoves per year and cluster
    private Map<String,Integer> stovesNotCounted;                //Map that contains stoves that are not counted for ER calculation
    private Map<String,Map<String,Integer>> stovesWithRecovery;   //Map of stoves for which an old fatam-pera has been recovered

    //Constructor
    public CO2ERCalc(Integer monitoringYear) {
        //Initialize adjustment factors
        initAF();
        initER();

        //Map that holds the stove days per cluster
        mapStoveDays = new Map<String,Decimal>(){
            'Charcoal' => 0,

```

```

        'Solar + OLI-b' => 0,
        'Solar + OLI-c' => 0,
        'Wood' => 0
    };

    //Initialize monitoring period
    monitoringPeriodStart = Date.newInstance(monitoredYear,1,1);
    monitoringPeriodEnd = Date.newInstance(monitoredYear,12,31);

    //Initialize counters
    stoveTypeCnt = new Map<String,Map<String,Integer>>();
    stoveClusterCnt = new Map<String,Map<String,Integer>>();
    initStovesNotCounted();

    //Initialize map of stoves for which a fata-pera has been recovered
    initStovesWithRecovery();

    //Define queries to get sales from database
    allClientSalesQuery = 'SELECT Cluster__c, ' +
        '(SELECT Stove__r.Type__c, Date_of_Sale__c FROM Sales__r ' +
        'WHERE Date_of_Sale__c <= ' +string.valueOf(monitoredPeriodEnd)
d)+
        ' ORDER BY Date_of_Sale__c ASC) ' +
        'FROM Client__c';
    allResellerSalesQuery = 'SELECT Date_of_Sale__c, Stove__r.Type__c FROM Sale__c ' +
        'WHERE Reseller__c != null AND Date_of_Sale__c <= ' +String.valu
eOf(monitoredPeriodEnd);

    clientSalesQuery = 'SELECT Cluster__c, Region__c, ' +
        '(SELECT Stove__r.Type__c, Date_of_Sale__c FROM Sales__r ' +
        'WHERE Stove__r.Type__c != \''+Label.Type_Yoyo+'\'' AND Stove__r.
Type__c != \''+Label.Type_OLI_60b+'\'' +
        'AND Stove__r.Type__c != \''+Label.Type_Box_GM+'\'' AND Stove__r.
Type__c != \''+Label.Type_OLI_60c+'\'' +
        'AND Stove__r.Type__c != \''+Label.Type_FS_Plus+'\'' +
        'AND Stove__r.Is_BV__c = false AND Stove__r.Unusable__c = NULL '
+
        'AND Date_of_Sale__c <= ' +string.valueOf(monitoredPeriodEnd)+
        ' ORDER BY Date_of_Sale__c ASC) ' +
        'FROM Client__c ' +
        'WHERE (NOT (Name LIKE \'%Blue%Vent%\')) AND Region__c != \'Other\'
AND Is_Institution__c = false';
    resellerSalesQuery = 'SELECT Date_of_Sale__c, Stove__r.Type__c FROM Sale__c ' +
        'WHERE Reseller__c != null AND Date_of_Sale__c <= ' +String.valueOf
(monitoredPeriodEnd)+
        'AND Stove__r.Type__c != \''+Label.Type_Yoyo+'\'' AND Stove__r.Type
__c != \''+Label.Type_OLI_60b+'\'' +
        'AND Stove__r.Type__c != \''+Label.Type_Box_GM+'\'' AND Stove__r.Ty
pe__c != \''+Label.Type_OLI_60c+'\'' +
        'AND Stove__r.Type__c != \''+Label.Type_FS_Plus+'\'';
    }

    //Return client sales query
    public String getAllClientSalesQuery() {
        return allClientSalesQuery;
    }

    //Return reseller sales query
    public String getAllResellerSalesQuery() {
        return allResellerSalesQuery;
    }

    //Return client sales query
    public String getClientSalesQuery() {
        return clientSalesQuery;
    }

    //Return reseller sales query
    public String getResellerSalesQuery() {
        return resellerSalesQuery;
    }

    //Return stove days per cluster
    public Map<String,Decimal> getStoveDaysMap() {
        return mapStoveDays;
    }

