



**Co-funded by
the European Union**



**UK Research
and Innovation**

**Horizon Europe
(HORIZON-CL5-2021-D1-01)**

Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts



Deliverable 7.2

**Links between non-CO2 climate forcer mitigation measures and
social and economic impacts**

Grant Agreement No.	101056783	
Project acronym	FOCI	
Project full title	Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts	
Call	HORIZON-CL5-2021-D1-01	
Deliverable name	7.2 Links between non-CO2 climate forcer mitigation measures and social and economic impacts	
WP contributing to the deliverable	WP7	
Task producing the deliverable	Task 7.2	
Type	X	Report
		Prototype
		Demonstrator
		Other: Data
Dissemination level	X	Public
		Sensitive
		UE/EU-Restricted
Due date of deliverable	Month 24	
Actual submission date	Month 36	
Lead beneficiary	SEI	
Author(s)	Chris Malley (SEI), Moran Nabriski (TAU)	
Other Contributor(s)	Johan Kuylenstierna (SEI), Jenniffer Pedraza (SEI), Colin Price (TAU), Drew Shindell, (TAU)	
Reviewer(s)	Alberto Troccoli (WEMC)	
Keywords	FOCI, deliverables, dataset, catalogue, global emissions, regional emissions	

ACKNOWLEDGEMENTS

This project has been co-funded by the European Union with funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101056783 and from UKRI under the UK Government's Horizon Europe Guarantee (UKRI Reference Numbers: 10040465, 10053814 and 10050799).

Version	Date	Modified by	Comments
1.0	24 Jan 2025	Chris Malley	First order draft written
2.0	15 Aug 2025	Alberto Troccoli	Reviewer comments provided
3.0	30 Aug 2025	Chris Malley	Reviewer comments addressed

	Name	Date
Verification Final Draft by WP leaders	Chris Malley (SEI)	30 th August 2025
Check before upload by project Coordinator	Tomas Halenka (CU)	31 August 2025

TABLE OF CONTENTS

TABLE OF CONTENTS	3
EXECUTIVE SUMMARY	4
CONTRIBUTION TO THE FOCI OBJECTIVES	5
1. INTRODUCTION	6
2. NON-CO2 CLIMATE FORCER MITIGATION AND ACHIEVEMENT OF SUSTAINABLE DEVELOPMENT GOALS: METHODS AND TOOLS TO QUANTIFY LINKS	6
2.1 Introduction	6
2.2 Methodology	10
2.3 Results.....	12
2.4 Climate Change mitigation – SDG links that can be quantified within LEAP currently	14
2.5 Climate change mitigation – SDG links with new methodologies to extend functionality of LEAP	15
2.6 Climate change mitigation – SDG links where new methodologies should be investigated.	23
3. IMPROVING CONSISTENCY OF QUANTIFYING FUTURE AIR POLLUTION HEALTH BURDENS FOR ASSESSING BENEFITS OF MITIGATION ACTIONS	50
3.1 Paper 1	50
3.2 Paper 2	51
4. ECONOMIC ASSESSMENT OF METHANE MITIGATION IN FOSSIL FUEL PRODUCTION	54
4.1 Methane mitigation background	54
4.2 Methods	55
4.3 Results: Incorporating Real Option Value into Methane Abatement Cost Curves	59
4.4 Discussion	59
REFERENCES	61
APPENDIX 1	62
Table A1: Methods that can be used within LEAP and Integrated Benefits Calculator to quantify SDG linkages	62
Table A2: Methods that can be used within AgHealth to quantify SDG linkages	96

EXECUTIVE SUMMARY

This document is the deliverable “D7.2 “Links between non-CO₂ climate forcer mitigation measures and social and economic impacts” for the European Union project “FOCI: Non-CO₂ Forcers and their Climate, Weather, Air Quality and Health Impacts” (hereinafter also referred to as FOCI, project reference: 101056783). In this context ‘mitigation measures’ refer to specific actions that can be implemented that reduce (i.e. mitigate) emissions of non-CO₂ climate forcers.

WP7 has previously delivered D7.1 and is currently working on the Deliverable D7.3, which also contributes to the Milestone M13 due Month 42. Deliverable 7.2 focusses on improving quantification of impacts of mitigation measures, while Deliverable 7.1 assessed the extent to which current emission projections (i.e. Shared Socioeconomic Pathways) are reported in such a way as to allow understanding of the emission changes associated with specific mitigation measures. Deliverable 7.3 will take the methodologies developed in 7.2 and integrate them into the Low Emissions Analysis Platform (LEAP) scenario analysis tool.

The overall aim of FOCI is to understand the impacts of non-CO₂ climate forcers on present and future climate as well as other impacts such as air quality. This deliverable aims to improve the way in which public health and economic impacts of mitigation actions to reduce non-CO₂ climate forcers are quantified. The report is split into 3 sections reflecting the different elements of work that has been undertaken under this task. First, a comparison of the potential links between specific non-CO₂ climate forcer mitigation measures and Sustainable Development Goals (SDGs) is made to identify the potential impacts that could be quantified when assessing the impacts of implementing particular actions. Secondly, two analyses, one published in a, and the other submitted to a peer-review journal, that aim to improve quantification of the health burden from air pollution in future scenarios are presented. Air pollution health burdens are the impact most commonly quantified for non-CO₂ mitigation measures but are done so using methods that lead to large biases. The paper presented (Paper 1) addresses inconsistencies in current common methods using a demographic model. Finally, a section on work to better quantify the economic consequences of reducing non-CO₂ climate forcing mitigation actions is presented.

CONTRIBUTION TO THE FOCI OBJECTIVES

The overall aim of the project is to improve our knowledge of individual and cumulative contribution of non-CO₂ radiative forcers and their precursors. This is achieved through targeted research on those species where there is the greatest uncertainty in determining their impact on climate change and the associated influence on weather patterns (e.g., atmospheric and ocean circulation and extreme weather events), air pollution episodes and health impacts.

Multiple sub-objectives of FOCI, implemented through distinct work packages, are addressed in whole or in part through quantitative assessments of the health impacts of ambient air pollution exposure presented in this report, including:

- Objective 5: To improve tailored emission inventories for non-CO₂ radiative forcers and scenarios for detailed, high resolution, multiscale climate, and associated impact projections for specific regions (e.g., Europe, South Asia, Africa, and Arctic) with the use of innovative coupled modelling frameworks (WP5 and WP7).
- Objective 6: To undertake innovative and regionally relevant integrated analysis of optimised mitigation strategies to support climate policy, deriving multiple benefits (e.g. climate mitigation and adaptation, human health, social, economic, and developmental), quantifying the sensitivity of climate system tipping points to nonCO₂ forcers and meeting the global challenge of stabilising global temperatures and minimising the associated impacts on climate, weather, air quality and health (WP6, WP7).
- Objective 7: To implement a global outreach, dissemination and stakeholder engagement strategy targeted at providing updated scientific evidence on the impact from key non-CO₂ radiative forcers for supporting national and international policy and operational services, including formulating recommendations and briefing papers on the most efficient pathways to stabilising global temperatures supported by integrating climate, health, urban and energy services (WP8).

1. INTRODUCTION

This Deliverable D7.2. report “Links between non-CO₂ climate forcer mitigation measures and social and economic impacts” describes three assessments and methodological developments for evaluating the broader implications of implementing actions to reduce non-CO₂ climate forcers.

WP7 is organised in three major tasks:

Task 7.1: Assessment of detailed emission projections in WP6 and comparison with SSPs and other inventories/projections (Lead beneficiary: SEI)

Task 7.2: Quantification of broader implications of implementing non-CO₂ climate forcing mitigation measures. (Lead beneficiary: SEI)

Task 7.3: Making the benefit quantification methods available to the emission policy modelling community (Lead beneficiary: TAU)

The aim of this report is to present the analyses conducted as part of this work package that allow for broader understanding of the impact of implementing actions to reduce non-CO₂ climate forcers, and the more robust quantification of these impacts.

Section 2 describes a mapping of mitigation measures and their likely impact across the Sustainable Development Goals. This mapping allows links between specific mitigation actions and their broader impacts to be identified, and those impacts which can be quantified to be investigated.

Section 3 presents two papers that highlight deficiencies in current commonly used methods to quantify the future health burden of air pollution. The limitations of current methods result from the applicability of methods for estimating historic health burdens into the future, which does not allow population and demographic dynamics resulting from changes in air pollution exposure to be accounted for. The two papers presented address these limitations by presenting a new demographic model and applying it to hypothetical future PM_{2.5} scenarios.

Section 4 presents a summary of evaluating the economic benefits and costs of taking action to reduce methane from the fossil fuel production sector, one of the three largest methane-emitting source globally.

2. NON-CO₂ CLIMATE FORCER MITIGATION AND ACHIEVEMENT OF SUSTAINABLE DEVELOPMENT GOALS: METHODS AND TOOLS TO QUANTIFY LINKS

2.1 Introduction

The long-term temperature targets committed to in the Paris Agreement require countries to take actions to limit global temperature increases to ‘well below 2 °C’, and to aim to limit increases to 1.5 °C. The IPCC 2018 Special Report on 1.5 degrees of global warming showed that to achieve these goals global greenhouse gas (GHG) emissions would need to be halved by 2030, and reach net zero emissions by 2050. The recent 6th Assessment Report highlights both that there are negative impacts of climate change that are inevitable

because of the GHG emissions that have already been emitted, and the speed and scale with which these emission reductions need to occur to avoid the worst impacts of climate change. The IPCC AR6 emphasises that every fraction of a degree of warming avoided, and tonne of GHG emission that does not occur will alleviate detrimental climate impacts.

To meet the goals of the Paris Agreement, countries are required, at least at five years intervals, to communicate their contribution to limiting global temperature increases, within their ‘Nationally Determined Contributions’ or NDCs. The first set of NDCs, submitted in 2015, were insufficient to meet the Paris Agreement, and consistent with over 3 °C of warming (REF). Countries are now submitting updated NDC, with enhanced climate change mitigation pledges, but these are also likely to be inconsistent with the Paris Agreement goals.

In addition to the setting of targets to reduce GHG emissions that are consistent with the Paris Agreement, commitments and targets need to be implemented if the goals of the Paris Agreement are to be met. This is not guaranteed, especially as the international finance required to implement all commitments is currently below the level required.

The Paris Agreement specifically frames the achievement of the long-term temperature goals as being implemented ‘in the context of sustainable development’. There has been a substantial body of research on the links between climate change mitigation and the achievement of the Sustainable Development Goals. This research includes identifying the specific links between climate change mitigation and particular Sustainable Development Goals. It also includes research suggesting that stronger links between climate change mitigation and sustainable development goals can i) increase climate change mitigation ambition through the identification and inclusion in targets of actions that also achieve important development priorities, and ii) increase implementation of climate change mitigation actions through building a broad coalition of support for actions taking place, due to the multiple constituents the implementation of the action benefits.

However, the research on the links between climate change mitigation and SDGs has not been integrated into climate change planning processes, such as the development of NDCs, as fully as it has the potential to be. Several frameworks, guides, tools and methods have been put forward that specifically aim to link SDGs with climate change planning. Existing tools and approaches for assessing the links between climate change mitigation and sustainable development provide a range of methodological approaches, which provide different insights into climate change mitigation and its ability to achieve SDGs. Examples of available tools for assessing this linkage include:

- NDC-SDG connections (<https://klimalog.die-gdi.de/ndc-sdg/>): Retrospective analysis of NDCs (following their publication), specific SDG targets evaluated, links are qualitative and not quantitative.
- NDC-SDG links (<https://www.climatewatchdata.org/ndcs-sdg/>): Retrospective analysis of NDCs (following their publication), specific SDG targets evaluated, links are qualitative and not quantitative.
- NDC Explorer tool (<https://klimalog.die-gdi.de/ndc/#NDCExplorer/worldMap?INDC??income???catIncome>): Retrospective analysis of NDCs (following their publication), high-level qualitative assessment of mention of sustainable development in NDC document
- iSDG (<https://www.millennium-institute.org/documentation/>): Prospective modelling tool for assessing SDGs, quantifiable. Focussed on specific SDG target framework.

- ICAT SDG policy assessment guide (<https://climateactiontransparency.org/icat-toolbox/sustainable-development/>): Prospective methodology for assessing SDG impacts of climate change policies. Lack of specific quantifiable methods for specific aspects of sustainable development.
- SDG analysis and interlinks visualisation tool (<https://sdginterlinks.iges.jp/visualisationtool.html>): Could be used for prospective analysis, limited in assessment of climate change in terms of how SDG 13 (Climate Action) targets are defined, qualitative.
- SDG synergies tool (<https://www.sdg synergies.org/>): Could be used for prospective analyses, limited in assessment of climate change in terms of how SDG 13 (Climate Action) targets are defined, qualitative.

