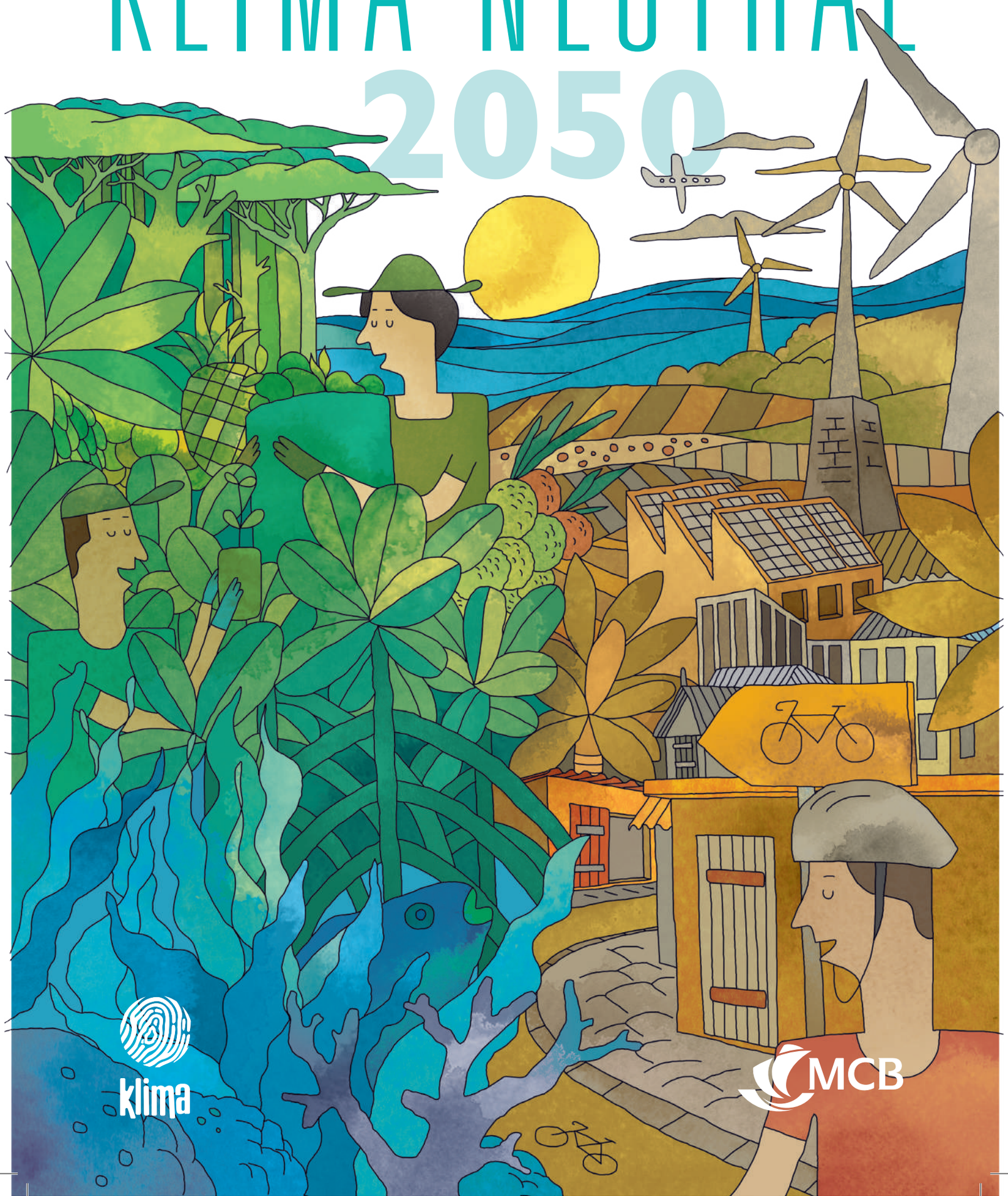
KLIMA NEUTRAL 2050



EDITORIAL

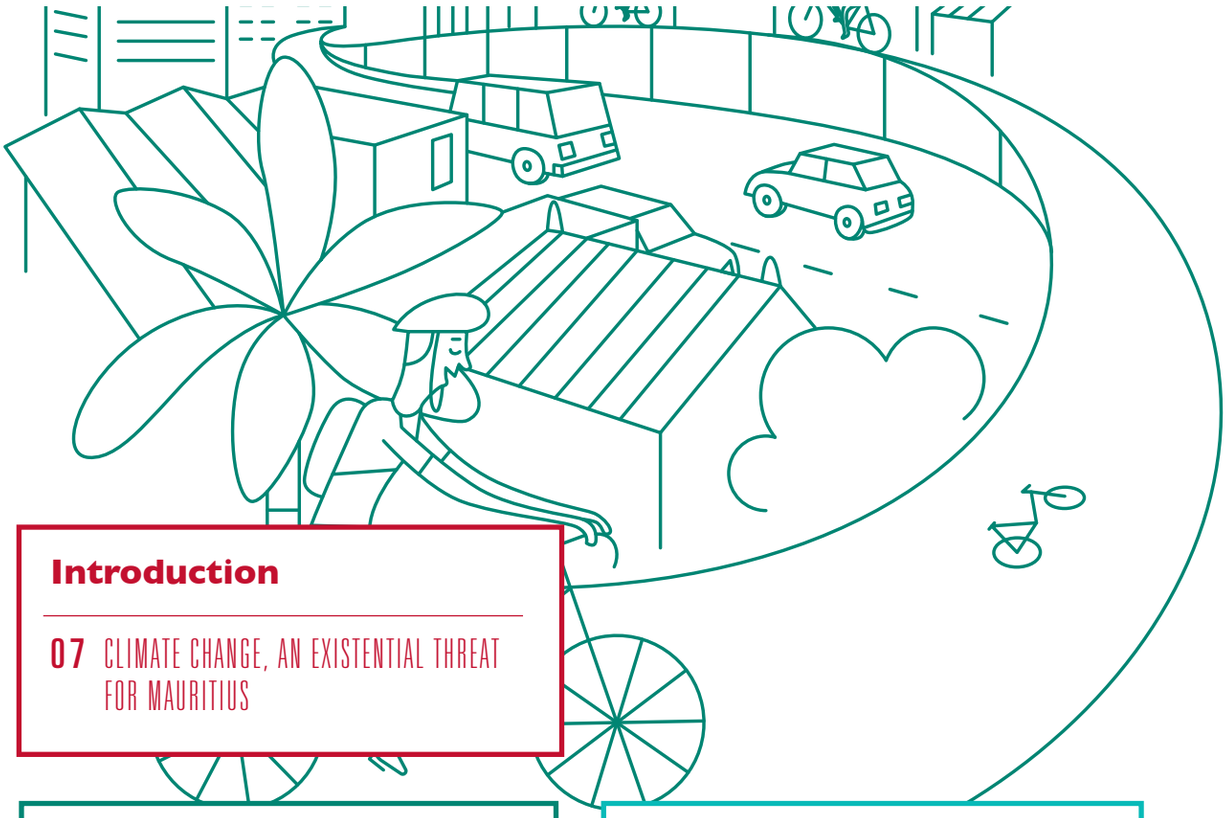
The MCB Group has worked relentlessly these past 180 years towards helping the country and its clients achieve prosperity. It has done so by supporting entrepreneurship and innovation and by financing the development of the territory.

However, global ecological challenges of this past decade have brought to the forefront the need to question the very model that has brought prosperity to the world throughout the 20th century, especially because of its heavy reliance on fossil fuels. Convinced that things need to be changed, the younger generation is urging us to rethink the very definition of development in terms of its impact on our territory and to turn it into an economy that is more sustainable, more inclusive and more respectful of ecosystems. One that is at the service of Mauritius and its people.

This is what we mean by "Success Beyond Numbers", MCB's corporate sustainability programme that seeks to mobilise civil society and the business community so that together, we can create a different kind of prosperity for our country. What MCB aims to do is imagine a new kind of development that does not jeopardise the future of our country, one that is truly able to mobilise the creative energy of the people of Mauritius so that we can successfully transition to a sustainable economy.

The challenges brought by Climate Change are huge and the solutions will require a high degree of innovation as well as collective initiatives in order to achieve the ideal of a carbon neutral territory, in accordance with the Paris Agreement. We are convinced that far from being a constraint, the levers at the disposal of companies to reduce their climatic impact constitute an opportunity to create a more stable and prosperous future. These levers – the development of low-carbon offers, the decarbonisation of the energy mix and the creation of a more local and decentralised economy – will become the new economy.

This report is MCB's contribution to the collective awareness that is essential if we are to make of Mauritius a more resilient territory – and better still, the world capital of the new climate economy. It sheds new light on achieving carbon neutrality and proposes ways to mobilise the country's economic players for the first courses of actions towards a carbon neutral economy.

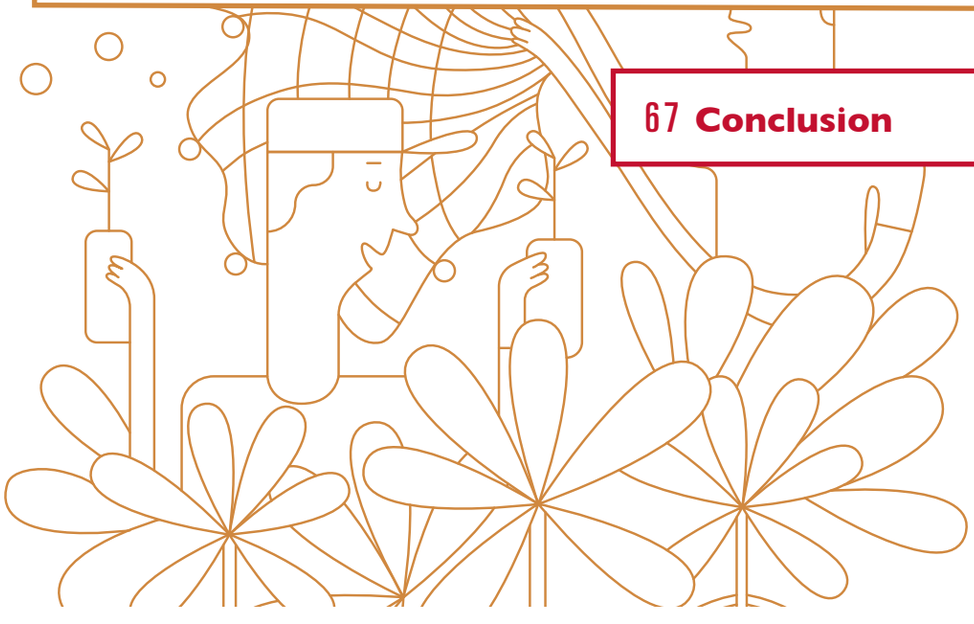


Introduction

Part 1

Part 2

Part 3



Introduction:

CLIMATE CHANGE: AN EXISTENTIAL THREAT FOR MAURITIUS

It was a long time coming but it is now unanimous: Climate Change is a major global concern. Its potentially catastrophic consequences, be it on natural systems or on human societies have finally garnered the attention of the scientific community, of politicians, of civil society and of businesses. As a testament to the enormity of the challenge it poses, many countries have declared a state of climatic emergency as a means to force strong actions in response to an imminent global crisis.