    //Return ER per cluster
    public Map<String,Decimal> getERclusterMap() {

```

```

        return ERclusterMap;
    }

    //Return monitoring year
    public Integer getMonitoringYear() {
        return monitoringPeriodStart.year();
    }

    //Return stoves per type and year counter
    public Map<String,Map<String,Integer>> getStoveTypeCnt() {
        return stoveTypeCnt;
    }

    //Return stoves per cluster and year counter
    public Map<String,Map<String,Integer>> getStoveClusterCnt() {
        return stoveClusterCnt;
    }

    //Return stoves that are not counted for ER calculation
    public Map<String,Integer> getStovesNotCounted() {
        return stovesNotCounted;
    }

    //Return stoves for which a fatam-pera was recovered
    public Map<String,Map<String,Integer>> getStovesWithRecovery() {
        return stovesWithRecovery;
    }

    //Calculate stove days for stoves sold to clients
    public void calculateClientSales(List<Client__c> clients) {
        List<Sale__c> sales; //Sales of a client
        Decimal stoveDays; //Stove days for one stove in wood or charcoal cluster
        Map<String,Decimal> stoveDaysSolarCluster; //Stove days for solar cluster

        for (Client__c client : clients) {
            sales = client.Sales__r;

            //Client has one, two or three stoves
            if (sales.size() <= CLIENT_MAX_STOVE_CNT && sales.size() > 0) {
                //Client has only one product
                if (sales.size() == 1) {
                    String cluster = client.Cluster__c;
                    cluster = (cluster.contains('OLI-b')) ? 'Wood' : (cluster.contains('OLI-
c')) ? 'Charcoal' : cluster;
                    incStoveTypeCnt(sales[0].Stove__r.Type__c, sales[0].Date_of_Sale__c.year());
;
                    incStoveClusterCnt(cluster, sales[0].Date_of_Sale__c.year());
                    stoveDays = calculateStoveDays(sales[0], cluster, client.Region__c);
                    updateCluster(cluster, stoveDays);
                }

                //Client has more than one stove in a Solar + OLI cluster
                else if (client.Cluster__c.contains('Solar + OLI')) {
                    //Client has two stoves
                    if (sales.size() == 2) {
                        incStoveTypeCnt(sales[0].Stove__r.Type__c, sales[0].Date_of_Sale__c.yea
r());
                        incStoveTypeCnt(sales[1].Stove__r.Type__c, sales[1].Date_of_Sale__c.yea
r());
                        incStoveClusterCnt(client.Cluster__c, sales[0].Date_of_Sale__c.year());
                        incStoveClusterCnt(client.Cluster__c, sales[1].Date_of_Sale__c.year());
                        stoveDaysSolarCluster = calculateStoveDaysSolarCluster(sales, client.Cl
uster__c, client.Region__c);
                        updateClusters(stoveDaysSolarCluster);
                    }

                    //Client has more than two stoves, so the two newest are counted
                    else {
                        Sale__c firstSale = sales[sales.size()-1];
                        Sale__c secondSale;
                        //Get the stove that is of a different type than the first one
                        for (Integer i=sales.size()-2; i>=0; i--) {
                            if (firstSale.Stove__r.Type__c.contains('OLI') &&
!sales[i].Stove__r.Type__c.contains('OLI')) {
                                secondSale = sales[i];
                            }
                        }
                        else if (!firstSale.Stove__r.Type__c.contains('OLI') &&
sales[i].Stove__r.Type__c.contains('OLI')) {

```

```

                secondSale = sales[i];
            }
        }

        incStoveTypeCnt(firstSale.Stove__r.Type__c, firstSale.Date_of_Sale__c.y
ear());
        incStoveTypeCnt(secondSale.Stove__r.Type__c, secondSale.Date_of_Sale__c
.year());
        incStoveClusterCnt(client.Cluster__c, firstSale.Date_of_Sale__c.year())
;
        incStoveClusterCnt(client.Cluster__c, secondSale.Date_of_Sale__c.year()
);
        incSecondaryStoves(sales.size()-2);
        stoveDaysSolarCluster = calculateStoveDaysSolarCluster(new List<Sale__c
>{secondSale,firstSale},
                                                                    client.Cluster__
c, client.Region__c);
        updateClusters(stoveDaysSolarCluster);
    }
}