There are several limitations in the effectiveness of the current suite of tools and approaches available for assessing links between climate change mitigation and SDGs links in climate change planning. Firstly, many of the approaches are retrospective. This makes them useful and insightful analyses of climate mitigation commitments **after** a country submits or updates an NDC, but are not designed to be able to understand the implications of different climate change mitigation strategies that can feed into decision making processes that results in an updated NDC. Some tools are designed, or could be applied for prospective analyses that could feed in to decision making. Three of these tools are focused on broader assessments of SDGs, rather than SDG-climate mitigation links. A result of this is that these tools are limited in their climate change mitigation assessment (particularly the two qualitative tools) to how the SDG framework defines climate targets under SDG 13. Other planning frameworks, such as the ICAT Sustainable Development Policy Assessment Guide provides a framework for assessing the SDG benefits of climate change mitigation actions, but does not specify the quantitative methodologies for each SDG impact area, that could be used to quantify these effects (i.e. it is a framework within which a tool like LEAP (described below) could be applied, rather than an alternative to LEAP).

The Low Emissions Analysis Platform (LEAP) is a tool that is well suited to prospective assessments of GHG mitigation, as well as energy system planning, that has been extremely widely used as the basis for the definition of climate change mitigation targets. For Intended NDCs submitted in 2015, over 30 countries used LEAP as the basis for all, or part of the GHG mitigation assessment, and an even larger number of countries have utilised LEAP for their 2020/2021 NDC updates, as well as National Communications and Biennial Update Reports submitted to the UNFCCC. A user community of over 40,000 people utilises LEAP for an even wider range of academic, government, and commercial applications in the fields of energy and low emissions planning.

The prospective and quantitative nature of how LEAP is used already in climate change planning makes it an interesting tool to consider how prospective and quantitative consideration of SDGs within climate change planning could be achieved already within the LEAP system, and through enhancements, extensions and improvements to LEAP's functionality. Over the past 5 years, LEAP has been extended to allow assess of a broader set of impacts of emission reduction strategies, such as assessment of air pollution and health benefits.

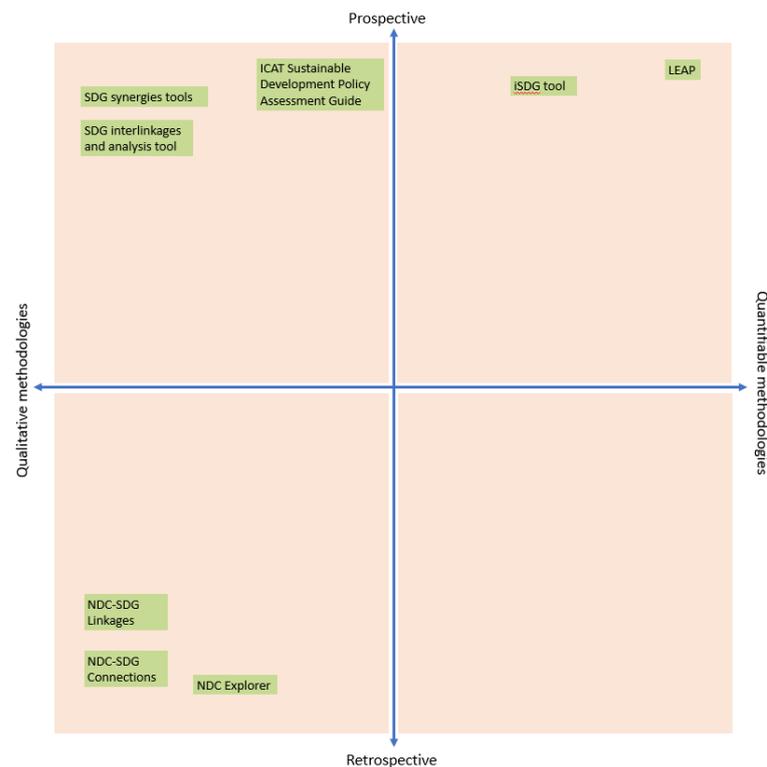


Figure 1: Summary of tools and methods for assessing climate change and SDG links located based on their quantitative-ness and suitability for prospective analysis.

There is a specific need for quantitative and prospective assessment of the links between climate change mitigation and sustainable development to support enhancement and implementation of climate change targets, as well as providing access to finance for implementation of development priorities that avoids trade-offs with climate goals. Therefore, the aim of this study is to systematically evaluate i) the ability of an existing climate change planning tool (LEAP) to quantify specific links between climate change mitigation actions and particular SDGs, and ii) to identify methodologies that could enhance the LEAP software to quantify a larger number of climate change mitigation and SDG links, and.

To do this, a database of ~180 climate change mitigation measures across all four major IPCC GHG emitting source categories (Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use, and Waste) is constructed and compared with the 200 Sustainable Development Goal targets to identify where implementation of the climate change mitigation measure could impact the achievement of a particular SDG target. Each linkage is then evaluated to identify whether it is possible to quantify, and if so whether the existing capabilities of LEAP can be used to quantify this link, and if not then what methodologies could be used to quantify this linkage. Based on the suite of methodologies identified for each climate change mitigation measure and SDG target, a comprehensive set of capabilities of the current iteration of LEAP to assess climate-SDG links, as well as a roadmap for the improvement of LEAP through the incorporation of additional methodologies for new climate-SDG links, are put forward.

2.2 Methodology

The methodology used to assess the links between climate change mitigation measures and linkage to Sustainable Development Goals is shown in Figure 2. First, the specific climate change mitigation measures and sustainable development metrics were identified that would be cross-analysed to identify those where there is a link, that could potentially be quantified.

For the Sustainable Development metrics that are used in the mapping, the SDG targets were used to identify links to climate change mitigation measures. The SDG targets are the intermediate disaggregated of the SDGs, and encompass approximately 180 specific targets. These targets are disaggregated, and more detailed targeted defined within the 17 overarching Sustainable Development Goals, and each target is further refined and assigned a specific indicator that are used to track progress on the achievement of each particular target. When assessing the link between climate change mitigation measures and SDGs, the 17 goals were considered too broad to be able to identify links that could be quantified and included in climate change planning. Conversely, the indicators defined for each target were considered too specific and potentially miss important links between climate change mitigation and development because of the specific indicator that has been defined for a particular target. Therefore, the targets were a compromise between identifying specific aspects of sustainable development that could be linked/achieved through climate change mitigation actions that avoided being too specific to exclude potential links.

In addition to the SDG targets that were included as the sustainable development metrics, an additional set of metrics were used to more comprehensively consider the health benefits that could be achieved from implementing climate change mitigation measures. Within the SDG framework, the health metrics are relatively aggregate (e.g. reducing the number of premature deaths from non-communicable diseases). Climate change mitigation measures have the potential to reduce exposure to specific human health risk factors, which are not specifically identified in the SDG framework. Therefore, the 84 risk factors included in the Global Burden of Disease project were also included as additional metrics evaluated to assess whether climate change mitigation measures could affect.

The list of climate change mitigation measures that were evaluated were extracted from global assessments of climate change mitigation, including the IPCC Assessment Reports. In total 180 mitigation measures were identified, and grouped according to the IPCC (2006) national emission inventory guidelines source categorisation, i.e. with Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Land Use and Waste categories. Mitigation measures were defined in sufficient detail that they could be linked to specific SDG targets, but not so detailed that the number became too large. For example, in the electricity generation sector, the mitigation measures were defined in terms of expanding the generation of electricity from wind, solar, tidal, geothermal etc. individually, as opposed to a single, aggregated 'expansion of renewable electricity generation' measure.

A matrix was then created of climate change mitigation measures and SDG targets. For each climate change mitigation measure-SDG target pair, a determination was made as to whether there was a specific link between implementation of the climate change mitigation measure, and achievement of the SDG target (including, where appropriate, situations in which achieving the climate change mitigation measure could actively lead to an SDG target not being achieved, or achieved to a lesser extent than if the mitigation measure was not implemented). The link between climate change mitigation measures and SDG targets were always judged from the starting point of implementing particular climate change mitigation measures, and a link was identified where the mitigation measure would have a direct impact on the SDG target.

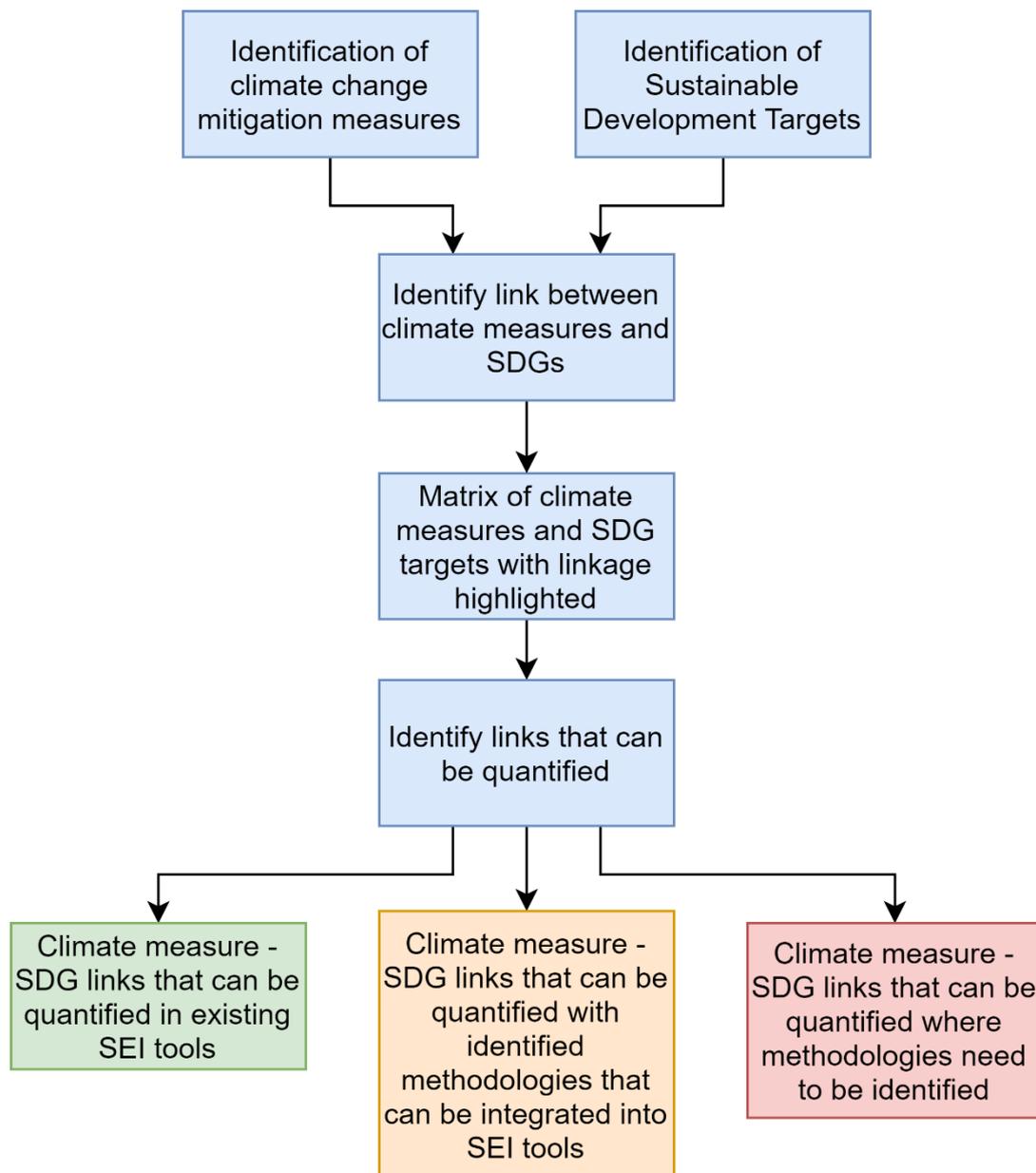


Figure 2. Overview of methodology to identify climate change mitigation measures and links to Sustainable Development Goal (SDG) targets.

Once all climate change mitigation measure-SDG target pairs had been evaluated, those where a link had been identified were collated. For each link, a qualitative description of the link was written, as well as i) whether the link could be quantified in general, ii) whether the link could be quantified within existing SEI tools, and iii) if available, what methodology could be used to quantify the link. The aim of identifying these characteristics of each link was to disaggregate the links between the implementation of climate change mitigation measures and SDG targets into three groups:

1. **Links between climate change mitigation measures and SDGs targets that can be quantified within existing SEI tools.** The LEAP Platform allows the user to build an energy system model, as well as representation of non-energy sectors to estimate GHG, Short-Lived Climate Pollutant

(SLCP) and air pollutant emissions. It also includes functionalities including cost-benefit analysis, least-cost optimisation, and air pollution health impact assessments. Therefore, within LEAP there is already functionality to allow quantification of the link between climate change mitigation actions and specific SDGs relating to energy, health etc.

2. **Links between climate change mitigation measures and SDG targets that have identified methodologies that need to be integrated within SEI tools.** A second group of links include those that cannot currently be quantified within SEI tools, but where there are clear methodologies that can be integrated into tools. This group of links provides a roadmap for the enhancement of SEI tools to cover a broader set of SDGs.
3. **Links between climate change mitigation measures and SDG targets where methodologies need to be identified to support their quantification and integration into SEI tools.** This category includes links that were identified as being possible to quantify, but where a methodology that could be integrated into SEI tools needs to be identified to allow the expansion of SEI tools to cover these links.