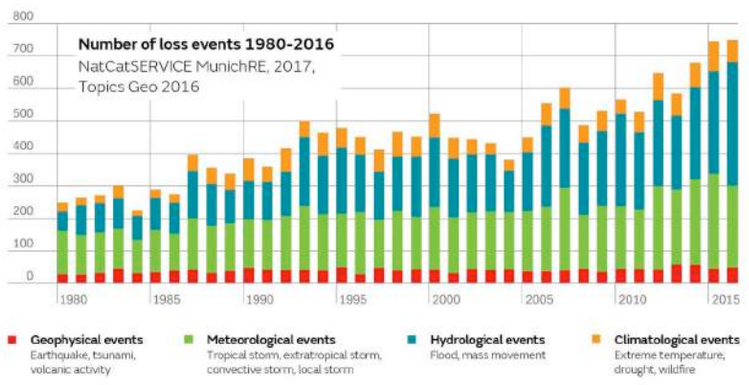
Out of control

2014-2018 represent the hottest years ever recorded[1]. The mean temperature of the world's surface has increased from 0.8 to 1.2° C compared to pre-industrial temperatures (before 1850) with resulting destructing effects – intense droughts, cyclones, floods and sea level rise.

The scientific community believes that irreversible damage can be avoided by limiting climate change to a manageable level (about +1.5° compared to pre-industrial temperatures, see inset). This means a drastic reduction in the worldwide emissions of greenhouse gases (GHG), the very cause of Climate Change[2]. Achieving this would require strong and ambitious actions. Yet, worldwide emissions of GHG show no sign of slowing down. On the contrary, 2018 shows record emissions with an increase of 2.7%[3] compared to 2017.

Are extremes becoming more frequent?

Evolution of the number of extreme weather events since 1990



Source: 2017 Munich Re, Geo Risks Research, NatCatSERVICE, January 2018

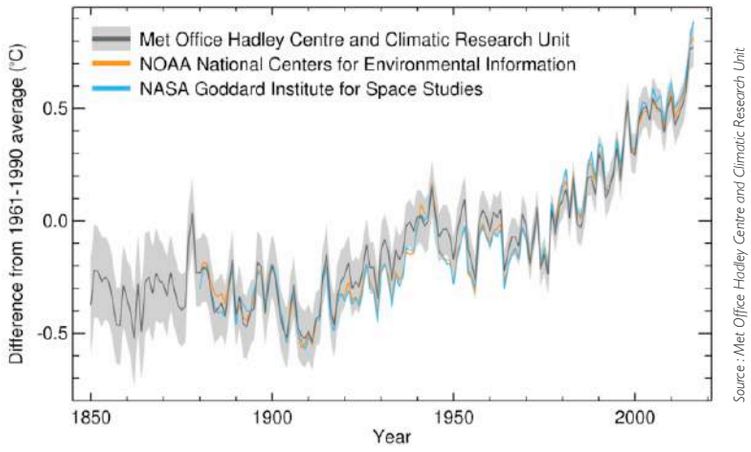
[1] *Borunda, A., (2019). The last five years were the hottest ever recorded. National Geographic. [https://www.nationalgeographic.com/environment/2019/02/2018-fourth-warmest-year-ever-noaa-nasa-reports/]*

[2] *Intergovernmental Panel on Climate Change (2018). Framing and Context. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Geneva, Switzerland. [https://www.ipcc.ch/sr15/]*

[3] *Global Carbon Project (2018). Carbon budget and trends 2018. University of East Anglia, UK. [www.globalcarbonproject.org/carbonbudget]*

Global average temperature anomaly 1850-2016

Anomalies in mean temperature on the earth's surface, combining land surfaces and oceans from 1850 to 2016. By convention, reference temperature (anomaly=0) refers to mean temperature from the 1961-1990 period. Source - Réseau Action Climat



Why not go beyond +1.5°C?

Why fight for as little as a few degrees centigrade? The notion may seem strange in the face of varying temperatures of some ten or more degrees in any given area. However, the rise in temperature due to Climate Change is very much unlike these one-off variations in temperature because they point to a rise in the average temperature, which has a profound impact on the way climate functions. Some perspective might help here: 10,000 years ago, at about the end of the last ice age, a mean temperature of just 4 to 5°C caused a rise in sea level of 130m, which brought about a change in the flora and fauna and in the conditions of agriculture. Compare it to the human body – an increase of just a few degrees can cause life-threatening conditions.

If we do nothing to bring down the mean temperature, GHG emissions concentrated in the atmosphere will lead to an increase in the mean temperature of 7°C by 2100. The scientific community believes that an increase of 1.5°C, though not ideal because it will still have huge implications, would be manageable. On the other hand, a rise in temperature above 2°C would spin the situation out of control.

Mauritius, a vulnerable state

The Republic of Mauritius was one of the first countries to ratify the Kyoto Protocol in 1997 as well as the Paris Climate Agreement in 2016, testament to its commitment to contribute to the fight against Climate Change. As a Small Island Developing State, Mauritius has to balance its development against economic, social and environmental challenges exacerbated by extreme climatic events. The latest World Risk Report ranks Mauritius **7th on the list of countries most exposed to natural hazards and as the 13th country with the highest disaster risk[4].** In 2016, the ministry responsible for the Environment and Sustainable Development expressed its concern that coastal zone degradation, the intensification of natural disasters and Climate Change due to the rise in sea level and temperature could potentially compromise the country's socio-economic development as set out in government's strategic plan for Mauritius, Vision 2030.[5]

[4] *UNH Institute for Environment and Human Security (2016). World Risk Report. Bündnis Entwicklung Hilft and United Nations University, Germany. [https://collections.unu.edu/eserv/UNU:5763/WorldRiskReport2016_small_meta.pdf]*

[5] *Government of Mauritius (2016). Third National Communication: Report to the United Nations Framework Convention on Climate Change. Port Louis, Republic of Mauritius. [https://unfccc.int/files/national_reports/non-annex_i_natcom/application/pdf/nc3_republic_of_mauritius_20jan17.pdf]*

Climate Change brings the risk of an increase in droughts, cyclones and floods. An estimate suggests, for instance, that a cyclone with a 100-year return period would cost Mauritius USD1.9bn[6]. It follows that activities of the private sector would be compromised with a resulting decrease in resources: coastal resources found inside a cyclone zone are especially vulnerable. Extreme weather would affect export and import activities, as was the case in 2013 when the container terminal suspended its activities for 21 days, resulting in a loss of MUR3.9bn[7] in earnings. The tourism industry and other coastal activities are already suffering from the effects of beach erosion, among which is a reduction of up to 20m in some zones, in the last few decades. Climate Change also affects populations that depend on fishing for their earnings or as food source while fishing resources diminish or become more erratic and productivity in fishing activities and aquaculture decrease. This impact is already being felt in Mauritius; in 2009-2010, fish stock marketed by local players decreased by 19.1%[8] due to climatic conditions. The agricultural sector is threatened by heat waves and lack of water. Between 1951 and 2014, rainfall recorded in Mauritius had decreased by 8% and in 2010, the availability of water was estimated to have fallen below the threshold that qualifies a country as water-stressed[9].

Source: CoastalDEM model v1.1, Climate Central

Areas directly threatened by submergence following rise in sea level by 2050 in the surroundings of Port-Louis, based on the RCP4.5 hypothesis (a peak of global GHG emissions by 2040 followed by a reduction by half of current emissions)

Based on the current increase in the surface temperature of Mauritius, a more pessimistic scenario than the status quo projection would mean an increase of 2°C in temperature for the period 2051-2070.[10]

40,000 people currently live in areas that are prone to coastal flooding[11]. This figure is likely to be revised upwards since the rise in sea level locally has reached an average level of 5.6mm a year in the past decade compared to a global average of 3.2mm.[12] A moderate projection model suggests that by 2030, wetlands lost to the sea will constitute losses valued at USD18.3m a year.[13]

[6] *World Bank (2016). Disaster Risk Profile – Mauritius, The World Bank Group, Washington DC*
[7] *Government of Mauritius (2016). Third National Communication: Report to the United Nations Framework Convention on Climate Change. Port Louis, Republic of Mauritius.*
[8] *Government of Mauritius (2012). National Climate Change Adaptation Framework. Port Louis, Republic of Mauritius.*
[9] *Ibid*
[10] *Government of Mauritius (2016). Third National Communication: Report to the United Nations Framework Convention on Climate Change. Port Louis, Republic of Mauritius.*
[11] *Kulp, S. A., & Strauss, B. H. (2019). New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding. Nature communications, 10(1), 1-12.*
[12] *Ibid*
[13] *Brown, S., Kebede, A. S., & Nicholls, R. J. (2017). Sea-level rise and impacts in Africa, 2000 to 2100. University of South Hampton, UK.*

A climate crisis would subject Mauritius to economic, sanitary, social and political risks – rise in sea level, damage to port infrastructure, supply difficulties and uncertainty, increase in the frequency and in intensity of cyclones, decrease in yields in fishing and agriculture, strains on food supply and on water resources and so on. The vulnerability of the ecosystems added to the economic frailty of the populations that will be affected suggest a series of internal migration as a result of Climate Change[14] while the combined effects of the climate crisis on the country's production capacity may well lead to economic and political instability in Mauritius, as elsewhere.

General mobilisation... a must but also a source of untold opportunities

The latest report of the Intergovernmental Panel on Climate Change (IPCC) posits that in order to keep Climate Change at a manageable level globally (+1.5°C compared to the pre-industrial era) and avoid a catastrophic scenario, CO_2 concentration in the atmosphere needs to be kept below 430 ppm. This implies the following:

- A drastic reduction in annual emissions – about 45% in 2030 compared to what it was in 2010 so that we do not exceed the threshold of CO_2 concentration – which would trigger a chain of climatic reactions beyond our control
- Reaching carbon neutrality with a net zero emission globally by 2050 – in other words, creating a state of equilibrium of the flow where the totality of CO_2 emissions in the atmosphere is absorbed by carbon sinks.

It is a tall order, whether it is for a developing country such as Mauritius or for humanity. Nevertheless, experts maintain that it is doable. The history of Mauritius is made of success stories that result from positive transformations linked to the diversification of its economic activities. Today, the challenge is greater still as the country is expected to maintain and develop its economic dynamics while reducing its carbon emissions. It is no exaggeration to say that it is a matter of survival; the country's economic players will have to mobilise resources to come up with new models that are more conservative in carbon activity in order to contribute to the objective of global carbon neutrality. Paradoxically, this constraint also represents a unique opportunity to innovate, to rethink economic models, to redefine the terms of our development, to better respond to the expectations of public opinion, of investors, of clients, of lawmakers.

Yet, faced with this challenge, economic players often find themselves powerless. How do they effectively take part in the effort to reduce GHG emissions? How to identify the opportunities for developing new models? What is the role of entrepreneurs in this climate emergency? **This report, commissioned by MCB, proposes several levers for the Mauritian territory to reach carbon neutrality and hence, meet the challenge of the climate crisis. Businesses have a fundamental role to play because the movement towards neutrality will only be achieved through concerted action at all levels. Only then will Mauritius be able to look forward to a future that is secure and sustainable.**

[14] *Sultan, R., (2017). Assessing the Climate Change-Migration Nexus Through the Lens of Migrants: The Case of the Republic of Mauritius. International Organization of Migration, Geneva, Swirzerland. [https://publications.iom.int/system/files/pdf/mauritius_survey_report_0.pdf]*

1

CARBON NEUTRALITY FOR MAURITIUS: DEFINITION AND APPROACH

1

CARBON NEUTRALITY: WHAT IS IT?

To be able to keep the rise in temperature below 1.5°C compared to pre-industrial temperatures, it follows that we must not exceed a maximum amount of CO_2 concentration in the atmosphere. To do that, a "carbon budget" needs to be established so that we know how much carbon we can emit in the atmosphere before we reach the threshold that leads to a warming of 1.5°C. Determining the "carbon budget" requires taking into consideration the emissions that have already been accumulated as at 2017 and estimated at 2220 $GtCO_2$. At the beginning of 2018, this total budget stood between 420 and 580 $GtCO_2$. In other words, only ten to fourteen years of emissions at the current rhythm!