//Client has more than one stove, but only one is counted (the newest)
else {
    Sale__c sale = sales[sales.size()-1];
    incStoveTypeCnt(sale.Stove__r.Type__c, sale.Date_of_Sale__c.year());
    incStoveClusterCnt(client.Cluster__c, sale.Date_of_Sale__c.year());
    incSecondaryStoves(sales.size()-1);
    stoveDays = calculateStoveDays(sale, client.Cluster__c, client.Region__c);
    updateCluster(client.Cluster__c, stoveDays);
}

//Client has more than three products and is considered a reseller, i.e. every prod
uct is counted
else {
    calculateResellerSales(sales);
}
}

//Calculate stove days for stoves that have been sold through resellers
public void calculateResellerSales(List<Sale__c> sales) {
    Decimal stoveDays; //Stove days for one stove
    String stType;      //Type of stove
    String cluster;     //Cluster of stove depending on type

    for (Sale__c sale : sales) {
        stType = sale.Stove__r.Type__c;

        //If the stove is an OLI-b or OLI-
45b, count it to the wood cluster, otherwise to the charcoal cluster
        cluster = (stType == 'OLI-b' || stType == 'OLI-45b') ?
            'Wood' : 'Charcoal';

        incStoveTypeCnt(stType, sale.Date_of_Sale__c.year());
        incStoveClusterCnt(cluster, sale.Date_of_Sale__c.year());

        stoveDays = calculateStoveDays(sale, cluster, '');
        updateCluster(cluster, stoveDays);
    }
}

//Initialize adjustment factors
private void initAF() {
    //Adjustment factor for every OLI-c
    AF_OLI_C = CO2_AF__c.getValues('Default').OLI_c_in_CC__c;
    AF_SOLAR_IN_HIGHLANDS = CO2_AF__c.getValues('Default').Solar_in_Highlands__c;

    //Aging for solar stoves per cluster
    CO2_Aging_AF__c co2AgingAF = CO2_Aging_AF__c.getValues('Default');
    AF_AGING_SOLAR = new Map<String,List<Decimal>>{
        'Charcoal' => convertToDecimalList(co2AgingAF.Solar_Charcoal__c),
        'Wood' => convertToDecimalList(co2AgingAF.Solar_Wood__c)
    };

    //Aging for OLI stoves per type
    AF_AGING_OLI = new Map<String,List<Decimal>>{
        'OLI-b' => convertToDecimalList(co2AgingAF.OLI_b__c),
        'OLI-45b' => convertToDecimalList(co2AgingAF.OLI_45b__c),

```

```

        'OLI-60b' => convertToDecimalList(co2AgingAF.OLI_60b__c),
        'OLI-c' => convertToDecimalList(co2AgingAF.OLI_c__c),
        'OLI-45c' => convertToDecimalList(co2AgingAF.OLI_45c__c),
        'OLI-60c' => convertToDecimalList(co2AgingAF.OLI_60c__c)
    };

    //Drop off per type (all solar stoves have same drop-off rate)
    CO2_Dropoff_AF__c co2DropoffAF = CO2_Dropoff_AF__c.getValues('Default');
    AF_DROPOFF = new Map<String,List<Decimal>>{
        'Solar' => convertToDecimalList(co2DropoffAF.Solar__c),
        'OLI-b' => convertToDecimalList(co2DropoffAF.OLI_b__c),
        'OLI-45b' => convertToDecimalList(co2DropoffAF.OLI_45b__c),
        'OLI-60b' => convertToDecimalList(co2DropoffAF.OLI_60b__c),
        'OLI-c' => convertToDecimalList(co2DropoffAF.OLI_c__c),
        'OLI-45c' => convertToDecimalList(co2DropoffAF.OLI_45c__c),
        'OLI-60c' => convertToDecimalList(co2DropoffAF.OLI_60c__c)
    };
}

//Initialize ER
private void initER() {
    CO2_ER__c co2ER = CO2_ER__c.getValues('Default');

    ERclusterMap = new Map<String,Decimal> {
        'Wood' => co2ER.Wood__c,
        'Charcoal' => co2ER.Charcoal__c,
        'Solar + OLI-b' => co2ER.Solar_OLI_b__c,
        'Solar + OLI-c' => co2ER.Solar_OLI_c__c
    };
}