2.3 Results

Across all 180 climate change mitigation measures evaluated, 4200 links were identified with the Sustainable Development Goals (Summarised in Table 1). The largest number of links between climate change mitigation measures and SDGs was with SDG3, Good Health and Well-Being. There are multiple health risks that are affected by the implementation of climate change mitigation measures (e.g. diet, physical activity and water and sanitation). However, the majority of these links reflect that the implementation of climate change mitigation measures frequently also reduce emissions of air pollutants. Reducing exposure to air pollutants has a beneficial impact on human health, through reducing the incidence of cardiovascular and respiratory diseases and other causes of ill health.

The second largest number of links was for SDG 12 Sustainable Consumption and Production, which were mostly linked to mitigation measures in the agriculture, industry and waste sectors, including activities that lead to more sustainable livestock and crop production, reducing, reusing and recycling materials in the industry sector, and reducing or diverting waste from landfill sites.

Sustainable cities (SDG11) had the third largest number of links, spread across mitigation measures in a large number of sectors including industry (reducing material consumption), transport (public transport, walking and cycling), and residential (efficient appliances, cooling solution, clean cooking) sectors.

Other SDGs had a smaller number of still-significant links to climate change mitigation actions. Important links between Poverty Reduction, Hunger and actions in the agriculture sector were identified, Education and Gender Equality and action on residential cooking and life on land and agriculture and land use change (action on forestry).

The following sections categorise these links by methodology, to identify those that can currently be quantified, those where additional data is needed, and those that could be integrated into SEI tools in the future.

Table 1: Summary of links between Climate change mitigation measures grouped into IPCC source categories and SDG targets and Global Burden of Disease Risk Factors for Human Health

	Number of Measures	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17	GBD Risk Factors	Total links	Total links (ex. health)
Energy																					
Transport	32	0	0	53	0	0	0	42	33	12	0	65	62	0	0	0	0	0	120	267	214
Residential	17	24	1	267	16	5	0	22	19	9	0	51	17	0	0	0	0	0	81	431	164
Commercial and Public Services	14	2	0	246	18	0	0	16	15	12	0	28	32	0	1	0	0	0	69	370	124
Industry	46	3	9	246	0	0	40	29	94	227	0	76	148	0	5	4	0	0	519	881	635
Agriculture, Forestry and Fishing	2	0	0	174	0	0	2	2	6	0	0	3	4	0	0	0	0	0	16	191	17
Electricity Generation	9	0	1	171	0	0	0	17	26	9	0	17	18	0	0	0	0	0	100	259	88
Oil and Gas	3	0	0	147	0	0	0	5	15	0	0	4	3	0	0	0	0	0	22	174	27
Coal Mining	1	0	0	108	0	0	0	2	3	0	0	1	1	0	0	0	0	0	8	115	7
Charcoal Making	2	2	0	111	0	0	0	3	4	0	0	4	2	0	0	0	0	0	16	126	15
Agriculture	37	11	147	116	0	0	32	3	41	0	57	29	122	0	0	147	0	0	1433	705	589
Waste	11	1	3	206	0	0	26	2	52	5	0	22	49	0	1	0	0	0	100	367	161
LULUCF	7	0	2	233	0	0	7	0	9	0	5	24	21	0	0	49	0	0	57	350	117
																				4236	2158
	181	43	163	2078	34	5	107	143	317	274	62	324	479	0	7	200	0	0	2541	4236	

2.4 Climate Change mitigation – SDG links that can be quantified within LEAP currently

Of the climate change mitigation–SDG target linkages currently quantifiable using SEI tools, two incorporate specific methods for linking to SDG targets. The LEAP model, with its Integrated Benefits Calculator for quantifying the health impacts of exposure to air pollutant emissions, is already widely used in climate change mitigation planning. The second tool, Aghealth, was developed to allow integrated analysis of health, climate and air pollution impacts of diet and health.

Table 1 highlights the methodologies that can be used within the LEAP software to quantify links between specific climate change mitigation measures and SDG targets. LEAP allows the development of an energy system model, and non-energy sector emission sources. Therefore, the implementation of energy and some non-energy mitigation measures that impact energy efficiency, renewable energy SDGs can be assessed within LEAP, as can multiple health SDGs that are assessed in terms of how air pollution exposure affects the incidence of disease. Table 2 include the ability to assess the following areas of climate change mitigation and SDG links currently.

- Residential sector: Switching to more efficient and cleaner biomass stoves for heating and cooking, and links with health, and energy SDGs
- Residential sector: Increasing efficiency of appliances and link to energy and health SDGs
- Transport: Changes to vehicle standards, modal shift (e.g. shifting from private vehicles to public transport, shifting freight transport from road to rail), and vehicle fuels (e.g. electric) and energy and health SDGs
- Industry: Changes to fuels, technologies and efficiency in industry sector and energy and health SDGs
- Services: Changes to fuels, technologies and efficiency in industry sector and energy and health SDGs
- Electricity Generation: Changes to T&D losses, expansion of renewable electricity generation and energy and health SDGs
- Oil and Gas: Reduction in fugitive emissions and energy and health SDGs

Table 2 summarises the methods included in the Aghealth model that can be used to link to multiple SDGs relating to health, agriculture, rural development, and sustainable consumption and production. The Aghealth model estimate food consumption for a particular country/scenario, and models the agricultural systems that produces this food. The GHG and air pollutant emissions associated with this production are considered, as well as the health impacts associated with a particular diet. The SDG targets that can be considered in Aghealth include:

- Food demand: Changes in diet and health, and sustainable consumption and production SDGs
- Livestock: Changes in feed, genetics and animal husbandry and agriculture, and rural development SDGs
- Crops: Changes in fertiliser efficiency and agriculture, SCP SDGs
- Crops: Reducing burning of crop residues and health, agriculture and SCP SDGs

2.5 Climate change mitigation – SDG links with new methodologies to extend functionality of LEAP

Table 2 outlines the climate change mitigation measures and SDG links for which quantitative methodologies exist but which have not been included in SEI tools to date. These methods have not been included due to lack of specific user demand, due to the relatively new development of these methodologies, and well as capacity constraints within the tool development to team. Table 4 therefore provides a roadmap that can be followed to expand the range of SDGs that can be considered within SEI tools. The methodologies that need to be added to tools to quantify the links to SDGs targets include:

- Health impact assessment methods from Global Burden of Disease for air pollution and adverse pregnancy outcomes, additional dietary health risks, occupational exposure to environmental toxins (e.g. lead, asbestos)
- Health impact assessment methods from GBD for unsafe water and sanitation
- Health impact assessment methods from GBD for low physical activity, and link to walking and cycling
- Methods for quantifying avoided deaths from road traffic accidents
- Time savings from cooking using different fuels and technologies

Table 2: SDGs for which quantitative methods exist that could be integrated into SEI tools

Methodology	Relevant Mitigation Measures	SDGs that it quantifies
GBD methods for quantifying air pollution impacts on pregnancy	Measures that reduce air pollution	short gestation for birthweight Low birthweight for gestation
GBD methods for quantifying health impacts from iron deficiency	Changes in diets to low-climate impact foods	Iron deficiency
Change number of vehicle-km travelled by different vehicles changes probability of collision with other road vehicles which links to health impacts from accidents	Expand carrying capacity of HDVs Enforce regular vehicle inspection and maintenance programmes Increase walking and cycling to avoid passenger car journeys Increase journeys taken by public transport (BRT, metro) compared to passenger cars Increase freight transported by rail compared to aviation and heavy duty vehicles	3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents
Global Burden of Disease health impact assessment methodology for occupational exposure	Switch to hybrid vehicles for trucks and buses operating in urban areas	diesel engine exhaust

to diesel engine exhaust		
Modify lead content of fuel in LEAP	Implement fuel quality standards	Lead exposure
Global burden of disease health impact assessment methodology for low physical activity	Increase walking and cycling to avoid passenger car journeys	Low Physical activity
Change in passenger-km due to efficient urban planning design	Improve urban planning to reduce transport demand	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents</p> <p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with</p>

		<p>special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>Ambient Particulate matter pollution</p> <p>Ambient ozone pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p> <p>Low Physical activity</p>
<p>Change % households cooking using solid biomass</p> <p>Quantify time spent cooking and collecting fuel for each cooking</p>	<p>Increase proportion of households cooking using LPG compared to solid biomass</p> <p>Increase proportion of households cooking using electricity compared to solid biomass</p> <p>Increase proportion of households cooking using more efficient biomass stoves</p>	<p>4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes</p> <p>4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education</p>

fuel/technology using Jeuland et al. 2012 method	Increase proportion of households with access to grid electricity compared to diesel generators	4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations 5.4 Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate
GBD health impact assessment methodology for residential radon exposure	Improve thermal envelope of buildings to reduce heat/cool loss	Residential radon exposure
GBD method for health impact assessment for asbestos, formaldehyde and silica	Ensure houses are constructed for low energy use and from sustainable materials Optimise building orientation, thermal mass and shape Maximise passive features (day-lighting, heating, cooling and ventilation)	
GBD health impact assessment methodology for second hand smoke exposure	Have efficient systems to meet requirements for lighting, heating, cooling etc.) Improve thermal envelope of buildings to reduce heat/cool loss	Second hand smoke
GBD occupational health impact assessment methodology	Increase proportion of clean fuels (e.g. low carbon electricity) used in industry sector Increase energy efficiency of steam systems	Lead exposure diesel engine exhaust Occupational Exposure to nickel Occupational Exposure to sulphuric acid Occupational particulate matter, gases, and fumes

	<p>Increase energy efficiency of furnace and boiler systems</p> <p>Increase energy efficiency of electric motors (pumps, fans, air compressors, refrigerators and material handling)</p> <p>Increase energy efficiency of electronic control systems</p> <p>Reduce demand for industrial products (e.g. clothing, cars)</p> <p>Reduce material losses and waste from industry</p> <p>More intensive use of products used for longer (e.g. clothing, car sharing)</p> <p>Improve energy efficiency in iron and steel production</p> <p>Switch from coal and coke to natural gas or clean electricity</p> <p>Improve energy efficiency of cement production</p> <p>Switch from coal in cement kilns to fossil or biomass wastes</p>	<p>Occupational Noise</p> <p>Occupational injuries</p> <p>Occupational ergonomic factors</p>
--	---	--

	<p>Improve energy efficiency of chemical production processes</p> <p>Switch to natural gas based ammonia production</p> <p>Implement material efficiency strategies for plastics</p> <p>Switch from heavy fuel oil to natural gas in food processing</p>	
--	--	--

2.6 Climate change mitigation – SDG links where new methodologies should be investigated.

Table 3 outlines the climate change mitigation measures and SDG links for which quantitative methodologies have not been identified but where a quantitative link between the measure and SDG target could be made. During the literature review, quantitative methods were identified for these SDGs/impacts. However, due to the data structures and data inputs needed for the development of a LEAP/Aghealth analysis, were not directly applicable to these tools. With further work these methodologies could likely be adapted to be conformable with LEAP. The links that require identification of appropriate methodologies include:

- Reduction in air pollutant emissions and exposure to **ambient ozone pollution** (human health and crop impacts)
- **Economic** impacts of implementation of climate change mitigation measures
- Impacts of climate change mitigation measures on **jobs**
- Impact of climate change mitigation measures in industry and agriculture sectors on **water quality**
- Impact of **agricultural soil management** on agriculture, SCP SDGs
- Impact of climate change mitigation actions on **material and resource flows and efficiency**
- Impact of Forestry and Other Land Use measures on **Life on Land SDGs**
- Impact of Forestry and Other Land Use measures on **Biodiversity**
- Additional:
 - Water (water balance accounting methodology)
 - Materials accounting SDG 9 and 12

Table 3: SDGs for which quantitative methods could be developed in the future that could be integrated into SEI tools

Methodology	Relevant Mitigation Measures	SDGs that it quantifies
		Ambient ozone pollution
	Increase proportion of clean fuels (e.g. low carbon electricity) used in industry sector	8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries
	Increase energy efficiency of furnace and boiler systems	8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors
	Increase energy efficiency of electric motors (pumps, fans, air compressors, refrigerators and material handling)	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
	Increase energy efficiency of electronic control systems	9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets
	Improve energy efficiency in iron and steel production	9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities
	Switch from coal and coke to natural gas or clean electricity	Ambient ozone pollution
	Improve energy efficiency of cement production	
	Switch from coal in cement kilns to fossil or biomass wastes	
	Reduce clinker percentage in cement	
	Reduce amount of cement used in concrete	

	<p>Improve energy efficiency of chemical production processes</p> <p>Switch to natural gas based ammonia production</p> <p>Install N2O emission reduction technologies for ammonia production</p> <p>Improve energy (electricity) efficiency of aluminium production</p> <p>Improve share of electricity for aluminium production that comes from renewable sources</p> <p>Increase efficiency of cooking and drying in food processing</p> <p>Improve efficiency of refrigeration in food processing</p> <p>Improve energy efficiency of agricultural machinery (stationary and mobile)</p> <p>Improve efficiency of fishing vessels</p>	
	<p>Reduce material losses and waste from industry</p> <p>Reduce demand for steel in buildings and vehicles</p>	<p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally</p>