From carbon neutrality to climate neutrality

There are other gases as well as CO_2, which create the greenhouse effect and contribute to Climate Change. They are methane (CH_4) and nitrous oxide (N_2O) that are emitted by agricultural activities and which have steadily risen these last decades. These gases have a powerful ability to warm the atmosphere and must also be reduced in line with the objective of "climate neutrality". The various greenhouse gases are identifiable by their lifespan in the atmosphere. The "CO_2 equivalent" is a unit created by the Intergovernmental Panel on Climate Change (IPCC) in a bid to compare the impact of these different GHG in terms of global warming and combine their emissions.

In the estimates and calculations below, CO_2 is used with a conversion in CO_2 equivalent whenever applicable.

	GWP, Global Warming Potential (CO_2eq)	
	On a 20-year period	On a 100-year period
CO_2 (carbon dioxide)	1	1
CH_4 (methane)	84	28
N_2O - (nitrous oxide)	264	265
CF_4 - (tetrafluoromethane)	4880	6630
HFC-152a – (1,1 – difluoroethane)	506	138

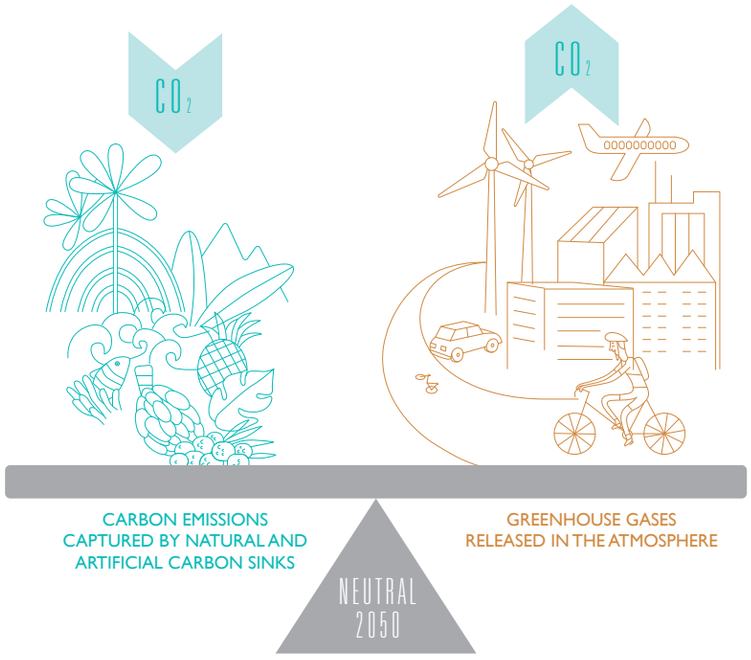
Conventional value of Greenhouse in "CO_2 equivalent"

So how do we meet this challenge? The Intergovernmental Panel on Climate Change is adamant: CO_2 emissions need to be reduced rapidly so that we do not exceed the carbon budget. This means a decrease of 45% as early as 2030 compared to what it was in 2010. The goal is to reach a "neutral" state by 2050 whereby CO_2 emissions produced by human activity and rejected in the atmosphere are absorbed by carbon sinks.

Not all CO_2 emissions produced by human activity are stocked in the atmosphere: the oceans absorb some of it while the soil and the surface vegetation absorb some more. These "natural carbon sinks" can absorb an estimated 13 $GtCO_2$ a year (the American Meteorological Society says the oceans have absorbed 7 $GtCO_2$ a year in recent years while the forests have taken in 6 $GtCO_2$ a year). So it follows that if the annual level of CO_2 emissions per year is limited to about 13 $GtCO_2$ every year, these emissions will be absorbed by the natural ecosystems so that the CO_2 stock in the atmosphere will not go up. This situation will bring the emissions to a "net zero", meaning that the world would have attained a state of "carbon neutrality".

What is carbon neutrality?

Carbon neutrality implies a strict equilibrium between greenhouse gases (GHG) released in the atmosphere and those captured by the natural carbon sinks (forests, soil, oceans) or artificial ones (capture and storage of CO_2).



CARBON NEUTRALITY: CHALLENGES AND OBJECTIVES FOR MAURITIUS

1/ Maximum emissions for carbon neutrality

Knowing that annual global emissions should be brought down to 13 $GtCO_2$ by 2050 so that CO_2 concentrations in the atmosphere do not go up is one thing. It is harder however to know how to distribute these emissions among countries.

• *An initial approach could be to evaluate the absorption potential of carbon sinks (forests, grasslands, mangroves etc) found on territories and based on that, calculate what would be an acceptable emission rate for the country in question.* As logical as this approach sounds, there is the risk of creating disparities between countries that are rich in carbon sinks and those that have poorer natural resources. Moreover, this approach fails to take into account oceanic carbon sinks that are often found in international waters, constituting an important sink but very much one that does not belong to any territory.

• *A more classical approach would be to divide the desired rate of emission of 13 $GtCO_2$ a year by three since that is by how much they need to be reduced. It would follow that countries would then be required to divide their emissions by three so that global neutrality can be attained.* If this reasoning seems sound, it nonetheless overlooks the fundamental requirement of equity: is it fair to ask all countries to make the same amount of effort when they are in very different situations?

• A more equitable solution would be to devise the distribution of emission on the more objective criteria of the size of the population. If the objective is to reach global emissions of 13 $GtCO_2$ a year as from 2050, then it would be fair to determine the corresponding amount of emissions per person on earth and to calculate the part of each country based on its respective population size. The 2019 edition of the *World Population Prospects* predicts that in 2050, there will be 9.73 billion people living on earth. Reaching carbon neutrality in 2050 with emissions of 13 $GtCO_2$ a year means that on average each person would be entitled to 1.34 tCO_2. Put that way, every person becomes in effect equal, having the same rights.

For Mauritius, with an estimated population of 1.19 million (UN figures)[15] in 2050, it would mean that each inhabitant would be entitled to 1.6$MtCO_2$ in 2050.

The table below goes into detail on the evolution of that objective until 2100, based on the evolution of the world population and that of Mauritius:

Year	2050	2060	2070	2080	2090	2100
World population (*1000) - UN projections	9 735 034	10 151 470	10 459 240	10 673 904	10 809 892	10 875 394
Mean CO_2/hab budget (tCO_2/hab)	1,34	1,28	1,24	1,22	1,2	1,2
Mauritian population (*1000) - UN projections	1 186	1 116	1 046	970	894	827
Mauritian emissions for neutrality ($MtCO_2$)	1,58	1,43	1,3	1,18	1,08	0,99

[15] *The United Nations base themselves on the continuation of past trends when they carry out prospective studies. The prediction for Mauritius is that the decline in the birth rate coupled with the ageing population will lead to a decrease in population following a peak that would be reached around 2030.*

2/ Mauritius' carbon footprint

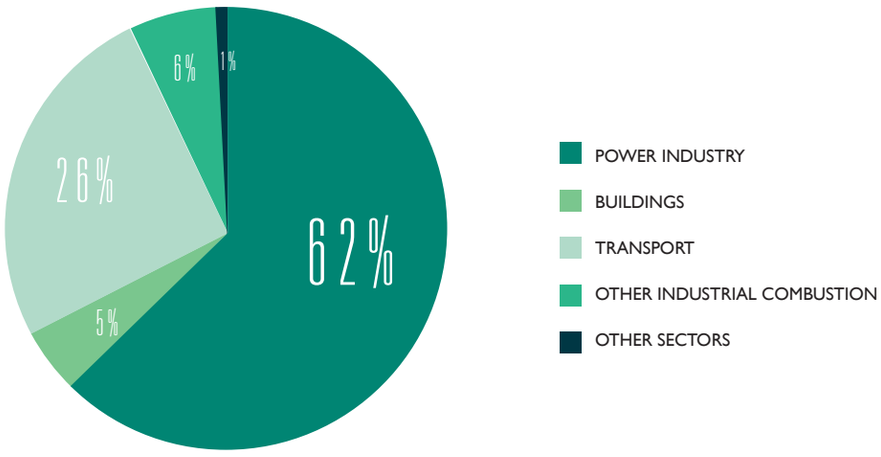
Territorial emissions are the total emissions produced physically in a country or a territory (a region, or island) and forms the basis of commitments that are taken in terms of CO_2 emissions. The United Nations uses it as its reporting standard for GHG emissions.

In 2018, territorial emissions of Mauritius amounted to 4.38MtCO_2 *To this number, must be added nearly 740,000 tonnes in CO_2 equivalent of other greenhouse gases[16] (Source: EDGAR – Emission Database for Global Atmospheric Research) with the following order of magnitude:*

- For every USD of GDP, the Mauritian economy releases 300 grams of CO_2.
- Production of energy by thermal power plants constitutes the main source of CO_2 emissions (62% - a 50% increase since 1970) followed by transport (26%).
- With an emission of 3.46 tonnes per inhabitant, Mauritius is situated in the median for island territories and below the world average by nearly 1.5 tonnes.
- To achieve carbon neutrality, Mauritius has to aim at a reduction of territorial emissions from 4.38MtCO_2 in 2017 to 1.6MtCO_2 in 2050. **In other words, Mauritius will need to divide its territorial emissions by 2.8.**

N.B. : In 2025, Mauritius' territorial emissions would have reached nearly 5.8MtCO_2 if its targeted annual growth of 4% until 2025 were achieved. (This is when Mauritius is expected to transit to the status of high-income country with USD15000 as GDP per capita.) **This means that everything being equal, CO_2 emissions would have to be decreased not by 2.8 but by 3.6.**

Sources of territorial CO_2 emissions (Mt CO_2) Mauritius 2018



Source : EDGAR

Evolution of territorial emissions (Mt CO_2) of Mauritius since 1970

	1970	1980	1990	2000	2010	2018
Power Industry	0,05	0,17	0,44	1,16	2,21	2,73
Buildings	0,05	0,07	0,12	0,16	0,18	0,21
Transport	0,13	0,24	0,44	0,75	0,92	1,13
Other industrial combustion	0,03	0,09	0,17	0,36	0,35	0,28
Other sectors	0,04	0,01	0,03	0,01	0,02	0,03

Source : EDGAR

[16] *Source: EDGAR – Emission Database for Global Atmospheric Research*

Territorial CO_2 emissions per inhabitant (tonnes) in island territories

Palau	57,95
Curaçao	52,14
New Caledonia	26,22
Trinidad and Tobago	26,19
Falkland Islands	13,59
Saint Pierre and Miquelon	12,49
Taiwan	12,01
Barbados	11,58
Seychelles	10,29
Aruba	9,34
Cayman Islands	8,13
Bahamas	7,72
Bermuda	7,21
Martinique	6,38
Cyprus	6,28
Antigua and Barbuda	6,23
Guadeloupe	5,23
AVERAGE WORLD	4,97
British Virgin Islands	4,82
Turks and Caicos Islands	4,73
Saint Kitts and Nevis	4,37
Saint Helena, Ascension and Tristan da Cunha	4,36
Malta	3,48
Mauritius	3,46
AVERAGE ISLANDS	3,46

Jamaica	2,74
Grenade	2,66
Cook Islands	2,41
Cuba	2,40
Dominican Republic	2,31
Saint Lucia	2,08
French Polynesia	2,01
Maldives	1,97
Anguilla	1,90
Cape Verde	1,87
Dominica	1,74
Saint Vincent and the Grenadines	1,67
Fiji	1,44
Sri Lanka	1,14
Tonga	1,12
Puerto Rico	0,87
São Tomé and Principe	0,72
Samoa	0,67
Haiti	0,33
Vanuatu	0,29
Comoros	0,25
Solomon Islands	0,21
Madagascar	0,17

Source : EDGAR

3/ A different perspective on measuring the carbon footprint of Mauritius: Emissions derived from consumption

Territorial emissions include the emissions from the production of goods for exportation. If polluting factories in India produce goods that will be exported to Mauritius, would Mauritius have to bear responsibility or would it have to be India? For those who believe that the reasoning should be based on consumption, the real carbon footprint of Mauritius would include its territorial footprint (direct emissions from businesses and households) as well as CO_2 emissions that result from imports, minus the territorial emissions contained in producing goods for exportation (part of territorial emissions or imported emissions contained in the exportation).