//Return aging AF for given age and cluster/type
private Decimal getAging(Integer age, String type, String cluster) {
    Decimal ret;

    if (type.contains('OLI')) {
        ret = AF_AGING_OLI.get(type)[age];
    }
    else {
        ret = AF_AGING_SOLAR.get(cluster)[age];
    }

    return ret;
}

//Return drop-off AF for given age and type
private Decimal getDropoff(Integer age, String type) {
    Decimal ret;

    if (type.contains('OLI')) {
        ret = AF_DROPOFF.get(type)[age];
    }

    else {
        ret = AF_DROPOFF.get('Solar')[age];
    }

    return ret;
}

//Return true if the region is in the highlands of Madagascar
//(i.e. Fianarantsoa, Antsirabe, Antananarivo, Tsiroanomandidy)
private Boolean isRegionInHighlands(String region) {
    Boolean ret = (region == 'Antananarivo' ||
        region == 'Antsirabe' ||
        region == 'Fianarantsoa' ||
        region == 'Tsiroanomandidy');

    return ret;
}

//Calculate the number of days that the stove was used during the monitoring year
private Decimal calculateStoveDays(Sale__c sale, String cluster, String region) {
    Decimal stoveDays; //Adjusted number of days that the stove has been used during moni
    toring year
    Integer stoveAge; //Age of stove
    String stoveType; //Type of stove
    Date d; //Date in monitoring year that the stove age has changed from x to
    x+1 (birthday)

```

```

//Calculate age of stove
stoveAge = monitoringPeriodEnd.year() - sale.Date_of_Sale__c.year();
stoveType = sale.Stove__r.Type__c;

//Stove has been bought in monitoring year
if (stoveAge == 0) {
    stoveDays = sale.Date_of_Sale__c.daysBetween(monitoringPeriodEnd);
}

//Stove has worked for more than one year
else {
    d = Date.newInstance(monitoringPeriodEnd.year(), sale.Date_of_Sale__c.month(), sale
.Date_of_Sale__c.day());
    stoveDays = monitoringPeriodStart.daysBetween(d) * getAging(stoveAge-
1, stoveType, cluster) * getDropoff(stoveAge-1, stoveType);
    stoveDays += d.daysBetween(monitoringPeriodEnd) * getAging(stoveAge, stoveType, clu
ster) * getDropoff(stoveAge, stoveType);
}

//Apply additional AF for OLI-c stoves
if (stoveType == 'OLI-c') stoveDays *= AF_OLI_C;

//Apply additional AF for solar stoves used in highlands
if (!stoveType.contains('OLI') && isRegionInHighlands(region)) stoveDays *= AF_SOLAR_IN
_HIGHLANDS;

return stoveDays;
}

//Calculate the number of days that the stoves in a Solar + OLI cluster were used during th
e monitoring year
private Map<String,Decimal> calculateStoveDaysSolarCluster(List<Sale__c> sales, String clus
ter, String region) {
    //Map of stove days per cluster (if stoves have not been bought together, the first sto
ve will be put in Wood / Charcoal cluster)
    Map<String,Decimal> ret = new Map<String,Decimal>();
    Decimal stoveDays;
    //Stove days of the stoves for single and combined usag
e
    String firstCluster;
    //Cluster for single stove usage (Wood for Solar + OLI-
b, Charcoal for Solar + OLI-c)
    Integer stoveAge, stoveAge2;
    //Ages of first and second stove
    Date d;
    //Date in monitoring year that the stove age has change
d from x to x+1 (birthday)
    Date beginCombined;
    //Date when the stoves have started to be used together

    //Cluster for single stove usage
    firstCluster = (cluster.contains('OLI-b')) ? 'Wood' : 'Charcoal';

    //Stoves have been bought together
    if (sales[0].Date_of_Sale__c == sales[1].Date_of_Sale__c) {
        stoveAge = monitoringPeriodEnd.year() - sales[0].Date_of_Sale__c.year();

        //Stoves have been bought in monitoring year
        if (stoveAge == 0) {
            stoveDays = sales[0].Date_of_Sale__c.daysBetween(monitoringPeriodEnd) *
((getAging(stoveAge, sales[0].Stove__r.Type__c, firstCluster) + get
Aging(stoveAge, sales[1].Stove__r.Type__c, firstCluster)) / 2) *
((getDropoff(stoveAge, sales[0].Stove__r.Type__c) + getDropoff(stov
eAge, sales[1].Stove__r.Type__c)) / 2);
        }