	<p>Reuse concrete components</p> <p>Extend lifespans of building</p> <p>Efficient urban design to reduce demand for concrete</p> <p>Increase paper recycling rates</p> <p>Increase energy efficiency of paper making process (particularly heat generation for drying paper)</p> <p>Reduce paper weight</p> <p>Reduce demand for paper</p> <p>Increase re-use of aluminium</p> <p>Reduce waste of aluminium</p> <p>Increase product lifetime</p> <p>Increase recycling rates for aluminium</p> <p>Reduce food waste in production/retail stage</p> <p>Reduce food waste by consumers</p>	<p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate</p> <p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment</p> <p>14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution</p>
--	--	---

	<p>Reduce demand for high-emitting food like meat and dairy Improve energy efficiency for textiles industry</p> <p>Reduce demand for clothing (increase product life) Improve energy efficiency of grinding process</p> <p>Increase recycling of metals Switch from fossil fuel electricity generation to renewable energy</p>	
	<p>Reduce demand for industrial products (e.g. clothing, cars)</p> <p>More intensive use of products used for longer (e.g. clothing, car sharing)</p>	<p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally</p> <p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution</p>

	Implement more efficient use of fertilisers	<p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally</p> <p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p>
	<p>Increase proportion of electricity generated from nuclear</p> <p>Increase proportion of electricity generated from wind</p> <p>Increase proportion of electricity generated from solar</p> <p>Increase proportion of electricity generated from geothermal</p> <p>Increase proportion of electricity generated from waste</p> <p>Increase proportion of electricity generated from tidal</p> <p>Increase proportion of electricity generated from hydro</p>	<p>8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value</p> <p>Ambient ozone pollution</p> <p>Occupational Exposure to arsenic</p> <p>Occupational Exposure to PAHs</p> <p>Occupational Exposure to sulphuric acid</p> <p>Occupational particulate matter, gases, and fumes</p> <p>Occupational Noise</p> <p>Occupational injuries</p> <p>Occupational ergonomic factors</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>

	Reduce transmission and distribution losses from electricity generation	<p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p>
	Increase use of carbon capture and storage on fossil fuel power stations	<p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
	<p>Eliminate gas flaring and capture the gas that would otherwise be flared and utilise it for a productive purpose (e.g. electricity generation)</p> <p>Minimise methane leakages from oil production, processing and distribution</p>	<p>8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value</p>

	<p>Minimise methane leakages from gas production and distribution</p> <p>Minimise methane emissions from coal mining through pre-mine degasification and recovery and oxidation of methane from ventilation air</p>	
	Substitute fly ash for clinker in cement production	<p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
	Phase out HFCs for low-GWP alternatives	8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental

		<p>degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
	Reduce process emissions from cement production	<p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p>

		12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
	<p>Reduce demand for livestock through increase in diets from low-GHG emitting foods</p> <p>Optimizing feed digestibility and availability for livestock animals</p> <p>Balancing and fine-tuning feed rations for herd</p> <p>Promoting better animal health</p> <p>Improving performance through breeding</p> <p>improving grazing and grassland management in grazing systems to increase feed quality and productivity</p> <p>Improving the quality and usage of crop residues as fodder</p> <p>Implement manure system to remove manure from animal housing in a minimum time after excretion</p> <p>Convert continuously flooded for rice production to alternate wetting and drying management regime</p>	<p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally</p> <p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate</p> <p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p>

		15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems
	Manure Treatment: Options to minimise methane emissions include anaerobic digesters, solids separation, aeration, and manure acidification	7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
	Manure Storage: Options to reduce methane emissions include decreasing storage time, storage cover with straw, natural or induced crust, aeration during liquid manure storage, composting, litter stacking, and storage temperature.	10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average
	Reduce demand for livestock and dairy products by switching to lower GHG diets	<p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p>

		<p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p>
	Increase efficiency of fertiliser use	<p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally</p> <p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate</p> <p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p>

		<p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p>
	<p>Conservation Agriculture (CA) methods that employ no-burn techniques, including no-till, lowtill, and strip-till</p>	<p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p>

		<p>10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies</p> <p>11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p>
--	--	---

		<p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p>
	Incorporation of biomass into soil	<p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p>

		<p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p> <p>10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies</p> <p>11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
--	--	---

		<p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p>
	<p>Use of biomass for pellet and/or briquette production</p> <p>Use of biomass for construction materials</p> <p>Use of biomass for bedding and fodder for livestock</p> <p>Use of biomass in biogas, second generation biofuels (cellulosic ethanol), boilers, cookstoves, heating; note: must be clean and efficient for use in household</p>	<p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p>

		<p>11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
	<p>Croplands—plant management C: High input carbon practices, e.g., improved crop varieties, crop rotation, use of cover crops, perennial cropping systems, agricultural biotechnology. 15, 16, 17 N2O: Improved N use efficiency.</p>	<p>1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters</p> <p>2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round</p>

	<p>Croplands—nutrient management C: Fertilizer input to increase yields and residue inputs (especially important in low-yielding agriculture). 19, 20 N2O: Changing N fertilizer application rate, fertilizer type, timing, precision application, inhibitors. 21, 22, 23, 24, 25, 105, 106</p> <p>Croplands—nutrient management C: Fertilizer input to increase yields and residue inputs (especially important in low-yielding agriculture). 19, 20 N2O: Changing N fertilizer application rate, fertilizer type, timing, precision application, inhibitors. 21, 22, 23, 24, 25, 105, 106</p> <p>Croplands—tillage/residues management C: Reduced tillage intensity; residue retention. 17, 24, 26, 27 N2O: 28, 96, 97 CH4: 96</p> <p>Croplands—water management C: Improved water availability in cropland including water harvesting and application. 29 CH4: Decomposition of plant residues. N2O: Drainage management to reduce emissions, reduce N runoff leaching</p> <p>Croplands—rice management C: Straw retention. 30</p>	<p>2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons</p> <p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p>
--	---	--

	<p>CH4: Water management, mid-season paddy drainage. 31, 32, 98 N2O: Water management, N fertilizer application rate, fertilizer type, timing, precision application. 32, 98, 99</p> <p>Rewet peatlands drained for agriculture C: Ongoing CO2 emissions from reduced drainage (but CH4 emissions may increase). 33</p> <p>Croplands—set-aside and LUC C: Replanting to native grasses and trees. Increase C sequestration. 34, 35, 36, 37, 38 N2O: N inputs decreased resulting in reduced N2O.</p> <p>Biochar application C: Soil amendment to increase biomass productivity, and sequester C (biochar was not covered in AR4 so is described in Box 11.3). 39, 40, 41 N2O: Reduced N inputs will reduce emissions.</p> <p>Grazing lands—plant management C: Improved grass varieties/sward composition, e.g., deep rooting grasses,</p>	<p>10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p>
--	---	---

	<p>increased productivity, and nutrient management. Appropriate stocking densities, carrying capacity, fodder banks, and improved grazing management. 43, 44, 45 N2O 46</p> <p>"Grazing lands—animal management C: Appropriate stocking densities, carrying capacity management, fodder banks and improved grazing management, fodder production, and fodder diversification. 43, 47 CH4 N2O: Stocking density, animal waste management. "</p> <p>"Grazing land—fire management C: Improved use of fire for sustainable grassland management. Fire prevention and improved prescribed burning. "</p> <p>Revegetation C: The establishment of vegetation that does not meet the definitions</p>	
--	--	--

	<p>of afforestation and reforestation (e.g., <i>Atriplex</i> spp.). 48</p> <p>CH4: Increased grazing by ruminants may increase net emissions.</p> <p>N2O: Reduced N inputs will reduce emissions.</p> <p>Organic soils—restoration C: Soil carbon restoration on peatlands; and avoided net soil carbon emissions using improved land management. 49 CH4: May increase.</p> <p>Degraded soils—restoration Land reclamation (afforestation, soil fertility management, water conservation soil nutrients enhancement, improved fallow). 100, 101, 102, 103, 104</p> <p>Biosolid applications C: Use of animal manures and other biosolids for improved management of nitrogen; integrated livestock agriculture techniques.</p>	
	<p>Capturing methane from wastewater treatment plants and using it to generate biogas</p> <p>Establish and enforce best practises implemented to capture methane from industrial wastewater</p>	<p>6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations</p> <p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally</p> <p>6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity</p>

		<p>6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and</p>
--	--	--

		<p>develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Unsafe Water Source Unsafe Sanitation No Access to Handwashing Facility</p>
	<p>Control forest and peatland fires by reducing agricultural expansion into forested lands through avoid unintended fires in forested and peatland areas through fuel management and ignition management techniques, and banning of agricultural residue burning</p> <p>Increase carbon sequestration in soils</p> <p>Increase afforestation/ reforestation: Improved biomass stocks by planting trees on non-forested agricultural lands. This can include either monocultures or mixed species plantings. These activities may also provide a range of other social, economic, and environmental benefits</p> <p>Forest Management: Management of forests for sustainable timber production including</p>	<p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage</p> <p>11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross</p>

	<p>extending rotation cycles, reducing damage to remaining trees, reducing logging waste, implementing soil conservation practices, fertilization, and using wood in a more efficient way, sustainable extortion of wood energy</p> <p>Reducing deforestation and forest degradation: Conservation of existing C pools in forest vegetation and soil by controlling deforestation protecting forest in reserves, and controlling other anthropogenic disturbances such as fire and pest outbreaks. Reducing slash and burn agriculture, reducing forest fires. Protection of peatland forest, reduction of wildfires.</p> <p>"Forest Restoration: Protecting secondary forests and other degraded forests whose biomass and soil C densities are less than their maximum value and allowing them to sequester C by natural or artificial regeneration, rehabilitation of degraded lands, long-term fallows"</p>	<p>domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p>
--	---	--

		<p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p> <p>15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage</p> <p>11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and</p>
--	--	---

		<p>develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements</p> <p>15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally</p> <p>15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species</p> <p>15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species</p> <p>15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts</p> <p>15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems</p> <p>15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation</p>
--	--	--

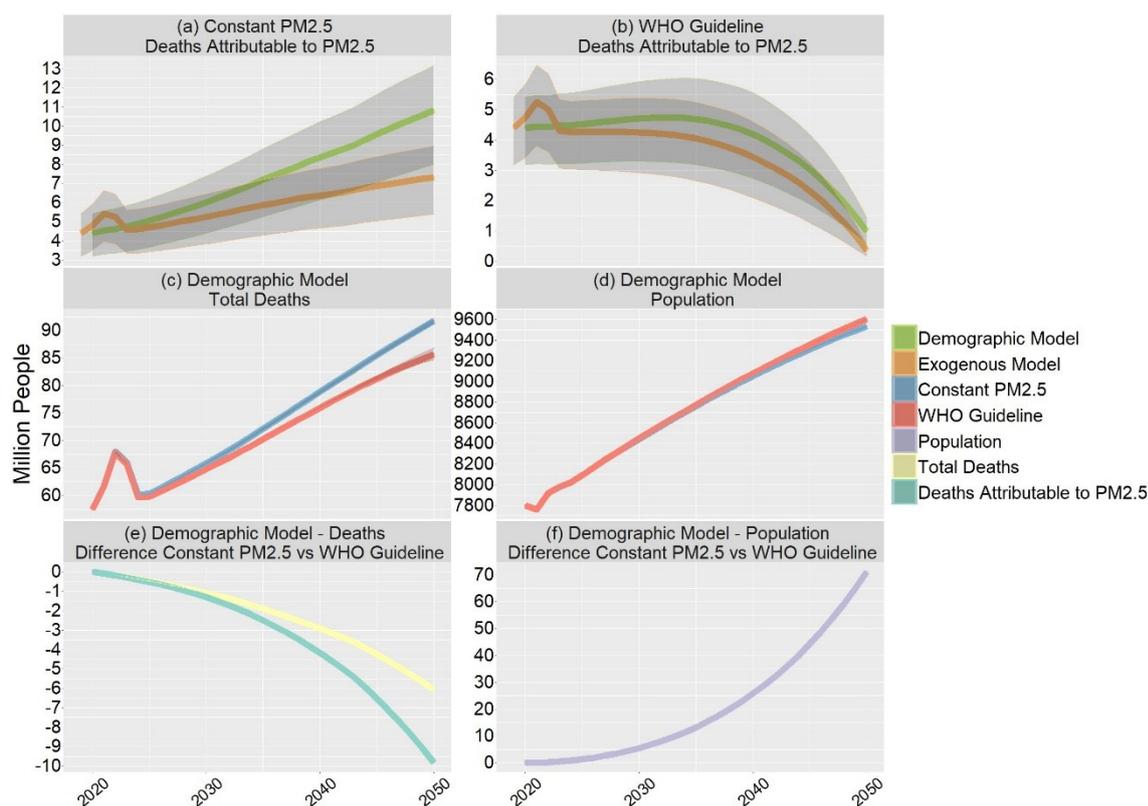
3. IMPROVING CONSISTENCY OF QUANTIFYING FUTURE AIR POLLUTION HEALTH BURDENS FOR ASSESSING BENEFITS OF MITIGATION ACTIONS

Deliverable 7.2 has resulted in two peer-reviewed papers that identify limitations with current tools for quantifying future air pollution health burdens and describe a demographic model that overcomes them.