This point of view would put Mauritius' "consumed" carbon footprint at nearly 7.38 $MtCO_2$[17] with the following order of magnitude:

Source : calculations carried out by Utopies[18], based on the LOCAL FOOTPRINT CLIMATE model

- Emissions added to imports by Mauritius (i.e adding all the emissions from other countries that include the value chain of imported goods) represent 5.2$MtCO_2$. Every USD spent in importing goods generates 750 grams of CO_2 in the world (1.1kg CO_2 eq)
- 59% of Mauritius' imported emissions come from Asia (China and India make up about a quarter of that total amount)
- 5 sectors make up about 60% of the imported emissions: machinery/equipment (0.8$MtCO_2$), food industry (0.6$MtCO_2$), transport/logistics (0.6$MtCO_2$), metallurgy (0.5$MtCO_2$) and chemicals (0.4$MtCO_2$)

[17] *Consumed emissions =territorial emissions (4.38$MtCO_2$) + imported emissions (5.2$MtCO_2$) – territorial emissions and imported from export sectors (2.2$MtCO_2$) = 7.38$MtCO_2$*

[18] *Local Footprint CLIMATE is a carbon footprint calculation model derived from the environmentally-extended input-output model, the objective of which is to understand how a flux that is injected in the global economy can impact that economy and consequently create GHG emissions. Local Footprint CLIMATE combines the econometric model LOCAL FOOTPRINT world (380 sectors X 220 countries, including Mauritius) and other international sectorial emission factors. (USEEIO, EXIOPOL).*

	Mt CO_2	Other GHG in Mt CO_2eq
Territorial footprint	4,38	0,74
Exporting sectors	0,71	0,37
Imported footprint (non territorial)	5,19	2,39
Exporting sectors	1,49	0,81
Consumed footprint	7,38	1,95

Source : EDGAR

5 ways to reduce imported emissions

1/ Increase local manufacture of goods (micro-plants, factory 4.0, micro-farming, industrial synergies...) and reduce transportation needs

► Imports by Mauritius mean 340 000 tonnes of CO_2 emitted by air transport and 340 000 tonnes caused by land transport

2/ Identify parts of the entire importation chain (parcelled throughout many countries) that can be replaced by synergies and local decarbonised energy

► Imports by Mauritius mean more than 730 000 tonnes of CO_2 are emitted by the production of electricity (mostly thermal) and nearly 400 000 tonnes are produced by mining or production of coal, petroleum products and natural gas

3/ Invest in the circular economy, in waste reduction, in waste management and services that prolong the life cycle of goods

► Imports by Mauritius mean that over 710 000 tonnes of CO_2 are produced by the steel industry, 550 000 tonnes are derived from the production of cement, 350 000 from the production of fibres and synthetic resins, 220 000 tonnes by mining and more than 150 000 tonnes by the cultivation of fruits, vegetables and cereals

4/ Develop new agricultural practices and cultivation in Mauritius with the aim of reducing imported inputs (fertilisers etc)

► Imports by Mauritius mean the emission of over 220 000 tonnes of CO_2 derived by the production of fertilisers and other organic chemicals (the same products that are the cause of important greenhouse gas emissions in Mauritius, namely nitrous oxide (N_2O))

5/ Develop new local substitution products for the various meat-based imported products

► Imports by Mauritius mean more than 350 000 tonnes of CO_2 emitted by the production of animal-based food products (meat, dairy products) as well as the breeding it implies.

Breakdown of imported emissions by region of physical production and emission

		CO_2 (tonnes)		Other GHG in CO_2eq (tonnes)	
EUROPE	Western Europe	594 128	21%	283 682	21%
	Eastern Europe	277 986		152 074	
	Southern Europe	92 637		33 246	
	North Europe	147 155		33 074	
AMERICA	North America	194 181	7%	88 658	12%
	Central America	10 642		8 163	
	South America	158 559		184 543	
	Caribbean	3 808		985	
ASIA	East Asia	1 333 928	59%	143 677	32%
	South Asia	629 529		265 912	
	South East Asia	541 999		116 573	
	Central Asia	40 115		6 908	
	West Asia	499 706		240 859	
AFRICA AND INDIAN OCEAN	North Africa	68 684	10%	25 571	19%
	West Africa	18 705		8 974	
	Central Africa	8 244		4 592	
	South Africa	333 356		318 183	
	East Africa	38 635		25 376	
	Indian Ocean	34 968		62 043	
OCEANIA	Australia and New Zealand	164 242	3%	391 957	16%
	Pacific islands	2 184		826	
	WORLD	**5 193 390**	**100%**	**2 395 876**	**100%**

Source: calculations carried out by the LOCAL FOOTPRINT CLIMATE model

Breakdown of imported emissions by sector of importation

How to read this table *For every sector of importation, there is one manufacturer somewhere in the world. The CO_2 emissions produced by this manufacturer will be added to all the CO_2 emissions of the different suppliers who have a role in the global supply chain. For instance, by importing food products, Mauritius also imports the emissions of the producers of meat products/ dairy products and hence the emissions derived from breeding livestock but also the emissions produced by manufacturers of chemical inputs as well as the emissions linked to the production of energy used for all the agricultural and industrial activities that were required for the production of said products, as well as the emissions generated by transportation involved in the chain of production. USD 744 million worth of importation of food products generate the emissions of 627 173 t of CO_2 in the world (843 grams of CO_2 for every USD imported) as well as 788 782 tonnes in CO_2 equivalent of other greenhouse gases such as methane and nitrous oxide.*

	Imports (Millions $)	CO_2 (tonnes)		Other GHG in eq. CO_2 (tonnes)	
TOTAL	**6 865**	**5 193 390**	**100%**	**2 395 876**	**100%**
Machinery/equipment	1 546	798 486	15,4%	81 830	3,4%
Food industry	744	627 173	12,1%	788 782	32,9%
Transport/logistics	545	591 008	11,4%	80 510	3,4%
Metalwork	265	514 100	9,9%	32 320	1,3%
Chemicals	317	428 209	8,2%	53 672	2,2%
Fashion/textile/accessories	449	382 406	7,4%	98 998	4,1%
Hotel industry/restaurants/food service	669	230 573	4,4%	93 658	3,9%
Agriculture/fishing	267	168 233	3,2%	548 168	22,9%
Energy	304	157 276	3,0%	87 178	3,6%
Plastic/rubber	117	148 832	2,9%	13 983	0,6%
Urban services	226	121 805	2,3%	375 605	15,7%
Quarrying	111	91 711	1,8%	67 989	2,8%
Pharmaceutical and medical products	108	44 750	0,9%	6 707	0,3%
Commerce	210	22 849	0,4%	4 009	0,2%
Support services for businesses	151	15 695	0,3%	2 812	0,1%
Information / Communication	102	10 169	0,2%	1 489	0,1%
Banking, finance, insurance	117	8 507	0,2%	1 337	0,1%
Other	617	831 606	16,0%	56 830	2,4%

Source: calculations carried out by the LOCAL FOOTPRINT CLIMATE model

IDENTIFYING PRIORITY SECTORS IN MAURITIUS

1/Applying the principle of carbon neutrality to Mauritian companies

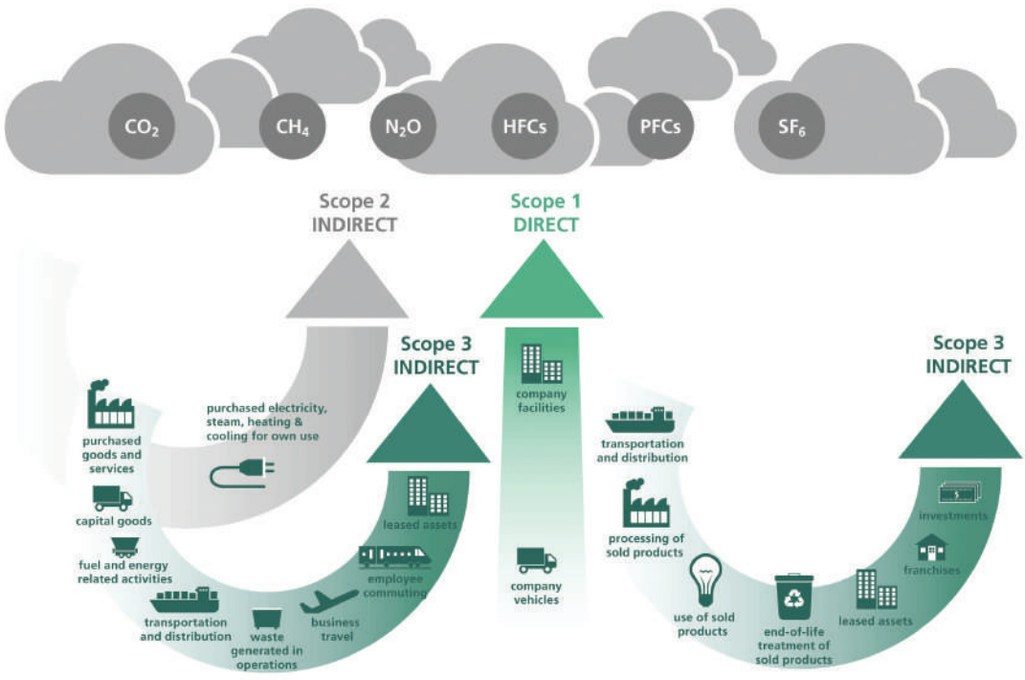
To what sectors can we attribute the territorial emissions as well as non-territorial emissions mentioned above? What is the extent of the responsibility and hence, of scope for action in each sector? For each one of them, what are the priority areas?

To evaluate the carbon footprint of the different lines of business in Mauritius, we have used the GHG protocol (Greenhouse Gas Protocol). It's a protocol launched in 2001 by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). The aim of the protocol is to standardise the fight against Climate Change on a global level. It quantifies the entire impact that is generated by the production and the consumption of a product. It has three scopes, each corresponding to an emission perimeter:

- Scope 1: Emissions coming from sources that are owned or managed by the company (for example: a vehicle pool belonging to the company, combustion from mobile or fixed sources, industrial processes without combustion, emissions from ruminants, leaks of refrigerating agent, nitrogenous fertilising etc.)

- Scope 2: Indirect emissions linked to the production of electricity, of heat or of steam, purchased to enable the company's activities.

- Scope 3: Other emissions produced indirectly by the activities of the company and linked to the complete value chain (For example, buying raw materials or services or other products, trips taken by employees, transportation of goods before and after, management of waste generated by the activities of the company, use and end-of-life cycle of products and services sold etc.)



Source : GHG Protocol

Can a company be "carbon neutral"?