        //Stoves have worked for more than one year
        else {
            d = Date.newInstance(monitoringPeriodEnd.year(), sales[0].Date_of_Sale__c.month
(), sales[0].Date_of_Sale__c.day());
            stoveDays = monitoringPeriodStart.daysBetween(d) *
((getAging(stoveAge-
1, sales[0].Stove__r.Type__c, firstCluster) + getAging(stoveAge-
1, sales[1].Stove__r.Type__c, firstCluster)) / 2) *
((getDropoff(stoveAge-
1, sales[0].Stove__r.Type__c) + getDropoff(stoveAge-1, sales[1].Stove__r.Type__c)) / 2);
            stoveDays += d.daysBetween(monitoringPeriodEnd) *
((getAging(stoveAge, sales[0].Stove__r.Type__c, firstCluster) + get
Aging(stoveAge, sales[1].Stove__r.Type__c, firstCluster)) / 2) *
((getDropoff(stoveAge, sales[0].Stove__r.Type__c) + getDropoff(stov
eAge, sales[1].Stove__r.Type__c)) / 2);
        }

        //Apply additional AF for solar stoves used in highlands

```

```

        if (isRegionInHighlands(region)) {
            if (cluster.contains('OLI-
b')) stoveDays = (stoveDays * AF_OLIB_WEIGHTING) + (stoveDays * (1 -
AF_OLIB_WEIGHTING) * AF_SOLAR_IN_HIGHLANDS);
            else stoveDays = (stoveDays * AF_OLIC_WEIGHTING) + (stoveDays * (1 -
AF_OLIC_WEIGHTING) * AF_SOLAR_IN_HIGHLANDS);
        }

        ret.put(cluster, stoveDays);
    }

    //Stoves have not been bought together
    else {
        d = Date.newInstance(monitoredPeriodEnd.year(), sales[0].Date_of_Sale__c.month(),
sales[0].Date_of_Sale__c.day());
        stoveAge = monitoredPeriodEnd.year() - sales[0].Date_of_Sale__c.year();

        //First stove was used alone during monitoring period because second stove has been
        bought during monitoring period
        if (sales[1].Date_of_Sale__c >= monitoredPeriodStart) {
            //Stove perhaps had "birthday" during sole usage
            if (d < sales[1].Date_of_Sale__c) {
                stoveDays = (stoveAge > 0) ?
                    monitoredPeriodStart.daysBetween(d) * getAging(stoveAge-
1, sales[0].Stove__r.Type__c, firstCluster) * getDropoff(stoveAge-
1, sales[0].Stove__r.Type__c) :
                    0;
                stoveDays += d.daysBetween(sales[1].Date_of_Sale__c) * getAging(stoveAge, s
ales[0].Stove__r.Type__c, firstCluster) * getDropoff(stoveAge, sales[0].Stove__r.Type__c);
            }
            else {
                stoveDays = monitoredPeriodStart.daysBetween(sales[1].Date_of_Sale__c) *
                    getAging(stoveAge-
1, sales[0].Stove__r.Type__c, firstCluster) * getDropoff(stoveAge-
1, sales[0].Stove__r.Type__c);
            }

            //Apply additional AF for OLI-c stoves
            if (sales[0].Stove__r.Type__c == 'OLI-c') stoveDays *= AF_OLIC;

            //Apply additional AF for solar stoves used in highlands
            if (!sales[0].Stove__r.Type__c.contains('OLI') && isRegionInHighlands(region))
stoveDays *= AF_SOLAR_IN_HIGHLANDS;

            ret.put(firstCluster, stoveDays);
        }

        //Calculate stove days for combined usage
        stoveAge2 = monitoredPeriodEnd.year() - sales[1].Date_of_Sale__c.year();
        beginCombined = (sales[1].Date_of_Sale__c < monitoredPeriodStart) ? monitoredPeri
odStart : sales[1].Date_of_Sale__c;