3.1 Paper 1

Malley, C.S., Anenberg, S.C., Shindell, D.T., Improving consistency in estimating future health burdens from environmental risk factors: Case study for ambient air pollution. 2024. Environmental International. Volume 185 Article 108560. <https://doi.org/10.1016/j.envint.2024.108560>

Summary: Future changes in exposure to risk factors should impact mortality rates and population. However, studies use mortality rates and population projections developed exogenously to the health impact assessment model used to quantify future health burdens attributable to environmental risks that are therefore invariant to projected exposure levels. This impacts the robustness of many future health burden estimates for environmental risk factors. This work describes an alternative methodology that more consistently represents the interaction between risk factor exposure, population and mortality rates, using ambient particulate air pollution (PM_{2.5}) as a case study. A demographic model is described that estimates future population based on projected births, mortality and migration. Mortality rates are disaggregated between the fraction due to PM_{2.5} exposure and other factors for a historic year, and projected independently. Accounting for feedbacks between future risk factor exposure and population and mortality rates can greatly affect estimated future attributable health burdens. The demographic model estimates much larger PM_{2.5}-attributable health burdens with constant 2019 PM_{2.5} (~10.8 million deaths in 2050) compared to a model using exogenous population and mortality rate projections (~7.3 million), largely due to differences in mortality rate projection methods. Demographic model-projected PM_{2.5}-attributable mortality can accumulate substantially over time. For example, ~71 million more people are estimated to be alive in 2050 when WHO guidelines (5 µg m⁻³) are achieved compared to constant 2019 PM_{2.5} concentrations. Accounting for feedbacks is more important in applications with relatively high future PM_{2.5} concentrations, and relatively large changes in non-PM_{2.5} mortality rates.



Summary Figure: Global demographic statistics (millions of people) between 2020 and 2050 output from the demographic model for scenarios in which fine particulate matter (PM_{2.5}) exposure is kept constant at 2019 levels (Constant PM_{2.5}), and is decreased to meet World Health Organisation Guidelines (5 µg m⁻³) by 2050 (WHO Guideline). Statistics include PM_{2.5}-attributable deaths for a) Constant PM_{2.5} and b) WHO Guideline scenarios estimated using the demographic model and traditional model, estimated total global c) deaths and d) population in each year for Constant PM_{2.5} and WHO Guideline scenarios, and the difference in estimated global e) deaths (PM_{2.5}-attributable deaths and total deaths) and f) population in each year for the Constant PM_{2.5} and WHO Guideline scenarios. The pulse in total deaths in panel c results from the COVID-19 pandemic and is echoed in panels a and b when using exogenous mortality rates.

3.2 Paper 2

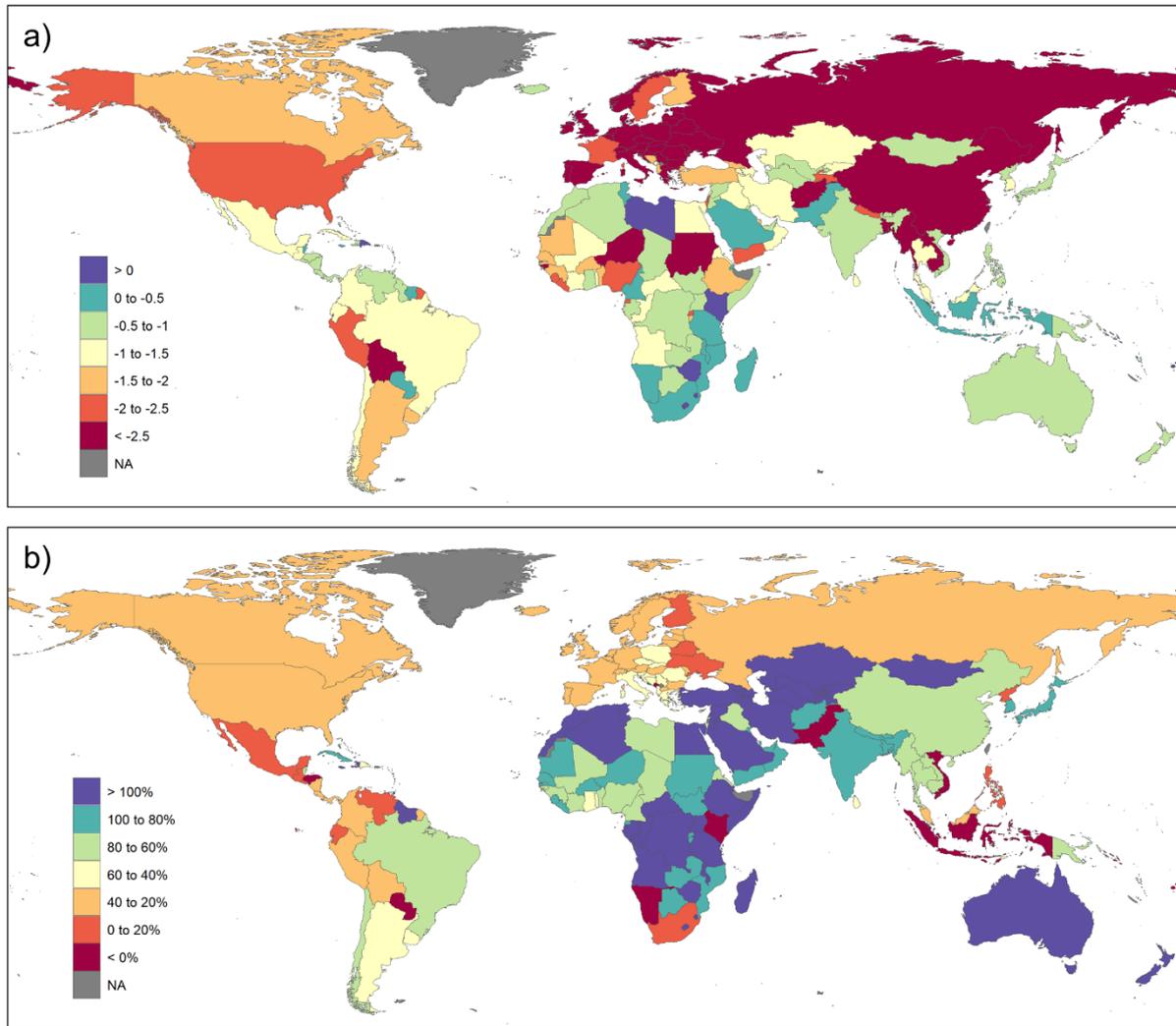
Malley, C.S., Shindell, D.T., Reduced vulnerability to air pollution avoided millions of premature deaths between 1990 and 2019. 2025. *Lancet Planetary Health* (under review).

Summary: Efforts to reduce air pollution's attributable health burden overwhelmingly focus on reducing pollutant exposure. However, changes in the vulnerability of populations to fine particulate matter (PM_{2.5}) exposure can also impact PM_{2.5}-attributable mortality rates. This contribution has been less studied. Epidemiological studies demonstrate that factors other than air pollutant exposure can impact the magnitude of air pollution health burdens. Searching the Scopus database identified that factors such as health care provision, underlying medical conditions, socioeconomic status etc. can impact the magnitude of air pollution health burdens for a given level of exposure. Previous health burden assessments identify vulnerability as a key driver of changes in global PM_{2.5} health burdens, but used older estimates of mortality rates and did not include large reductions in PM_{2.5} exposures that have occurred in several countries with

large populations during the last decade. Implications for future PM_{2.5} health burden and health burden assessments also were not considered.

We disaggregate 1990-2019 trends in PM_{2.5}-attributable mortality rates between the contribution from changes in PM_{2.5} exposure and vulnerability. PM_{2.5}-attributable mortality rates are quantified using first a standard health burden model that accounts for changes in PM_{2.5} exposure and vulnerability, and then separately using a demographic model accounting only for the impact of PM_{2.5} exposure changes. Differences between modelled PM_{2.5}-attributable mortality rates quantifies the impact of changes in vulnerability to PM_{2.5} mortality rate trends. Between 1990 and 2019, global average PM_{2.5}-attributable mortality rates decreased by ~45%. Approximately 48% of the decrease resulted from changes in PM_{2.5} exposure, and over half was due to reductions in vulnerability to PM_{2.5}. Without the reductions in vulnerability, 1.7 million additional PM_{2.5}-attributable deaths would have occurred in 2019. Globally, the sensitivity of PM_{2.5}-attributable mortality rates to vulnerability changes was, on average, that a 7% reduction in non-PM_{2.5} non-communicable disease mortality rates was associated with a 1% reduction in PM_{2.5}-attributable mortality rates.

Given the major contribution reductions in vulnerability to air pollution have made to reducing PM_{2.5}-attributable mortality rates over the past three decades, identifying actions to reduce non-communicable diseases could contribute to reducing future air pollution health burdens. Strategies to reduce health effects of air pollution typically focus on reducing PM_{2.5} exposure. As a result of larger reductions in vulnerability to air pollution, some regions (e.g. Europe) have achieved substantially greater reductions in PM_{2.5} mortality rates compared to others (e.g. North America) despite similar reduction in air pollutant exposure over the last thirty years. Air quality strategies could benefit substantially from considering interventions which reduce non-PM_{2.5} mortality rates, as a complement to exposure reductions.



Summary Figure: a) Change in PM_{2.5}-attributable mortality rate between 1990 and 2019 (deaths per 100,000 per year), and b) percentage contribution of changes in vulnerability to PM_{2.5} to 1990-2019 PM_{2.5}-attributable mortality rate trends.

4. ECONOMIC ASSESSMENT OF METHANE MITIGATION IN FOSSIL FUEL PRODUCTION

4.1 Methane mitigation background

The urgency of climate change mitigation has driven global efforts to reduce greenhouse gas (GHG) emissions, with particular emphasis on carbon dioxide (CO₂). However, non-CO₂ GHGs, particularly methane (CH₄), play a critical role in global warming due to their high radiative forcing potential and shorter atmospheric lifetime. Methane accounts for approximately 30% of the observed warming since the pre-industrial era, primarily from anthropogenic sources such as fossil fuel extraction, agriculture, and waste management (Masson-Delmotte et al., 2021). Unlike CO₂, which persists in the atmosphere for centuries, methane degrades through photochemical reactions within a decade, making its mitigation an effective near-term strategy for slowing global warming. Recognizing this, over 150 countries, led by the United States and the European Union, have committed to the Global Methane Pledge, aiming to reduce their national methane emissions by 30% by 2030.

Despite the apparent economic and environmental benefits of methane mitigation, financial and market uncertainties continue to impede large-scale investment in abatement measures. Methane is a valuable energy commodity, and reducing emissions from fossil fuel infrastructure can generate direct financial returns. Additionally, methane mitigation measures provide co-benefits, such as improved air quality, enhanced agricultural yields, and reduced public health costs (Lecocq et al., 2023). However, estimating the net cost of methane mitigation remains complex due to uncertainties in cost-benefit calculations, technological learning curves, and energy price fluctuations, which directly impact the expected return on investment for mitigation measures (United States Environmental Protection Agency, 2019; Höglund-Isaksson et al., 2020).

A central challenge in methane mitigation investment lies in the financial structure governing climate action. Basic financial principles dictate that the availability and cost of capital are directly tied to risk and expected returns. The longer the expected return period, the higher the risk and the lower the capital availability (Kreibiehl et al., 2021). Since methane mitigation projects depend on energy markets, fluctuations in natural gas prices introduce uncertainty into the financial viability of abatement strategies. Decision-makers should consider these price dynamics in their investment decisions and in designing incentive programs. This study directly addresses this gap by modeling energy price volatility and its impact on methane mitigation investment decisions, rather than relying on static projections.

This research applies the real-option approach to estimate the effect of changing energy prices on the financial co-benefits of methane mitigation. Marginal Abatement Cost (MAC) curves are commonly used to assess the financial desirability of investing in different mitigation measures, incorporating both costs and monetized benefits. However, MACs are typically constructed using static cost assumptions. By treating uncertainty in one of the key drivers of monetized benefits—the revenue from recovered gas—this study examines how energy price volatility may alter MAC estimates or reveal factors not fully accounted for in existing MACs. The real-option approach complements MAC analysis by framing investment decisions under uncertainty, highlighting cases where delaying or accelerating investments may be financially justified. We employ a stochastic model to represent the uncertainty in natural gas prices—the primary asset influencing the net cost of methane mitigation measures. The model generates a range of expected future gas prices, allowing for probability assignment to two distinct price ranges. The parameters for this process, such

as volatility and drift, are extracted from publicly available energy price datasets rather than estimated independently. These probabilities are then used to apply real-option theory, enabling an analysis of how energy price fluctuations influence the financial rationale for delaying or advancing methane mitigation investments.

In the real option theory, investment decisions are based on the probability that the price of an underlying asset will increase or decrease in the near future relative to the current, known price. By modeling investment decisions under energy market uncertainty, this study aims to assess the economic feasibility of abatement measures in varying price environments. Furthermore, it contributes to the broader literature by demonstrating the application of real-option theory to climate policy evaluation, improving our understanding of how financial risks and market fluctuations influence climate-related investments (Dixit & Pindyck, 1994; Liu et al., 2022).