A growing number of companies boast that their products or activities are carbon neutral, making the argument a central part of their communication campaign, as a means to differentiate themselves from their competitors. Laudable though the initiative is, the concept of carbon neutrality is often ambiguous:

- The very concept of neutrality is often wrongly defined and in an arbitrary manner. Can a business really say it is carbon neutral just by basing itself on its scope 1?
- Instead of reducing their GHG emissions to a level that's compatible with maintaining global warming at under 1.5°C, companies finance development projects that are low in carbon to be able to take into account the "avoided" emissions, used as compensation for their real emissions (see chapter 3)
- Although the compensation process avoids the creation of additional emissions by other players, it does not contribute to the capture or the absorption of CO_2 outside the atmosphere. So emissions that have not been reduced by a company do not correspond to emissions that have been absorbed and hence it is debatable whether a company is carbon neutral is really carbon neutral.

A robust definition of carbon neutrality is to define as wide a scope as possible (scope 1,2 and 3), to reduce emissions on that scope as much as possible, to finance the absorption of GHG emissions that haven't been reduced and to contribute to avoid the production of additional emissions elsewhere, outside the scope of the company.

The Net Zero Initiative is a vision based on "triple counting" and driven by players from the private sector. It takes into account the following:

- Emissions "induced" by the company's activities on a wide perimeter (scope 1,2 and 3) to be reduced to the maximum and to a level compatible with a trajectory of 2°C or even 1.5°C;
- "Avoided" emissions, that is those that haven't been produced by other economic players thanks to help or financing by the company outside of its wider scope (financing of low carbon projects, helping the development of renewable energy etc);
- "Negative" emissions, meaning those that have been absorbed thanks to the creation of new additional carbon sinks financed by the company. These emissions will have to correspond to those that have not been reduced.

2/ The profile and the perimeter of carbon footprint vary according to the sector

The food industry outweighs by far the energy sector in terms of GHG emissions (1.69MtCO_2) if a wider scope of responsibility is used (scope 1 to scope 3 upstream) – electricity (1.38), transport (1.17) and agriculture (1.09). The textile industry is 5th (0.86), followed by real estate (0.63).

Judging by this classification, the carbon footprint of sectors such as hotels/restaurants (12th, 0.38MtCO_2eq) or banking and financial activities (25th, 0.076 MtCO_2) may seem incidental. But the real carbon footprint of these two sectors is more of a downstream matter (cf. warning below): such as the carbon impact of air transport of tourists to and from Mauritius, the carbon impact of loans granted by banks etc.

This classification highlights the existence of several models of carbon footprint.

Only six sectors have an upstream scope 3 lower than 40% of all emissions (the threshold set by the Science Based Targets initiative (SBTi)[19] to determine when they start having an impact):

- The carbon footprint of energy (in this case, production, transportation and distribution of electricity) is mostly entirely linked to the combustion of fossil fuel
- The transport footprint is mainly linked to the use of transport equipment (airplanes, trucks, cars) owned or controlled by the company
- Scope 1 represents two-thirds of the carbon footprint of agriculture in Mauritius, mainly because of non-CO_2 emissions (namely methane and nitrous oxide) that just between themselves, represent more than half of the emissions from that sector, indicated as CO_2 eq
- Real estate is the only activity having a majority of its emissions (2/3) in scope 2 (purchase or production of electricity)

Nearly 40% of the sectors (11) show an upstream scope 3 above 75% of the total emissions:

- 93% of all emissions from the mineral products sector and the building materials sector are in scope 3
- Numerous industrial sectors in Mauritius show a scope 3 that is above 80% (metal industry, equipment, stationary, plastics engineering, textile, food industry…) The same is true for service activities to companies
- The food industry and the textile industry have in common the peculiarity of an upstream scope 3 heavy in non-CO_2 emissions because of their upstream value chain (agricultural and chemical activities).

[19] *The Science-Based Target initiative (SBTI) launched by the Carbon Disclosure Project, the World Resources Institute (WRI) and the United Nations Global Compact (UNGC), proposes methods to companies to allow them to determine ambitious climate targets based on the state of scientific knowledge, compatible with an emissions trajectory that limits climate change to +2°C.*

The carbon footprint of the different sectors in Mauritius

	Scope 1		Scope 2		Scope 3 (upstream)		TOTAL
	kt CO_2	Other GHG in kt CO_2eq	kt CO_2	Other GHG in kt CO_2eq	kt CO_2	Other GHG in kt CO_2eq	kt CO_2eq
Agriculture, fishing	154	574	25	1	188	154	**1 096**
Forestry, woodwork, furniture	52	12	5	0	141	16	**227**
Mining	64	1	6	0	36	3	**110**
Energy	1 297	19	11	0	39	32	**1 398**
Urban services	3	77	8	0	40	19	**147**
Buildings, public works	139	21	6	0	263	28	**457**
Mineral products, building materials	37	0	3	0	505	9	**554**
Metalwork	58	1	12	0	382	44	**498**
Machines/equipment	32	3	6	0	226	22	**288**
Pharmaceutical and medical products	14	1	1	0	23	2	**40**
Fashion, textile, accessories	39	1	68	1	455	302	**866**
Leisure/culture/sports	26	7	30	0	135	23	**222**
Food industry	132	6	44	1	625	885	**1 693**
Chemicals	200	90	15	0	114	23	**442**
Paper, carton, printing	17	5	12	0	119	25	**179**
Plastic, rubber	28	0	9	0	164	16	**217**
Commerce, negotiations	20	4	73	1	124	16	**237**
Automotive services (sale, hire, maintenance)	5	0	5	0	17	2	**28**
Transport/logistics	794	17	64	2	241	61	**1 179**
Information/communication	2	1	12	0	77	8	**100**
Banking, finance, insurance	9	0	6	0	57	3	**76**
Real estate	88	0	392	5	120	33	**638**
Services to individuals	29	2	12	0	51	6	**101**
Support services to companies	48	24	38	1	350	41	**502**
Headquarters/ offices	3	0	8	0	9	1	**21**
Consulting/experts	6	1	8	0	118	11	**144**
Health, education, social	22	1	19	0	88	26	**155**
Hotels, restaurants	24	2	129	2	156	67	**380**

Source: calculations carried out by the LOCAL FOOTPRINT CLIMATE model

Warning:

► In the calculations above, scope 3 is based mainly on the upstream suppliers, Mauritian or international. In other words, we are talking about the carbon footprint generated by the procurement of goods and services (all the flows that can be traced and modeled with local and international statistics). Emissions linked to home to work commutes, to the use and end-of-life cycle of products as well as those linked to financing and investments by businesses and the banking sector in Mauritius have not been integrated in the analysis of scope 3 above.

► The sectorial breakdown (macro sectors) is inspired by the International Standard Industrial Classification (ISIC) and relates to sectors that are more or less homogenous. Heterogeneous sectors such as "tourism" are regrouped under several sectors (hotel industry, restaurants, services, transports…).

3/ Sectorial objectives for carbon neutrality

A Mauritian company will only be in a position to announce that they have reached "carbon neutrality" in 2020 if their CO_2 emissions (we will focus solely on CO_2 emissions here) are compatible with a +1.5°C trajectory. This means that their emissions will need to be absorbed entirely by carbon sinks and not be emitted in the atmosphere. It is thus essential for each company to evaluate a "carbon budget". The company stays within budgetary limit either by offsetting carbon or by reducing its emissions (see part 3). The SBTi proposes seven different methods to evaluate such a budget. The simplest method, known as the "absolute method" assigns a reduction target (national or global) to each economic player (depending on the population size for instance). Global CO_2 emissions must be reduced by 3 (and by 2.8 for Mauritius)[20]. We have thus devised a "carbon budget" for each sector in Mauritius by adhering to the SBTi guidelines and taking into consideration 100% of the scope 1 and 2 perimeters and 66% of the scope 3 perimeter.

If a company engaged in the transport sector in Mauritius wants to achieve "carbon neutrality" as from 2020, it should, on average, reduce its annual CO_2 emissions by 26 tonnes per job. A company in the hotel industry/restaurant sector would have to reduce its CO_2 emissions by 4 tonnes per job. For the energy sector, the target would be 300 tonnes of CO_2 per job.

On average, considering all the sectors, a Mauritian business has to reduce its carbon footprint (CO_2 only) by 67% to be able to achieve carbon neutrality. Because the strategy for reducing emissions (scopes 1 to 3) is staggered over time (with a need to prioritise efforts over the next ten years), the emissions that have not been reduced will have to be offset through "carbon credits".

If all Mauritian companies were to commit to a carbon neutral strategy, they would need to reduce their CO_2 emissions by 6% as from 2020 (a reduction of 6% a year will help achieve the intermediary objective of -45% in 2030). This would also mean that the cost of their residual emissions would progressively go down – it is estimated for instance that in 2020, the budget for carbon offset by Mauritian companies would be about USD45 million[21], representing 0.3% of Mauritius' GDP.

Estimated carbon budget and targeted CO_2 emissions reduction by sector

	CARBON BUDGET	TO REDUCE OR TO OFFSET	
	kt CO_2	kt CO_2	t CO_2 / JOB
Agriculture, fishing	111	194	15
Forestry, woodwork, furniture	53	98	31
Mining	35	59	44
Energy	512	822	300
Urban services	13	25	7
Buildings, public works	114	206	15
Mineral products, building materials	128	249	230
Metalwork	112	213	39
Machines/equipment	65	124	21
Pharmaceutical and medical products	11	19	27
Fashion, textile, accessories	142	268	5
Leisure/culture/sports	52	95	14
Food industry	207	386	18
Chemicals	108	183	75
Paper, carton, printing	38	71	20
Plastic, rubber	50	95	45
Commerce, negotiations	63	112	2
Automotive services (sale, hire, maintenance)	7	13	2
Transport/logistics	383	635	26
Information/communication	23	43	4
Banking, finance, insurance	18	35	2
Real estate	211	349	17
Services to individuals	27	48	8
Support services to companies	111	209	6
Headquarters/ offices	6	11	2
Consulting/experts	32	61	4
Health, education, social	35	64	3
Hotels, restaurants	94	164	4

Source: calculations carried out by the LOCAL FOOTPRINT CLIMATE model

[20] *We used the agreed upon the factor 2,8 for the scope 1, 2 and factor 3 for the emissions of scope 3*

[21] *On the basis of USD 10/tonne CO_2 (on the voluntary carbon offset market)*

4/Turning scope 3 constraints into opportunities for development of Mauritian businesses

Scope 3 emissions are more indirect and/or less visible than scope 1 and 2 emissions, hence the reason they are not taken into account to the same extent as emissions from other scopes. Scope 3 calculations are however increasingly being integrated in extra-financial reporting, due in part to some legal requirements or international protocols. Scope 3 is regarded as optional or as more flexible than scopes 1 and 2 and yet over and above the regulatory constraints, scope 3 represents some real opportunities. Scope 3 emissions represent an important part of the total emissions and thus carry the potential to transform companies and brands on top of being a strong lever for local economic development.

A company that wishes to decarbonise its scope 3, has two ways of doing so:

1. Build a responsible chain by involving suppliers (and their suppliers) in endeavours such as a "climate charter" with the aim of reducing their CO_2 emissions *(see CDP's supply chain programme for instance)*.

2. Have a more pro-active approach by choosing to transform part of the supply chain: new inputs or creation of a new decarbonised productive ecosystem *(one that is closer, more circular, more efficient…)*.

In both cases, working on scope 3 will potentially enhance the company's image and reputation.

Let us take the food industry, for instance as it is the more emission-heavy sector in scope 3 (see table below). A Mauritian company engaged in the food sector can decide to have a supplier charter to guide its choice of partners in its supply chain, based on their agricultural or breeding techniques, on the chemicals used, the choice of energy or transportation. The same company can decide to rebuild part of its supply chain by choosing, for instance:

- To substitute meat products for plant-based products (breeding is an activity that is very high in greenhouse gas emissions). The world market for meat substitute was worth more than USD10 billion in 2019 (USD30 billion in 2025)
- To reduce transportation distance (very high in CO_2 emissions) by local or regional procurement (Indian Ocean or South East Africa). This stimulates micro food factories, micro farms, urban agriculture or agro-ecology. The company can also evolve into a distributed manufacturing network through contracts and franchises.
- To rethink part of the global "linear" supply chain in terms of a circular local/regional ecosystem, recycle unsold stocks of fruit and vegetables, develop an industrial ecology partnership (for inputs such as manure or energy) or develop collection and recycling facilities for plastic waste (packaging of food products).