        //To simplify calculation, lowest AF are used
        stoveDays = beginCombined.daysBetween(monitoredPeriodEnd) *
            ((getAging(stoveAge, sales[0].Stove__r.Type__c, firstCluster) + getAgin
g(stoveAge2, sales[1].Stove__r.Type__c, firstCluster)) / 2) *
            ((getDropoff(stoveAge, sales[0].Stove__r.Type__c) + getDropoff(stoveAge
2, sales[1].Stove__r.Type__c)) / 2);

        //Apply additional AF for solar stoves used in highlands
        if (isRegionInHighlands(region)) {
            if (cluster.contains('OLI-
b')) stoveDays = (stoveDays * AF_OLIB_WEIGHTING) + (stoveDays * (1 -
AF_OLIB_WEIGHTING) * AF_SOLAR_IN_HIGHLANDS);
            else stoveDays = (stoveDays * AF_OLIC_WEIGHTING) + (stoveDays * (1 -
AF_OLIC_WEIGHTING) * AF_SOLAR_IN_HIGHLANDS);
        }
        ret.put(cluster, stoveDays);
    }
}

return ret;
}

//Update the cluster by adding the stove days to it
private void updateCluster(String cluster, Decimal stoveDays) {
    stoveDays += mapStoveDays.get(cluster);
    mapStoveDays.put(cluster, stoveDays);
}

```

```

//Update all clusters in the map
private void updateClusters(Map<String,Decimal> clusterDaysMap) {
    for (String cluster : clusterDaysMap.keySet()) {
        updateCluster(cluster, clusterDaysMap.get(cluster));
    }
}

//Convert a string to a list of decimals
private List<Decimal> convertToDecimalList(String field) {
    String fieldNorm = field.normalizeSpace();
    List<Decimal> ret = new List<Decimal>();

    for (String item : fieldNorm.split(' ')) {
        ret.add(Decimal.valueOf(item));
    }

    return ret;
}

//Increment counters for client sales
public void incClientStoveCnt(List<Client__c> clientSales) {
    //Count all stoves sold to clients
    for (Client__c client : clientSales) {
        List<Sale__c> sales = client.Sales__r;

        //Client is considered as a reseller
        if (sales.size() > CLIENT_MAX_STOVE_CNT) {
            incResellerStoveCnt(sales);
        }
        else {
            //Increment cluster and stove type count
            for (Sale__c sale : sales) {
                incStoveClusterCnt(client.Cluster__c, sale.Date_of_Sale__c.year());
                incStoveTypeCnt(sale.Stove__r.Type__c, sale.Date_of_Sale__c.year());
            }
        }
    }
}

//Increment counters for reseller sales
public void incResellerStoveCnt(List<Sale__c> resellerSales) {
    //Count all stoves sold to resellers
    for (Sale__c sale : resellerSales) {
        //Increment cluster count
        String cluster = (sale.Stove__r.Type__c == 'OLI-
b' || sale.Stove__r.Type__c == 'OLI-45b') ?
            'Wood' : 'Charcoal';
        incStoveClusterCnt(cluster, sale.Date_of_Sale__c.year());

        //Increment stove type count
        incStoveTypeCnt(sale.Stove__r.Type__c, sale.Date_of_Sale__c.year());
    }
}

//Increment type counters
private void incStoveTypeCnt(String type, Integer year) {
    Map<String,Integer> tmpMap;
    Integer cnt;

    //Check if year and type are in map, otherwise add them
    if (!stoveTypeCnt.containsKey(''+year)) stoveTypeCnt.put(''+year, new Map<String,Integer>());
    if (!stoveTypeCnt.get(''+year).containsKey(type)) {
        tmpMap = stoveTypeCnt.get(''+year);
        tmpMap.put(type, 0);
    }

    tmpMap = stoveTypeCnt.get(''+year);
    cnt = tmpMap.get(type) + 1;
    tmpMap.put(type, cnt);
    stoveTypeCnt.put(''+year, tmpMap);
}

//Increment cluster counters
private void incStoveClusterCnt(String cluster, Integer year) {
    Map<String,Integer> tmpMap;
    Integer cnt;