The findings of this research will provide valuable insights for policymakers, investors, and energy sector stakeholders, offering evidence-based recommendations for enhancing financial mechanisms to support methane mitigation. The analysis refines MAC estimates and evaluates policy mechanisms that could enhance investment certainty, providing a clearer understanding of how energy price fluctuations influence methane mitigation strategies. Specifically, it explores how variations in energy prices affect the cost-effectiveness of methane abatement measures and the willingness of decision-makers to commit to mitigation strategies. By bridging the gap between economic theory and policy implementation, this study aims to facilitate more effective climate action in line with global methane reduction commitments.

4.2 Methods

Study Design and Objective

This study applies a real-option approach to assess the financial feasibility of methane mitigation investments under energy price uncertainty. The analysis integrates stochastic modeling of energy prices with marginal abatement cost (MAC) curves to evaluate the option value of delaying investments. The objective is to determine how fluctuations in natural gas prices influence the decision-making process regarding methane mitigation in the energy sector, particularly where cost-effective opportunities appear to be postponed.

Data Sources and Processing

This analysis is based on methane mitigation data from the U.S. Environmental Protection Agency (EPA). The dataset provides estimates of methane emissions, abatement costs, and net cost calculations based on projected energy prices. While other sources such as the International Energy Agency (IEA) and the International Institute for Applied Systems Analysis (IIASA) contain relevant methane mitigation data, only the U.S. EPA dataset is used in this study due to data availability limitations.

The dataset includes:

- Abatement potential for various mitigation technologies.
- Mitigation costs incorporating capital, operational, and revenue from recovered methane.
- Energy price projections used by the EPA, obtained directly from the agency.

For stochastic modeling, historical natural gas price data was extracted from publicly available sources. These data were used to estimate the parameters governing the price evolution process and to simulate a range of future energy price outcomes.

Stochastic Modeling of Energy Prices

Energy price uncertainty is modeled using a Geometric Brownian Motion (GBM) process, also known as a random walk with drift. This approach captures the continuous, stochastic nature of market-driven price evolution.

Model implementation:

- Historical monthly price data were used to extract drift and volatility parameters.
- Simulations were conducted using 100 runs for time horizons of 14 and 39 years.
- The simulation output was validated against actual 2023 prices, confirming that the forecast distribution (lognormal) captured observed values within the 95% confidence interval.
- For each country and time horizon, the upper and lower 95% confidence interval bounds were used to estimate the range of expected future prices.

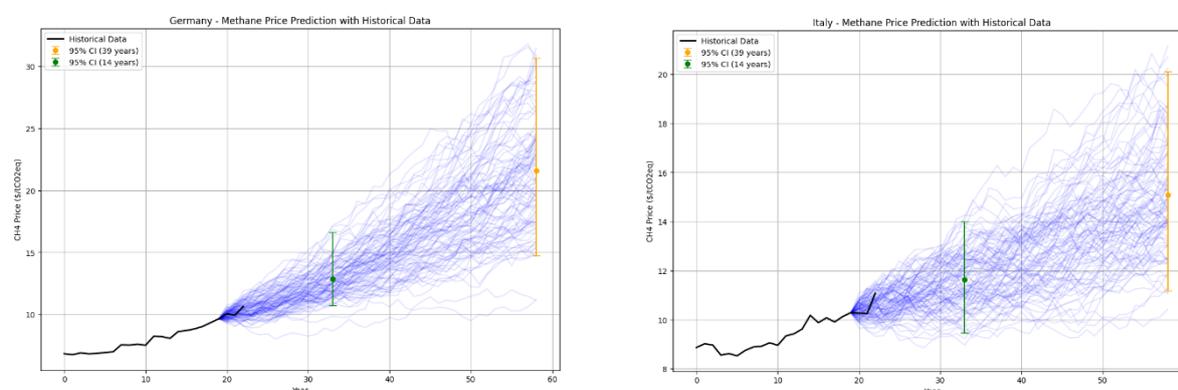


Figure 3: Forecast distribution of natural gas price for 2030 and 2050 for exemplary EU countries.

These bounds were then used to reconstruct the MAC curves, enabling comparison of the EPA's original MAC (based on EPA energy price assumptions) with MACs under more realistic price scenarios derived from GBM. Separate reconstructions were performed for 2030 and 2050.

Real-Option Analysis: Investment Timing under Uncertainty

Real-option analysis is used to evaluate whether delaying methane mitigation investments can be rationalized under energy price uncertainty. The investment decision is modeled discretely on an annual basis.

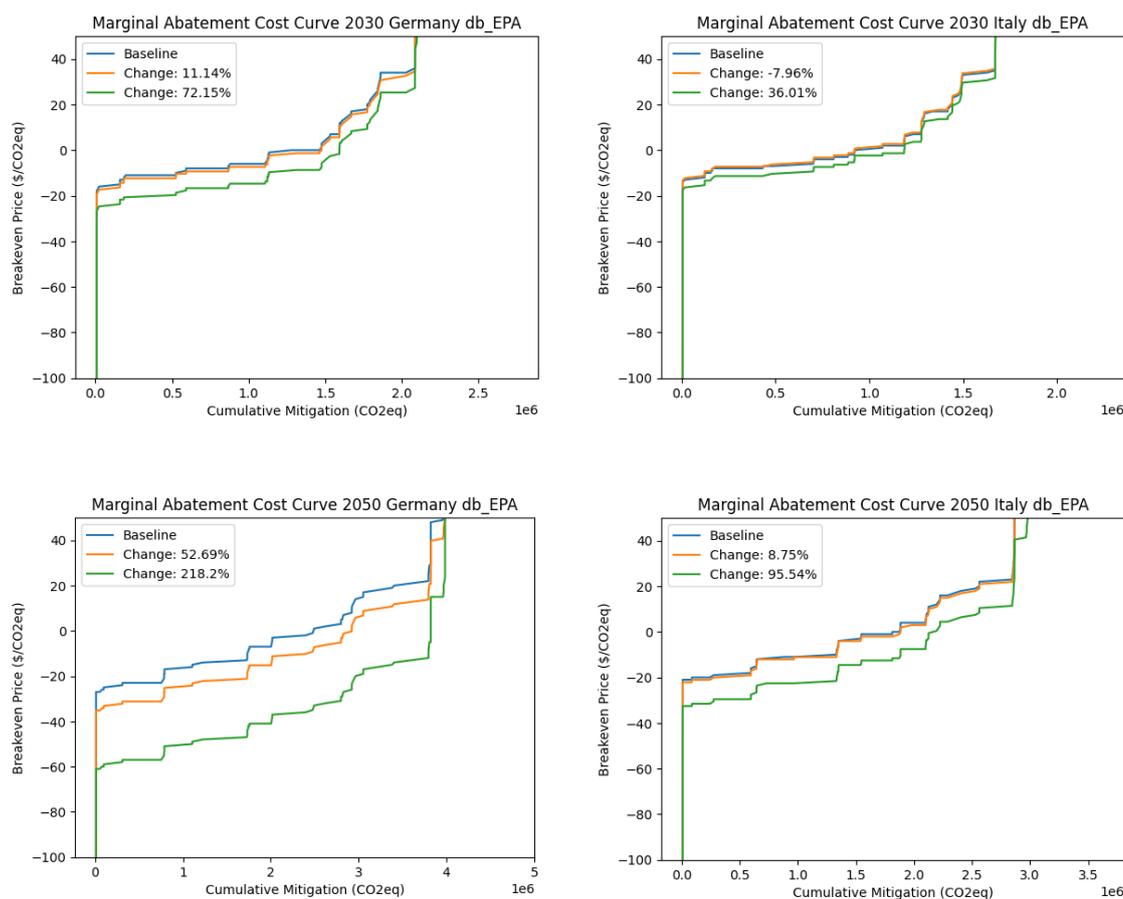


Figure 4: MACCs for 2030 and 2050 for exemplary EU countries based on US EPA data (Baseline) and GBM results 95% CI

Investment Decision Structure:

- At $t = 0$ (the present), the decision-maker observes the current energy price and the potential future price and their probabilities, to evaluate the present value of an investment for the target year (B_0). If the net present value is greater than zero, a rational decision-maker would execute on the investment option. Otherwise, it is preferred to wait for the future and gain additional knowledge of price evolution to decide on investment.
- At $t = 1$, if at $t = 0$ the NVP decision rule led to postponing the investment, the energy price evolves according to the stochastic process, and the investment is executed only if its expected future value exceeds the immediate payoff.
- If prices remain uncertain, the process is repeated.
- For this study, the initial energy price (2019) serves as the reference point, with two future energy price scenarios, both are an increase from the 2019 energy price due to the drift motion characterizing the energy price dynamics. The low price threshold chosen is 1.5 times the 2019 energy price and the high price threshold chosen is 3 times the 2019 energy price.

- The probabilities of energy prices exceeding these reference points are estimated empirically using the simulated distributions.

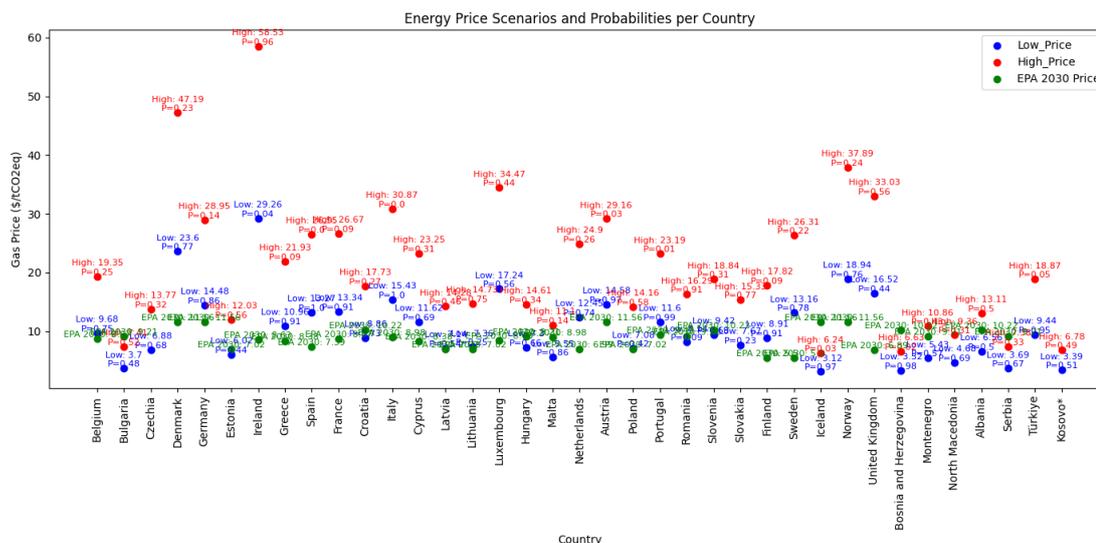


Figure 5: Scatter plot of energy prices and probability thresholds for each country.

To calculate the option value of waiting, we estimate the expected net present value of delaying the investment using two discrete future price scenarios ($1.5\times$ and $3\times$ the 2019 energy price), each weighted by its probability based on the empirical cumulative distribution function (ECDF) of the GBM simulation. The option value is then the difference between this expected NPV and the NPV of immediate investment under the baseline price (B_0).

- B_0 : Potential benefit of investment under the EPA's baseline energy price assumptions.
- B_1^h, B_1^l : Future benefit values under the high and low price scenarios ($3\times$ and $1.5\times$ the 2019 price, respectively), calculated by adjusting the revenue component of the abatement cost accordingly.
- p^h, p^l : Probabilities assigned to each scenario are extracted from the ECDF constructed from 100 GBM-simulated price paths. For each country, the probability of reaching or exceeding the high-price threshold and the probability of falling below the low-price threshold are used to assign weights to B_1^h and B_1^l , respectively. These weighted values are then used to calculate the expected NPV of future investment.

4.3 Results: Incorporating Real Option Value into Methane Abatement Cost Curves

This section presents the results of applying the real-option framework to methane mitigation investments across EU countries in the energy sector. For each country, a MAC curve was reconstructed using EPA data and energy price assumptions, then adjusted to reflect the real option value (ROV) of waiting under uncertainty.

Rather than modeling future uncertainty with separate upper and lower scenarios, the ROV was integrated directly into the breakeven cost per unit of abatement. This approach produces a single adjusted MAC curve for each country, capturing the added value—or risk adjustment—associated with delaying investment under uncertain future energy prices.

Across countries, the resulting ROV-adjusted MAC curves exhibit a consistent pattern: they lie above the baseline MAC curves derived from static energy price assumptions. This divergence is most pronounced in the higher-cost segments of the curves, where the flexibility to delay investment provides greater financial value. In contrast, mitigation measures that are already cost-effective under baseline prices show smaller adjustments, reflecting limited gains from waiting.

These shifts result in steeper MAC curves overall, suggesting that conventional approaches may systematically underestimate the true cost of mitigation when investment timing flexibility is considered. This pattern holds across the EU countries analyzed, indicating that the effects of price uncertainty are not country-specific but structural.

The general pattern described above is illustrated in Figure 6, which presents the baseline and ROV-adjusted MAC curves for two example countries in the dataset (Germany and Italy, 2030).