Main sectors emitters of greenhouse gas in the supply chain of the Mauritian food industry

Promote the commitments taken by the brand

Rebuild an ecosystem for the supply chain (local or regional)

Responsible supply chain
Supplier charter
Traceability
Certification

Meat substitution (plant-based or cereal-based)

		Scope 3 (upstream)	
		kt CO_2	Other GHG in kt CO_2 eq
Breeding	Livestock husbandry including feedlots	19	205
	Pig farming, sheep and horse breeding and aquaculture	6	63
	Dairy cattle breeding and dairy production	4	63
Cultivation	Cereal, rice, legumes and oil plants	61	301
	Fruits	10	124
	Other plants (sugar cane, spices, aromatics, etc.)	10	47
	Agriculture support activities	4	13
	Wet corn milling	14	0
Chemicals	Production of fertilisers	25	13
	Production of other basic organic chemicals	22	2
	Production of other inorganic chemicals	12	0
	Production of synthetic resins and plastic materials	11	0
Energy	Generation, transmission and distribution of electricity	80	1
Mining	Mining of petrol and gas	11	13
	Coal mining	2	17
Pharmaceuticals	Manufacture of pharmaceutical products and herbal products	17	0
Metalwork	Ironworks (ferroalloy, steel, etc)	29	0
Food Industry	Slaughter and production of meat-based products (excluding poultry)	60	0
Transport	Land transport for goods	79	3
	Pipeline transport	0	14
	Air transport	10	0
	Maritime and inland waterway transport	9	0
	Other sectors	11	2

Local or regional chain, micro-transformation and micro-farms

Industrial ecology/ circular economy/ food recycling

Commitments (Technical, agricultural, inputs, energy, means of transportation…)

Promote the company and add to storytelling of the brand

Constrain, raise awareness or incite existing supply chain

Source: calculations carried out by the LOCAL FOOTPRINT CLIMATE model

2

TURNING MAURITIUS INTO A LABORATORY FOR A NEW CLIMATE ECONOMY

2

In order to meet head-on the climate challenge, Mauritius must address both its territorial emissions (to attain neutrality) and its imported emissions. **Questioning its imported emissions will be an opportunity for Mauritius to rethink its current model of manufacturing, its energy use and its food supply, as these constitute the very heart of the country's economy and hence, its resilience - or not, as the case may be.**

Territories just like businesses have to face up to their responsibility and go beyond just addressing the matter of their own emissions. A step further would be to commit to reduce their impact on other scopes and do so by collaborating with one another. Platforms such as "Nou Lenerzi" can help to do so by opening the dialogue between local businesses. "Nou Lenerzi" is a dynamic focused on energy efficiency and renewable energy, driven by Business Mauritius and addressed to the business community in Mauritius.

THE EQUATION FOR A NEW CLIMATE ECONOMY

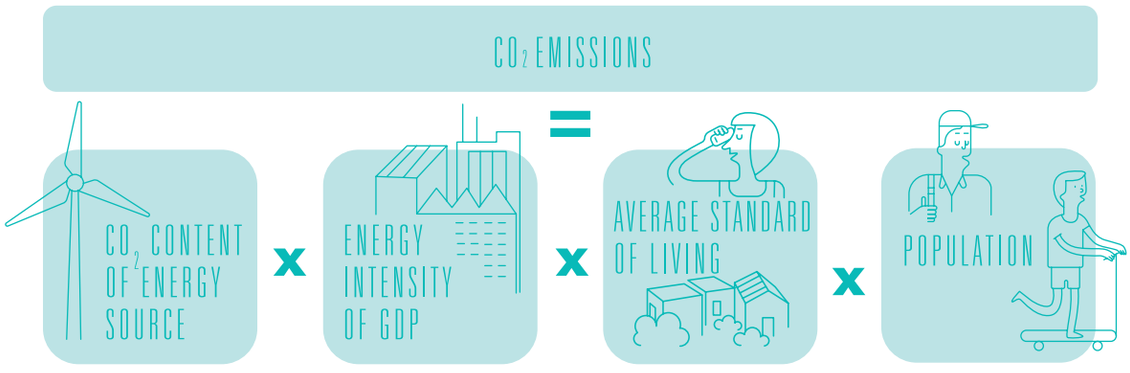
What is the relationship between CO_2 emissions and socio-economic parameters such as GDP, energy intensity and the population? Understanding this is key to helping Mauritius and its economic players understand the opportunities that lie ahead. The KAYA[22] equation is relevant here.

The global KAYA equation is as follows:

$$CO2 = \frac{CO2}{NRJ} \times \frac{NRJ}{GDP} \times \frac{GDP}{POP} \times POP$$

With the following variables:

- GDP/POP: GDP per inhabitant: It's a measure of the average standard of living
- NRJ/GDP: Energy intensity of GDP: It's the amount of energy that is needed to produce one dollar worth of goods or services.
- CO_2/NRJ: CO_2 content of energy: It is the amount of CO_2 that needs to be emitted to obtain a given amount of energy. It depends on the share of the various sources of energy used in the world. Reducing it implies increasing the share of "low carbon" energy.

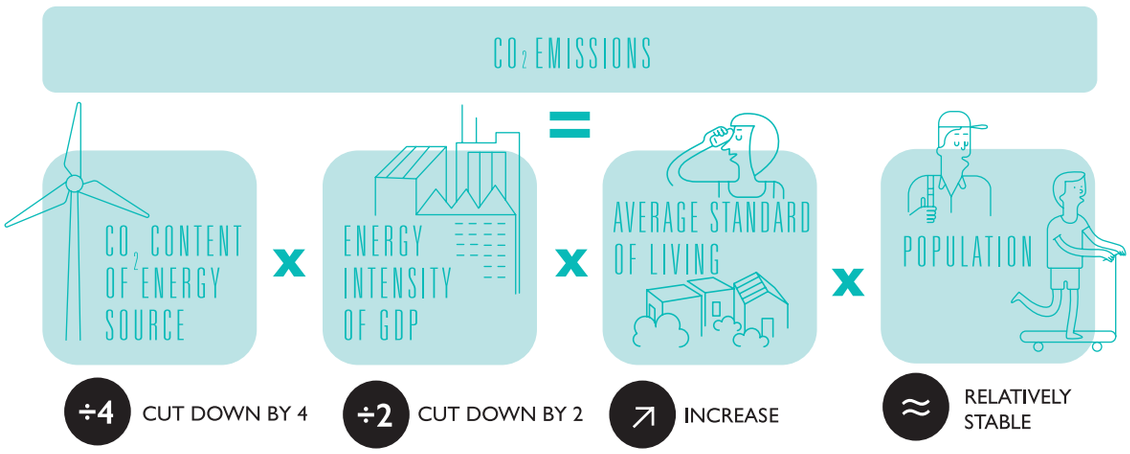


[22] *The KAYA equation is used by the Intergovernmental Panel on Climate Change (IPCC) to analyse the evolution of CO_2 emissions. The KAYA equation is also used by the International Energy Agency to analyse the evolution of the CO_2 emissions released by fossil fuels. For Mauritius, the KAYA equation is as follows: (data from 2017) : CO_2 (4,28MT) = TOE/GDP (0,11 tonne of oil equivalent by K$ GDP) x CO_2/TOE (2,9456E-06 Mt CO_2 by tonne of oil equivalent) x GDP/HAB (10,5 K$ GDP by inhabitant) x 1 265 000 inhabitants*

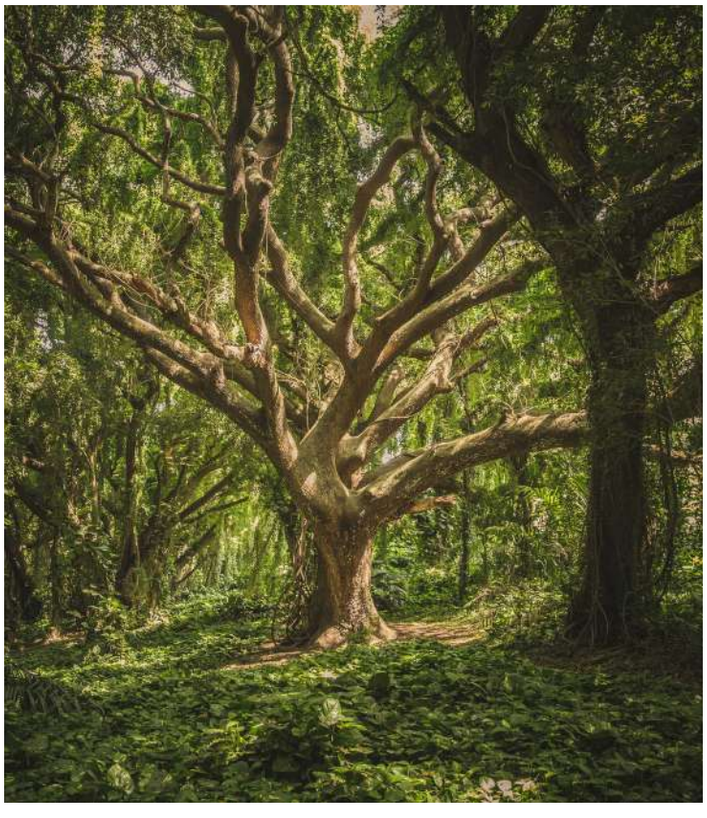
The KAYA equation shows four factors that have a direct impact on the evolution of CO_2 emissions: the population, the standard of living, the energy intensity of an economy and the carbon content of energy. In the case of Mauritius, two of the four factors have to be de facto dismissed as the country intends to continue to raise the standard of living of its inhabitants while also intending to transit to a high-income economy. This means that the two remaining levers have to be activated – a reduction in the energy intensity of the economy (using less energy to produce one dollar of GDP) and the decarbonisation of the energy mix (emitting less CO_2 for every unit of energy produced).

In view of the economic and demographic projections for 2050 (a slight decrease in the population and an increase in the standard of living with a 4% annual growth in GDP per capita)[23], the division by three of CO_2 emissions would entail the following : a division by two of the energy intensity (it will be hard to do more), and a division by four (at the minimum) of the carbon weight of energy (decarbonisation of energy).