    //Check if year and cluster are already in map, otherwise add them

```

```

        if (!stoveClusterCnt.containsKey(''+year)) stoveClusterCnt.put(''+year, new Map<String,
Integer>());
        if (!stoveClusterCnt.get(''+year).containsKey(cluster)) {
            tmpMap = stoveClusterCnt.get(''+year);
            tmpMap.put(cluster, 0);
        }

        tmpMap = stoveClusterCnt.get(''+year);
        cnt = tmpMap.get(cluster) + 1;
        tmpMap.put(cluster, cnt);
        stoveClusterCnt.put(''+year, tmpMap);
    }

    //Increment recovery counters
    private void incStovesWithRecoveryCnt(String type, Integer year) {
        Map<String,Integer> tmpMap;
        Integer cnt;

        //Check if year and cluster are already in map, otherwise add them
        if (!stovesWithRecovery.containsKey(''+year)) stovesWithRecovery.put(''+year, new Map<S
tring,Integer>());
        if (!stovesWithRecovery.get(''+year).containsKey(type)) {
            tmpMap = stovesWithRecovery.get(''+year);
            tmpMap.put(type, 0);
        }

        tmpMap = stovesWithRecovery.get(''+year);
        cnt = tmpMap.get(type) + 1;
        tmpMap.put(type, cnt);
        stovesWithRecovery.put(''+year, tmpMap);
    }

    //Increment secondary stove counter
    private void incSecondaryStoves(Integer inc) {
        Integer cnt = stovesNotCounted.get('Secondary stoves');
        cnt += inc;
        stovesNotCounted.put('Secondary stoves', cnt);
    }

    //Initialize map of not counted stoves
    private void initStovesNotCounted() {
        stovesNotCounted = new Map<String,Integer>();
        stovesNotCounted.put('Blue Ventures',
            [SELECT Count() FROM Sale__c
            WHERE (Client__r.Name LIKE '%Blue%Vent%' OR Stove__r.Is_BV__c = true)
            AND Date_of_Sale__c <= :monitoringPeriodEnd]);
        stovesNotCounted.put('Outside project area',
            [SELECT Count() FROM Sale__c
            WHERE Client__r.Region__c = 'Other' AND Stove__r.Type__c != :Label.Type_FS_PLUS
            AND Date_of_Sale__c <= :monitoringPeriodEnd]);
        stovesNotCounted.put('Institution',
            [SELECT Count() FROM Sale__c
            WHERE Client__r.Is_Institution__c = TRUE AND Stove__r.Type__c != :Label.Type_OLI_6
0b
            AND Stove__r.Type__c != :Label.Type_OLI_60c AND Stove__r.Type__c != :Label.Type_Bo
x_GM
            AND Stove__r.Type__c != :Label.Type_FS_PLUS AND Date_of_Sale__c <= :monitoringPeri
odEnd]);
        stovesNotCounted.put('Yoyo',
            [SELECT Count() FROM Sale__c
            WHERE Stove__r.Type__c = :Label.Type_Yoyo AND (NOT Client__r.Name LIKE '%Blue%Vent
%'
            AND Date_of_Sale__c <= :monitoringPeriodEnd]);
        stovesNotCounted.put('New model',
            [SELECT Count() FROM Sale__c
            WHERE (Stove__r.Type__c = :Label.Type_OLI_60b OR Stove__r.Type__c = :Label.Type_OL
I_60c
            OR Stove__r.Type__c = :Label.Type_Box_GM OR Stove__r.Type__c = :Label.Type_FS_Plus
            AND Date_of_Sale__c <= :monitoringPeriodEnd]);
        stovesNotCounted.put('Broken',
            [SELECT Count() FROM Sale__c WHERE Stove__r.Unusable__c != NULL AND Date_of_Sale__c
<= :monitoringPeriodEnd]);
        stovesNotCounted.put('Secondary stoves', 0);
    }

    //Get stoves for which a fata-pera has been recovered
    private void initStovesWithRecovery() {
        List<Sale__c> recoveredStoves = [SELECT Date_of_Sale__c, Stove__r.Type__c FROM Sale__c

```

```

WHERE Stove__r.Recovery_Fatampera__c = TRUE AND Stove_
_r.Sold__c = TRUE];
    stovesWithRecovery = new Map<String,Map<String,Integer>>();

    for (Sale__c sale : recoveredStoves) {
        incStovesWithRecoveryCnt(sale.Stove__r.Type__c, sale.Date_of_Sale__c.year());
    }
}
}

```