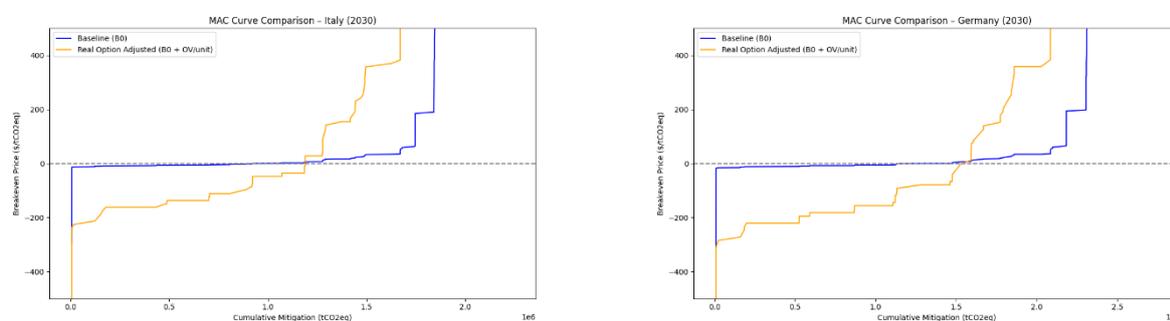


Figure 6: Baseline and ROV-adjusted marginal abatement cost (MAC) curves for Germany and Italy (2030).

4.4 Discussion

This analysis applies a real-option perspective to methane mitigation cost curves, revealing how uncertainty in future energy prices can affect the financial attractiveness of investment. Across all EU countries analyzed, incorporating the option value of waiting into marginal abatement cost (MAC) curves produced a consistent steepening effect. The ROV-adjusted curves show higher breakeven prices for many measures, particularly those with higher baseline costs, indicating that delay under uncertainty may be economically rational—especially for costlier projects.

Findings are based on preliminary results from the 2030 scenario using EPA data. While they offer early insights into the financial logic behind deferred investment, further analysis—including 2050 projections and alternative datasets—is planned to test the robustness and generality of these patterns.

The framework presented here helps interpret the widely observed gap between the availability of cost-effective methane mitigation technologies and their limited real-world deployment. While this study does not directly observe investment behavior, the steepening of the MAC curves suggests that uncertainty itself could be a significant barrier to adoption. Traditional MACs assume deterministic inputs and immediate decision-making, whereas the real-option approach accounts for the value of deferring investment in the face of unknown future conditions. In this light, a portion of the delay or hesitation seen in practice may not be due to inefficiency, but rather to the rational valuation of flexibility.

The magnitude of the option value varies across mitigation measures, even within the same country and price scenario. This heterogeneity likely reflects differences in investment characteristics, including project duration, technological maturity, capital intensity, and exposure to price volatility. Moreover, institutional and market conditions differ across countries, further shaping perceived risk and the value of delay. Future work will aim to explore these dimensions more systematically and assess whether these characteristics explain the observed variation in option value adjustments.

These preliminary results also raise early considerations for policy design. Measures that are already profitable under static assumptions—those with negative total costs—are further supported by energy price uncertainty, suggesting that regulatory efforts might focus more intensively on enabling their rapid adoption. In contrast, higher-cost measures benefit disproportionately from the option to delay, and their implementation may require more targeted support. For these segments, incentive structures that reduce uncertainty or create predictable price signals—such as price floors, contracts-for-difference, or long-term purchase agreements—could be especially effective. Overall, the influence of energy price uncertainty on investment execution should be explicitly accounted for in cost-effectiveness assessments and policy prioritization frameworks.

REFERENCES

- Dixit, A. K., & Pindyck, R. S. (1994). *Investment under uncertainty* (Reprinted). Princeton Univ. Press.
- Höglund-Isaksson, L., Gómez-Sanabria, A., Klimont, Z., Rafaj, P., & Schöpp, W. (2020). Technical potentials and costs for reducing global anthropogenic methane emissions in the 2050 timeframe –results from the GAINS model. *Environmental Research Communications*, 2(2), 025004. <https://doi.org/10.1088/2515-7620/ab7457>
- Kreibiehl, S., Yong Jung, T., Battiston, S., Carvajal, P. E., Clapp, C., Dasgupta, D., Nokuthula, D., Jachnik, R., Morita, K., Samargandi, N., & Williams, M. (2021). *WG III contribution to the Sixth Assessment Report- Chapter 15: Investment and Finance*. https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_Chapter15.pdf
- Lecocq, F., H., W., J.P., D., S., F., J.S., G., S., K., V., K., H., L., T., M., R., M., J., P.-P., B.K., S., M.V., V., & N., Z. (2023). Mitigation and development pathways in the near- to mid-term Supplementary Material. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In *Climate Change 2022—Mitigation of Climate Change* (pp. 409–502). Cambridge University Press. <https://doi.org/10.1017/9781009157926.006>
- Liu, J., Zhang, Q., Li, H., Chen, S., & Teng, F. (2022). Investment decision on carbon capture and utilization (CCU) technologies—A real option model based on technology learning effect. *Applied Energy*, 322, 119514. <https://doi.org/10.1016/j.apenergy.2022.119514>
- Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S., Péan, C., Berger, S., & et al. (Eds.). (2021, Forthcoming). *Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- United States Environmental Protection Agency. (2019). *Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation Potential: 2015-2050* (EPA 430-R-19-010). United States Environment Protection Agency, Washington, DC, US. https://www.epa.gov/sites/default/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf

APPENDIX 1**Table A1: Methods that can be used within LEAP and Integrated Benefits Calculator to quantify SDG linkages**

Methodology	Tool	Relevant Mitigation Measures	SDGs that it quantifies
Change % efficiency of charcoal kilns	LEAP	Increase proportion of charcoal generated using efficient charcoal kilns	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p>

			short gestation for birthweight
Change % gas flared and quantify economic benefit of available gas	LEAP	Eliminate gas flaring and capture the gas that would otherwise be flared and utilise it for a productive purpose (e.g. electricity generation)	<p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p>

			<p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change % households cooking using solid biomass</p> <p>Change % households cooking using solid biomass</p> <p>LEAP-IBC ambient air pollution health impact assessment method</p>	LEAP	<p>Increase proportion of households cooking using LPG compared to solid biomass</p> <p>Increase proportion of households cooking using electricity compared to solid biomass</p> <p>Increase proportion of households cooking using more efficient biomass stoves</p>	<p>Goal 1. End poverty in all its forms everywhere</p> <p>1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day</p> <p>1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p>

			<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>household air pollution from solid fuels</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change % households lighting using kerosene</p> <p>LEAP-IBC ambient air pollution health impact assessment method</p> <p>LEAP household air pollution health impact</p>	LEAP	<p>Increase proportion of households lighting using electricity compared to kerosene</p>	<p>Goal 1. End poverty in all its forms everywhere</p> <p>1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day</p> <p>1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p>

assessment method (HAPIT)			<p>11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution household air pollution from solid fuels Low birthweight for gestation short gestation for birthweight</p>
Change % of households cooking using different fuels	LEAP	Reduce demand for charcoal by switching to cleaner fuels	<p>Goal 1. End poverty in all its forms everywhere</p> <p>1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day</p> <p>1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p>

			<p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change % of households using diesel generators</p> <p>Change number of hours diesel generators used</p>	LEAP	<p>Increase proportion of households with access to grid electricity compared to diesel generators</p>	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year</p>

Change capacity of power stations to supply grid electricity			<p>Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change % of schools cooking using solid biomass	LEAP	<p>Increase number of schools cooking using clean fuels</p> <p>Increase number of restaurants cooking using clean fuels</p>	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p>

LEAP-IBC ambient air pollution health impact assessment			<p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change % of vehicles meeting different vehicle emission standards	LEAP	Implement vehicle emission standards Enforce regular vehicle inspection and maintenance programmes	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p>

LEAP-IBC ambient air pollution health impact assessment methodology			<p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change % of vehicles using CNG	LEAP	Switch from gasoline and diesel to CNG/LNG	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year</p>

			<p>Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>Ambient Particulate matter pollution</p>
--	--	--	---

			Low birthweight for gestation short gestation for birthweight
Change % of vehicles using electricity	LEAP	<p>Increase proportion of battery electric vehicles in LDV fleet</p> <p>Increase proportion of plug in electric hybrid vehicles in LDV fleet</p> <p>Increase electrification of LCVs (vans, garbage trucks)</p> <p>Increase electrification of urban bus fleet (battery, overhead wires)</p> <p>Increase switching from fossil fuels to electric vehicles</p>	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p>

			<p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
Change % of vehicles using hydrogen	LEAP	Increase proportion of hydrogen fuel cell vehicles	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year</p>

			<p>Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
Change % T&L losses from electricity generation	LEAP	Reduce transmission and distribution losses from electricity generation	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services</p>

			<p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change activity data for production</p> <p>Change waste generation rate</p>	LEAP	<p>Reduce material losses and waste from industry</p> <p>Reduce demand for industrial products (e.g. clothing, cars)</p> <p>More intensive use of products used for longer (e.g. clothing, car sharing)</p>	<p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities</p>

	<p>Reduce demand for steel in buildings and vehicles</p> <p>Reuse concrete components</p> <p>Extend lifespans of building</p> <p>Efficient urban design to reduce demand for concrete</p> <p>Implement more efficient use of fertilisers</p> <p>Increase paper recycling rates</p> <p>Reduce paper weight</p> <p>Reduce demand for paper</p> <p>Increase re-use of aluminium</p> <p>Reduce waste of aluminium</p> <p>Increase product lifetime</p> <p>Increase recycling rates for aluminum</p> <p>Reduce demand for clothing (increase product life)</p>	<p>9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending</p> <p>9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States</p> <p>9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
--	---	--

		Increase recycling of metals	
Change clinker content of cement	LEAP	Reduce clinker percentage in cement	8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead
Change EF from cement production for PM		Substitute fly ash for clinker in cement production	9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
		Reduce process emissions from cement production	9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries 9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities 9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending 9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States 9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate

			<p>change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change electricity generation module to reflect increase capacity of different power plant types</p>	LEAP	<p>Increase proportion of electricity generated from nuclear</p> <p>Increase proportion of electricity generated from wind</p> <p>Increase proportion of electricity generated from solar</p> <p>Increase proportion of electricity generated from geothermal</p> <p>Increase proportion of electricity generated from waste</p> <p>Increase proportion of electricity generated from tidal</p>	<p>7.2 By 2030, increase substantially the share of renewable energy in the global energy mix</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p>

		<p>Increase proportion of electricity generated from hydro</p>	<p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change energy intensity of appliances</p> <p>Change % of appliances met by different lighting types with different efficiencies</p>	LEAP	<p>Improve thermal envelope of buildings to reduce heat/cool loss</p> <p>Increase efficiency of air conditioners in households</p> <p>Increase efficiency of refrigerations in households</p> <p>Increase efficiency of other appliances</p> <p>Encourage behaviour change to reduce appliance use/thermostat setting</p>	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums</p> <p>11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate</p>

		<p>Optimise building orientation, thermal mass and shape</p> <p>Maximise passive features (day-lighting, heating, cooling and ventilation)</p> <p>Have efficient systems to meet requirements for lighting, heating, cooling etc.)</p> <p>Highest possible efficiencies and adequate sizing of individual energy-using devices</p> <p>Proper commissioning of systems and devices</p> <p>Improve thermal envelope of buildings to reduce heat/cool loss</p> <p>Ensure commercial and public buildings are constructed for low energy use and from sustainable materials</p>	<p>change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
--	--	---	---

		<p>Improve energy efficiency in hospitals</p> <p>Improve energy efficiency in public buildings</p> <p>Improve energy efficiency in restaurants</p> <p>Improve energy efficiency in tourism</p> <p>Improve energy efficiency in other commercial sectors</p> <p>Optimise building orientation, thermal mass and shape</p> <p>Maximise passive features (day-lighting, heating, cooling and ventilation)</p> <p>Have efficient systems to meet requirements for lighting, heating, cooling etc.)</p> <p>Highest possible efficiencies and adequate sizing of individual energy-using devices</p>	
--	--	--	--

		<p>Proper commissioning of systems and devices</p> <p>Increase efficiency of electric lighting in households</p>	
Change energy intensity of shipping/aviation fuel consumption	LEAP	<p>Increase efficiency of international shipping</p> <p>Increase efficiency of aviation</p>	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change methane and VOC emission factor from coal mining	LEAP	<p>Minimise methane emissions from coal mining through pre-mine degasification and recovery and oxidation of methane from ventilation air</p>	<p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>

Change methane and VOC emission factor from oil and gas infrastructure	LEAP	<p>Minimise methane leakages from gas production and distribution</p> <p>Minimise methane leakages from oil production, processing and distribution</p>	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change number of passenger-km	LEAP	Increase occupancy/loading rates of vehicle	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate</p>

<p>or tonnes-km per vehicle</p> <p>LEAP-IBC ambient air pollution health impact assessment methodology</p>			<p>change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
<p>Change number of passenger-km taken using non-motorised transport</p>	<p>LEAP</p>	<p>Increase walking and cycling to avoid passenger car journeys</p>	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate</p>