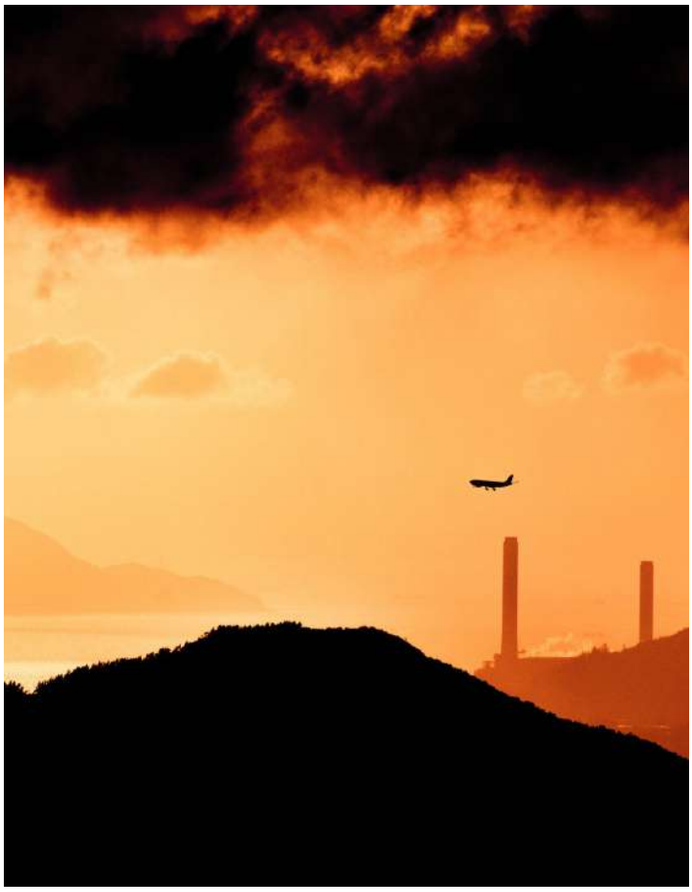
REDUCING EMISSIONS AND ENABLING ABSORPTION BY CARBON SINKS



[23] *Based on the assumption that the current growth rate continues to rise between 2025 and 2050*



THE TWO CHALLENGES OF THE NEW CLIMATE ECONOMY



The two challenges of the new climate economy are to reduce energy consumption and to decarbonise energy. Reducing energy consumption implies less transport, more energy efficiency, more restraint, less linearity to allow for more local loops, in short to better "distribute" the economy and organise it in terms of networks. Decarbonising energy means a completely different energy mix by 2050 in terms of renewable energy and future technological innovations – stocking of energy, nuclear fusion.

1/ CHALLENGE 1: Decrease the energy intensity of the economy

Decreasing the energy intensity of the economy means a situation where there is a decrease in energy consumption for an equivalent economic production.

A study of the flow of primary energy between different sectors of the economy globally[24] (direct consumption in the sector or indirect via procurement from other sectors) shows theoretical ways of reducing by half the energy intensity by 2050:

1. Reduction of 1/3 of international transport: -10% of energy consumption (from the reduction of transports' distance and not from the reduction of international exchanges)
2. Reduction of electricity consumption and fossil products: -25% of energy consumption (except mobility)
3. Implementation of a circular economy up to 75% in every industrial and manufactured sectors: -15% of energy consumption[25]

[24] *Source: LocalFootprint, Utopies*
[25] *with the assumption that recycling will enable a 50% energy gain*

A/ Reduce distance in terms of international B2B transportation

International transport is an important lever for reducing Mauritius' carbon footprint in all sectors. 340 000 tonnes of CO_2 are emitted by air transport and another 340 000 tonnes of CO_2 are emitted by land transport for the purposes of the country's importation needs. But, reducing the emissions generated by air transport requires an in-depth pondering on the possibilities of relocating some of the production nearer to its market.

However, relocation for the sake of benefitting Mauritius in terms of profitability and competitiveness makes sense only if the processes used locally emit less than when imported.

To reduce the emissions linked to international transport by one third, Mauritius needs to intervene on the following:

- Plan local production sectors, in particular with regards to the food industry and textile as well as research substitutes for the importation of chemical products, machinery and equipment;
- Develop local industry, paying particular attention to micro-production in all the sectors.

ACTION PLAN FOR MAURITIAN BUSINESSES

► Analyse and question supply chains: could some products (imported in high volume) be produced on Mauritian territory or in the Indian Ocean region? If not, could those products be replaced by substitutes?

► Progressively structure local chains of production by investing in industrial tools

► Rethink production so that relocation becomes an opportunity for better climate performance (next part)

► Direct production to local market as much as possible and develop consumer demand for new substitution products

► Finance research on new models of production/processing/distribution

► Meet and organise networking with actors in all sectors of local manufacturing (small producers and makers).

Reduce distance not (necessarily) international exchange! Towards a distributed economy

Throughout the world, the average physical distance between an exporter and an importer of goods is 6,700 km (as the crow flies between the two countries and taking into account the economic barycentre of the each country). The distance between Mauritius and its international suppliers is more than 7,600 km. Interestingly, there is little variation between products (around 300 km). This shows a strong polarisation in terms of globalisation and highlights the specialisation of the major economic blocs. The "distribution rate" of global exchange is only at 10% (the exchange of a product on average impacts only 10% of the countries). To reduce international transport by one third means reducing the distance: the average distance between international exchanges would then be 4,400 km. This would also mean that more countries would become involved in international commerce of a given product.

Average distance between an importer and an exporter (km)	World average	Mauritian imports
Livestock and animal-based products	6 209	8 128
Plant-based products	6 564	7 439
Fat and animal or vegetable oils	6 813	7400
Food products	6 274	7 764
Mineral products	6 201	7 657
Chemical or industrial products	6 177	7 802
Plastic, rubber etc.	6 553	7 760
Leather, pelts etc.	6 843	7 897
Wood, wood charcoal etc.	6 192	7 534
Paper and carton	6 374	7 537
Textiles etc.	6 855	7 355
Shoes and fashion accessories	6 971	7 223

Distance can be reduced the following ways:

• By a "local" approach: bringing production closer to consumption by adapting production tools, industrial synergies, digital tools (platforms, automation) and proximity logistics;

• By introducing "regional" approaches (major regions of the world), thanks to massive diversification of national economies, the development of regional free trade zones and the creation of "Special Economic Zones". These would aim to attract international investors, in particular those specialised in the new climate economy (see below) and to allow territories to diversify, to build more complex economies and to integrate into a regional trade network.

• Reducing distance also means working towards enabling distribution directly from production sites, meaning that there is a need for strategies of direct investment abroad (instead of exportation of goods). This, in time, will separate creation or design done abroad from local production.

From a decentralised economy (current globalisation) to a "distributed" or collaborative economy

Centralised **Decentralised** **Distributed**

Examples //

#textile / TEKYN is a technological platform as well as a short-circuit production model that produces clothes in desired quantities. Brands can order the production of the exact number of clothes they need, based on demand from the shops. Production happens in France, a practice that contrasts with the more conventional one of ordering large quantities of ready-made garments at low prices in faraway corners of the world. TEKYN has devised this Made in France production solution that can produce what is needed in just four days and in short circuit, thus eliminating overstocking. The way it works is that a brand connects to the platform, selects the number and the models needed as well as their size and colour. The pre-production centre is computerised and automated and already stocks fabric supplies and labels. Once the order is received, it launches the cut-out of the models based on the sewing patterns that have been selected. It will then send the ready-to-make kits to one of the workshops. Once the clothes are ready, they are dispatched to the storage centre of the brand in question.

#building materials / ROOSENS BÉTON is a Belgian manufacturer of concrete that uses micro factories to reduce the logistic requirements associated with the use of concrete on building sites. The production unit is in a converted shipping container, making it perfect in terms of size for transportation at the back of a lorry. Because it produces the concrete on-site, entrepreneurs can buy their primary materials (sand, gravel, cement) from local sources rather than having to transport bricks and heavy slabs over long distances. These production units have been successfully used on projects in Africa and in South America.

The Belgian family-owned SME has three operating facilities in Belgium, one in Poland and six African partnerships through micro-factories. It produces on average 300,000 tonnes of cement a year with a carbon footprint of 91.17kgCO_2eq/tonne of concrete manufactured. That is about 40% less than standard concrete.

B/ Reduce consumption of electricity and petroleum products

Coal, used mainly for the production of electricity, constitutes nearly 40% of Mauritius' territorial emissions in primary energy[26]. Consumption of petroleum products (fuel, kerosene, gasoline and diesel) make up more than 60% of the country's territorial emissions in terms of primary energy[27].

Industrial and tertiary efficiency can be improved in the following ways:

- Developing a bioclimatic architecture by adapting buildings (residential, commercial and tertiary) to technology to fit the specificities of a tropical climate;
- Testing industrial equipment for energy efficiency. This can contribute to energy savings of nearly 40%[28]. In Mauritius, the National Energy Efficiency Programme, led by the ministry of Energy and Public Utilities and Business Mauritius, evaluate that energy efficiency would bring energy capacity requirements down by 40 MW, representing savings of Rs1.2 billion a year[29].
- Consider pooling energy needs in planning zones, whether industrial, tertiary or mix. The dynamics of industrial ecology constitute interesting opportunities for energy collaboration. For instance, factories can create their own electricity by cogeneration, which is by producing it simultaneously from the heat needed for the process. They can also sell the excess steam produced or heat recuperated from the effluents. In doing this, they participate in setting up real ecosystems of local energy;
- Evolution in transport through the development of low carbon transportation, new infrastructure, energy transition of the fleet of vehicle but also the evolution of ways of living and of working; telecommuting allows the reduction of nearly 30% of environmental impacts associated with home-office commuting[30].

Examples //

#performing industry / RENAULT X VEOLIA X MOROCCO/ ZERO EMISSION PLANT

Renault and Veolia, in partnership with the Moroccan government, have built the most sustainable automobile production unit in the world with zero carbon emission and zero industrial liquid discharge. Thermal energy consumption has gone down by 35% and the processes have been reviewed to minimise water consumption. Water consumption has been reduced by 70% per year, equivalent to 175 Olympic swimming pools thanks to a water recirculation loop. All industrial liquid discharge has been eliminated. A sustainable cogeneration system using renewable biomass as main energy source is used for the thermal needs of the site. 60% of the energy used onsite comes from the wind and 40% from biomass issued from olive residue. This reform has eliminated 135 000 tonnes of CO_2. The plant won the Production prize of the 5th Sustainable Energy Europe Awards organised by the European Union and was registered for the UN's Clean Development Mechanism.

[26] *Total energy consumption required to satisfy final energy demand, including loss of energy in electricity transmission lines*
[27] *http://statsmauritius.govmu.org*
[28] *Negawatt Report/RAC – Energy transition of the industrial sector*
[29] *Programme National d'Efficacité Energétique, 2018*
[30] *ADEME study*

#industrial ecology /REDA INDUSTRIAL PARK (RIZHAO, CHINA)

Reda Industrial Park is an eco-industrial park that was created following the introduction of legislation encouraging the setting up of a circular economy, in a bid to compensate for environmental issues (pollution, lack of space at the landfill, expensive virgin materials). This legislation dates back to 2008 and makes it mandatory for plants and industries, especially those that are resource intensive, to be part of a recycling network. Using a top down guidance, China managed to create an industrial symbiosis much faster than other eco-industrial parks such as the one in Kalundborg. The park has attracted 420 businesses and USD640 M in investment. REDA does not host any waste treatment plant and yet, thanks to a combination of symbiosis and cleaner production practices, 98% of the solid industrial waste is recycled.
In 2011 alone, 71 446 tonnes of white sludge were used as substitution for calcium carbonate in the citric acid and concrete plants of REDA. Nearby concrete plants and factories manufacturing building materials obtained over 66 000 tonnes of fly ash and 20 000 tonnes of green slime as raw materials. Heat transfer and recycled water as well as reduced distance in terms of transportation of materials have had a major impact on the carbon footprint of the site.

#bioclimatic architecture/UNIVERSITY OF LA REUNION (MOUFIA AMPHITHEATRE) SAINT-DENIS

In tropical countries, the climate is not always taken into consideration when building. This often results in excessive energy consumption to counter the heat (through the use of air conditioning). The intertropical zones are also being densely urbanised with an increase in built-up areas, a lack of green zones and inadequate air circulation and a high impermeability of soils. These urban heat islands increase the temperature by at least 6°C, which means even more intense use of air conditioning. A bioclimatic approach can be taken for new buildings or those that are being renovated. There are three ways this can be done: an efficient thermal shell, natural ventilation and the use of renewable energy.
The Moufia amphitheatre in Saint-Denis, Reunion Island has been designed like an outdoor theatre. It is built from wood and uses only natural ventilation. Because of its bioclimatic concept, the room temperature remains comfortable without the need for air conditioning. This enables savings of 25% in energy consumption compared to a more classical amphitheatre.