			<p>change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>Ambient Particulate matter pollution</p>
<p>Change number of passenger-km taken using public transport modes</p> <p>LEAP-IBC ambient air pollution health impact assessment methodology</p>	LEAP	<p>Increase journeys taken by public transport (BRT, metro) compared to passenger cars</p>	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate</p>

			<p>change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change number of tonnes-km transported road, rail and aviation	LEAP	Increase freight transported by rail compared to aviation and heavy duty vehicles	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>

			<p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change percent share of fuel or energy intensity used for fishing	LEAP	Improve efficiency of fishing vessels	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
Change percent share of fuel used for agricultural applications	LEAP	Improve energy efficiency of agricultural machinery (stationary and mobile)	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>

Change percent share of fuel used for industry applications	LEAP	<p>Increase proportion of clean fuels (e.g. low carbon electricity) used in industry sector</p> <p>Increase energy efficiency of steam systems</p> <p>Increase energy efficiency of furnace and boiler systems</p> <p>Increase energy efficiency of electric motors (pumps, fans, air compressors, refrigerators and material handling)</p> <p>Increase energy efficiency of electronic control systems</p> <p>Improve efficiency and introduce emissions standards for Brick Kilns</p> <p>Improve energy efficiency in iron and steel production</p> <p>Switch from coal and coke to natural gas or clean electricity</p>	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.2 By 2030, increase substantially the share of renewable energy in the global energy mix</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities</p> <p>9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending</p> <p>9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States</p> <p>9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p>
---	------	--	---

	<p>Improve energy efficiency of cement production Switch from coal in cement kilns to fossil or biomass wastes</p> <p>Improve energy efficiency of chemical production processes Switch to natural gas based ammonia production</p> <p>Increase energy efficiency of paper making process (particularly heat generation for drying paper) Improve energy (electricity) efficiency of aluminium production</p> <p>Improve share of electricity for aluminium production that comes from renewable sources Increase efficiency of cooking and drying in food processing</p>	<p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
--	---	---

		<p>Improve efficiency of refrigeration in food processing</p> <p>Switch from heavy fuel oil to natural gas in food processing</p> <p>Improve energy efficiency for textiles industry</p> <p>Improve energy efficiency of grinding process</p> <p>Switch from fossil fuel electricity generation to renewable energy</p>	
Estimate cost of implementation of changes to T&L infrastructure	LEAP	Reduce transmission and distribution losses from electricity generation	2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries
Modify energy intensity of vehicle fleet	LEAP	<p>Increase fuel efficiency of vehicles</p> <p>Increase number of hybrid light duty vehicles</p>	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year</p>

Increase share of vehicle fleet with more efficient vehicles		<p>LDVs: Lower fuel consumption of vehicles through reducing engine load through reducing aerodynamic drag, rolling resistances, auxillary components and reducing weight</p> <p>Modernise HDVs to have more efficient engines, tyres and vehicle maintenance</p> <p>Switch to hybrid vehicles for trucks and buses operating in urban areas</p>	<p>Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
Modify energy intensity per tonnes-km of freight transport by road	LEAP	Expand carrying capacity of HDVs	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p>

			12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
Modify Sulphur content of fuel in LEAP	LEAP	Implement fuel quality standards	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Quantify fuelwood consumption from current	LEAP	Increase proportion of households cooking using LPG compared to solid biomass	12.2 By 2030, achieve the sustainable management and efficient use of natural resources

fuel/technology mix for cooking		Increase number of schools cooking using clean fuels Increase number of restaurants cooking using clean fuels	
Reduce energy intensity of aviation fuel consumption	LEAP	Optimise aircraft design to maximise fuel efficiency Retrofit aircraft with efficiency improvements Improve aircraft management through more direct routings and flying at optimal altitudes and speeds	7.3 By 2030, double the global rate of improvement in energy efficiency 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels 12.2 By 2030, achieve the sustainable management and efficient use of natural resources 12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle Ambient Particulate matter pollution Low birthweight for gestation short gestation for birthweight
Reduce energy intensity of shipping	LEAP	Improve efficiency of new built vessels through changes in engine and transmission technologies, waste heat recovery, auxiliary power systems, propeller and rotor systems, aerodynamics and	7.3 By 2030, double the global rate of improvement in energy efficiency 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate

		<p>hydrodynamics of the hull structure, air lubrication systems, electronically controlled engine systems to give fuel efficient speeds, and weight reduction</p> <p>Implement retrofit and maintenance of vessels</p> <p>Employ coatings to cut water resistance and operation at optimal speeds to improve efficiency of vessels</p> <p>Employ wind propulsion on vessels and renewable electricity generation (PVs, wind) for on board electricity</p>	<p>change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Reduce energy intensity of rail transport	LEAP	Optimise length and nose shape of trains	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p>

			<p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Switch % of rail activity undertaken using electricity vs diesel or coal	LEAP	Switch to electric rail and employ regenerative braking systems	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</p> <p>11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p>

			short gestation for birthweight
--	--	--	---------------------------------

Table A2: Methods that can be used within AgHealth to quantify SDG linkages

Methodology	Tool	Relevant Mitigation Measures	SDGs that it quantifies
Change % crop residue burned in fields	Aghealth	<p>Conservation Agriculture (CA) methods that employ no-burn techniques, including no-till, lowtill, and strip-till</p> <p>Incorporation of biomass into soil</p> <p>Use of biomass for pellet and/or briquette production</p> <p>Use of biomass for construction materials</p> <p>Use of biomass for bedding and fodder for livestock</p> <p>Use of biomass in biogas, second generation biofuels (cellulosic ethanol), boilers,</p>	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p>

		cookstoves, heating; note: must be clean and efficient for use in household	
Change % diet from different foods	Aghealth	Reduce demand for high-emitting food like meat and dair	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p>

			<p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>
Change % diet from different foods and apply health impact assessment methods	Aghealth	Reduce demand for high-emitting food like meat and dairy	<p>Iron deficiency</p> <p>Vitamin A deficiency</p> <p>Zinc Deficiency</p> <p>Diet low in fruits</p> <p>Diet low in vegetables</p> <p>Diet low in legumes</p> <p>Diet low in whole grains</p> <p>Diet low in nuts and seeds</p> <p>Diet low in milk</p> <p>Diet high in red meat</p> <p>Diet high in processed meat</p> <p>Diet high in sugar-sweetened beverages</p> <p>Diet low in fibre</p> <p>Diet low in calcium</p> <p>Diet low in seafood omega 3 fatty acids</p> <p>Diet low in polyunsaturated fatty acids</p> <p>Diet high in trans fatty acids</p> <p>Diet high in sodium</p> <p>High fasting plasma glucose</p> <p>High low-density lipoprotein cholesterol</p> <p>High systolic blood pressure</p> <p>High body-mass index</p> <p>low bone mineral density</p> <p>Impaired kidney function</p>

Change % diets met by livestock and how food production and associated air pollutant emissions change	Aghealth	<p>Reduce demand for livestock through increase in diets from low-GHG emitting foods</p> <p>Reduce demand for livestock and dairy products by switching to lower GHG diets</p>	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p> <p>Iron deficiency</p> <p>Vitamin A deficiency</p> <p>Zinc Deficiency</p> <p>Diet low in fruits</p> <p>Diet low in vegetables</p> <p>Diet low in legumes</p> <p>Diet low in whole grains</p> <p>Diet low in nuts and seeds</p> <p>Diet low in milk</p> <p>Diet high in red meat</p> <p>Diet high in processed meat</p> <p>Diet high in sugar-sweetened beverages</p> <p>Diet low in fibre</p> <p>Diet low in calcium</p> <p>Diet low in seafood omega 3 fatty acids</p> <p>Diet low in polyunsaturated fatty acids</p> <p>Diet high in trans fatty acids</p> <p>Diet high in sodium</p> <p>High fasting plasma glucose</p> <p>High low-densite lipoprotein cholesterol</p>
---	----------	--	---

			<p>High systolic blood pressure</p> <p>High body-mass index</p> <p>low bone mineral density</p> <p>Impaired kidney function</p>
Change % feed met by different feed groups	Aghealth	<p>Optimizing feed digestibility and availability for livestock animals</p> <p>Balancing and fine-tuning feed rations for herd</p> <p>improving grazing and grassland management in grazing systems to increase feed quality and productivity</p> <p>Improving the quality and usage of crop residues as fodder</p>	<p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>

Change % food intake met by different diets	Aghealth	Reduce demand for high-emitting food like meat and dairy	<p>1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters</p> <p>2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round</p> <p>2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p>
Change % food waste	Aghealth	Reduce food waste in production/retail stage Reduce food waste by consumers	<p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities</p> <p>9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending</p>

			<p>9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States</p> <p>9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses</p> <p>12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change % food wasted and distribution of daily calorie	Aghealth	Reduce food waste in production/retail stage Reduce food waste by consumers	<p>1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters</p> <p>2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round</p>

consumption across income levels			<p>2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons</p> <p>Iron deficiency Vitamin A deficiency Zinc Deficiency Diet low in fruits Diet low in vegetables Diet low in legumes Diet low in whole grains Diet low in nuts and seeds Diet low in milk Diet high in red meat Diet high in processed meat Diet high in sugar-sweetened beverages Diet low in fibre Diet low in calcium Diet low in seafood omega 3 fatty acids Diet low in polyunsaturated fatty acids Diet high in trans fatty acids Diet high in sodium High fasting plasma glucose High low-density lipoprotein cholesterol High systolic blood pressure High body-mass index low bone mineral density Impaired kidney function</p>
Change % manure	Aghealth	Implement manure system to remove manure from	2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access

<p>handled in different manure management systems</p>		<p>animal housing in a minimum time after excretion</p> <p>Manure Treatment: Options to minimise methane emissions include anaerobic digesters, solids separation, aeration, and manure acidification</p> <p>Manure Storage: Options to reduce methane emissions include decreasing storage time, storage cover with straw, natural or induced crust, aeration during liquid manure storage, composting, litter stacking, and storage temperature.</p>	<p>to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries</p> <p>8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors</p> <p>8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value</p>
---	--	--	---

			<p>10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p> <p>Ambient ozone pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
Change % mortality rate of livestock and weight of livestock	Aghealth	Promoting better animal health Improving performance through breeding	<p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p>

			<p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p>
Change % of calories met from livestock and shift to plant-based diets	Aghealth	Reduce demand for livestock through increase in diets from low-GHG emitting foods	<p>Goal 1. End poverty in all its forms everywhere</p> <p>1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day</p> <p>1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions</p> <p>1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters</p> <p>2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round</p> <p>2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons</p>
Change EF of NH3 from manure and fertiliser application	Aghealth	Increase efficiency of fertiliser use	<p>2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p>

			<p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>Ambient Particulate matter pollution</p>
Change percent share of fuel used for agricultural applications		Improve energy efficiency of agricultural machinery (stationary and mobile)	<p>7.3 By 2030, double the global rate of improvement in energy efficiency</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p> <p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p>

<p>Change percent share of fuel used for industry applications</p>		<p>Increase proportion of clean fuels (e.g. low carbon electricity) used in industry sector</p> <p>Increase energy efficiency of steam systems</p> <p>Increase energy efficiency of furnace and boiler systems</p> <p>Increase energy efficiency of electric motors (pumps, fans, air compressors, refrigerators and material handling)</p> <p>Increase energy efficiency of electronic control systems</p> <p>Improve efficiency and introduce emissions standards for Brick Kilns</p> <p>Improve energy efficiency in iron and steel production</p> <p>Switch from coal and coke to natural gas or clean electricity</p>	<p>7.1 By 2030, ensure universal access to affordable, reliable and modern energy services</p> <p>7.2 By 2030, increase substantially the share of renewable energy in the global energy mix</p> <p>7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support</p> <p>8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead</p> <p>9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities</p> <p>9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending</p> <p>9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States</p> <p>9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities</p> <p>11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</p> <p>11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels</p> <p>12.2 By 2030, achieve the sustainable management and efficient use of natural resources</p>
--	--	--	---

	<p>Improve energy efficiency of cement production Switch from coal in cement kilns to fossil or biomass wastes</p> <p>Improve energy efficiency of chemical production processes Switch to natural gas based ammonia production</p> <p>Increase energy efficiency of paper making process (particularly heat generation for drying paper)</p> <p>Improve energy (electricity) efficiency of aluminium production</p> <p>Improve share of electricity for aluminium production that comes from renewable sources</p> <p>Increase efficiency of cooking and drying in food processing</p>	<p>12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle</p> <p>3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births</p> <p>3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births</p> <p>3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being</p> <p>Ambient Particulate matter pollution</p> <p>Low birthweight for gestation</p> <p>short gestation for birthweight</p>
--	---	---

		<p>Improve efficiency of refrigeration in food processing</p> <p>Switch from heavy fuel oil to natural gas in food processing</p> <p>Improve energy efficiency for textiles industry</p> <p>Improve energy efficiency of grinding process</p> <p>Switch from fossil fuel electricity generation to renewable energy</p>	
Change yield of rice for different water management regimes	Aghealth	Convert continuously flooded for rice production to alternate wetting and drying management regime	<p>1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters</p> <p>2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round</p> <p>2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons</p> <p>2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access</p>

			<p>to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment</p> <p>2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality</p>
--	--	--	---