ACTION PLAN FOR MAURITIAN BUSINESSES

- For all economic players: carry out energy audits and introduce an energy performance plan: tertiary, residential, commercial… depending on the sector
- Work in terms of sector of activities in order to encourage energy collaborations and anticipate these opportunities when analysing investments or implantation projects
- Initiate transformation of fleet
- Optimise commuting of employees (introduce telework etc.)
- Initiate Research and Development in industrial ecology. Creating a network for players in the same sector or of the same size is a good idea.

Mobility – towards a new trend

It is not just about infrastructure or fleet transformation; it is also about changing trends and practices in mobility.

- **Multimodality:** Beauregard is an economic activity zone in Vienne, France, created in 2017 with a multimodal centre of 2,800m^2 with 45 parking spaces covered with photovoltaic shading, a carpooling area, a regional bus-stop for connectivity to central areas such as Nantes and Poitiers, a departmental bus-stop as well as school transport. The centre encourages connectivity with neighbouring areas and offers secure parking space for bicycles as well as charging points for electric vehicles (automobiles and bicycles).
- **Carpooling:** In North America, motorway connections (known as managed lines) that lead to big metropolises often have one lane (out of six or eight) dedicated to vehicles carrying more than two people, buses, taxis and hybrid cars. Punitive fines of USD200 and USD400 in case of repeat offenders ensure the success of the measure.
- **Car sharing in zones of activity:** The Compagnie des Transports de la Porte Océane, a subsidiary of Transdev launched a car-sharing platform, DRAKCAR, in 2016. The platform connects drivers and passengers who work for companies found in the industrial zone and port zones of Le Havre – home to 30,000 jobs altogether. Many of the workers are temporary staff who come from the town centre or have limited means. Contrarily to classic car sharing, all the destination points in the zone are predetermined as all the companies of the zone are de facto and freely referenced. The employer, who pays a yearly fee based on the number people it employs, can request other destination points. A trip currently costs 0.12 euro per passenger and nearly 280 local companies are referenced on the platform.
- **New schedules:** In California, a new experiment encouraged commuters to move their traveling times outside peak hours in exchange for points (1 to 6 depending on the time) that are converted into cash. 18,000 people tried the experiment, resulting in a 10% decrease in the number of passengers in peak hours. This went on for four months after the end of the experiment.
- **Supporting users:** In Chambery, MobiLAB offered new and free alternative means of transport as replacement for the individual car for short trips (bicycles, scooters, electric scooters, monocycles etc). Volunteers were given individual coaching sessions to help them use the new means of transport.
- **Contactless payments:** In London, the contactless method of payment is used by all modes of public transport – buses, the Tube, Overground, DLR, Tfl, Rail, River Bus etc. This measure saves time as the amount is debited straightaway from the bank account of the traveller. This system is also in place in Moscow, Vancouver, Singapore and Milan.

C/ Develop the circular economy and local loops

Introducing the dynamics of the circular economy in the main industrial and manufacturing sectors would reduce upstream emissions linked to mining, the importation and processing of raw materials with a high footprint. Sectors that would benefit the most are those that can ambitiously integrate recycling in their activities: mining, metal, plastic, wood and paper.

As mentioned before, the metal industry is one of the sectors of the Mauritian economy that emits the most CO_2 with 90% of imported emissions. It is thus a sector with a lot of potential for gains in terms of primary energy (hence of avoided emissions) by recycled unit: aluminium: 94%, copper: 85%, lead: 75%, silver & steel: 72%, cadmium: 50%[31].
Metal products in the form of machinery and equipment also have a heavy footprint.

The textile sector is as heavy an emitter mainly due to the production of synthetic fibres, more often than not, imported. The importation of chemicals has a high climatic impact due to the manufacture of artificial resin and plastic materials.

ACTION PLAN FOR MAURITIAN BUSINESSES

- Structure recycling facilities, invest collectively in recovery infrastructure in all sectors
- Provide for the recycling of main packaging from the moment of conception of the product and communicate the news.

Examples //

#rare earth/ HYDROMETAL

Hydrométal is a recycling company based in Engis, Belgium that deals in a wide range of raw materials, by-products and complex industrial residues that contain nonferrous metals. The hydrometallurgy treatment provides an important alternative to the landfill and contributes to the development of sustainable solutions that reduce the consumption of natural resources. Hydrométal has developed a recycling process for rare earth (95% of which is supplied by China) by producing salts or oxides/carbonates of rare earth, essential in windfarms, fibre optics, electric cars and low energy bulbs.

#textile / REGENERATOR

Recycling fabric is a delicate enterprise in particular when it concerns blends such as polyester and cotton, two extremely popular materials. The Regenerator is one of the winners of the Global Change Award 2018 and they have created a circular technology, using an environmentally friendly chemical product to separate and delicately regenerate the blends of cotton and polyester into a new fibre material fit for use. The process decomposes polyester while leaving the cotton intact.

The team is currently targeting industrial fashion networks outside of its geographical location. A subsidy by the Global Change Award will help to improve, optimise and extend the process of the Regenerator.

[31] *United States Environmental Protection Agency (EPA), American Geoscience Institute*

II/ CHALLENGE 2: Decarbonise the energy mix

To attain global neutrality, the carbon weight of the energy mix will have to be divided by four.

Understanding the magnitude of the challenge as well as the course that needs to be chartered goes through a proper analysis of the consumption of primary energy by sector. The current global CO_2/NRJ coefficient stands at 2.88 tCO_2/TOE. **To reach a figure of 0.64 means a radical change in the energy mix, namely a drastic decrease in the share of three fossil energies – gas, coal and petrol. Ideally, they should each be limited to an average of 3% of the world mix –** against 28% each currently. This would constitute their quasi-elimination in the world's energy mix as they currently stand at 75%!

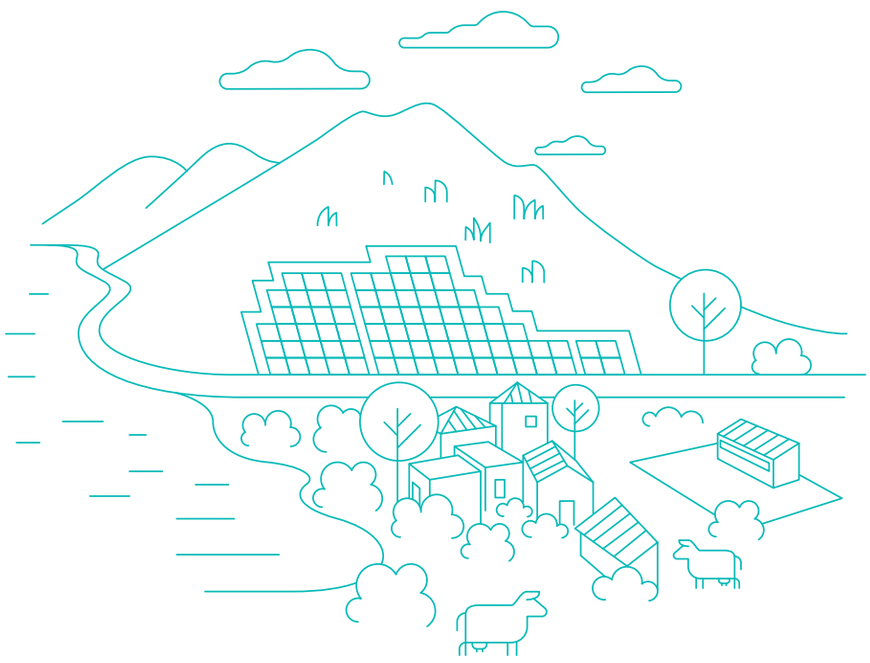
Conversely, the share of lower carbon energy in particular RE such as wind, sun, geothermal, hydro-electricity and biomass should leap from 15% in 2015 to **90% in 2050.**

The challenge is the same locally: we need to reach a CO_2/NRJ co-efficient of 0.7 tCO_2/TOE from 3 currently and greatly reduce in an order of magnitude of 80%, the consumption of coal and oil (gasoline, fuel oil, diesel, kerosene) representing 28% and 53% respectively of the energy mix in primary energy.

The potential of RE in Mauritius is fortunately up to the challenge and in theory, even exceeds the projected energy consumption of the country for 2030. The potential for solar energy, thermal energy, biomass as well as onshore and offshore wind energy and marine energy (ocean wave energy)[32] is remarkable. Yet, renewable energy currently only accounts for 13% of the demand for primary energy. 88% of that come from bagasse.[33]

The decarbonisation of the energy mix will have to go through the setting up of new infrastructure at all levels; decentralised RE production, development and complementarity of the distribution network, conversion and energy storage infrastructure, new RE production equipment…

Recent technological and legal innovations, namely blockchain, pave the way for new decentralised and collaborative models of production and storage of renewable energy that limits loss of energy due to transportation. In turn, it opens up many opportunities for sharing. The opportunities are many in the industrial, agricultural and tertiary/residential, with new economic models that offer an important complementary source of revenue to producers.



[32] *http://publicutilities.govmu.org/English/Documents/Doc_2018/Mauritius%20Marine%20Energy%20Roadmap.pdf,http://statsmauritius.govmu.org/English/Publications/Documents/2019/EI1454/Energy_Yr18.pdf, https://www.tandfonline.com/doi/pdf/10.1080/15435075.2014.888657,*

[33] *The share of bagasse in the RE mix is expected to remain stable; the land dedicated to sugarcane and the low level of agricultural diversity in Mauritius lead to high CO_2 emissions (see emissions from importation in the food industry sector)*

Decentralising energy

Decentralised production works inversely from the classical model where a big power station would supply an entire territory with energy. Instead, there would be several small units, mainly electric (but also of biomethane) that are connected to the network through low voltage levels.

Decentralisation brings about several important revolutions in the energy system:

- **It gives a territorial dimension to the energy system, that can be conceived in different scales according to the resources of renewable energy on said territory and depending on the local energy needs; whether it is to serve a region, a district or a community;**
- **The consumer becomes central to the system and knows the source and the cost of the energy and this in turn, reinforces the feeling of responsibility in the way he or she will consume energy… they could eventually even collaborate in producing the energy needed;**
- **It reinforces the performance and the resilience of the network; in time, decentralisation will lead to a reduction in line losses and ultimately bring about a decrease in network costs, namely electric. The network is currently adapted to cater for a few hours of peak time consumption a year and brings partial autonomy from the local energy system in case of major accident on the network.**

For instance, should the consumption of primary energy be divided by two (the first factor of the KAYA[34] equation), Mauritius would need the following (without prejudging the capacity of future innovations in hydrogen, nuclear and marine energy):

1- A reduction of over 80% of the share of coal and petroleum products in the consumption of primary energy

2- The production of some 9 400 MW from renewable energy capacities by combining the following infrastructures :

- Solar power plants and a mass deployment of solar panels on the roofs
- Large-scale biomass plants and mini-units, in hotels, factories or small farms
- Medium-sized wind turbines (more than 380 to reach 10% of the energy needs)
- A network of storage (more than one hundred units) to make up for the intermittency of solar, marine and wind energy
- In view of the current performance of renewable energy technologies, the decarbonisation of Mauritius' energy mix also requires further research efforts to increase efficiency and maintain the level of energy production.

Example of energy capacity depending on the size of infrastructure

Objective // 9 400 MW	**Micro** (habitation)	**Small** (commercial centre)	**Medium** (industrial equipment and community projects)	**Big** (community production)	**Maximum**	**Load factor**[35]
Solar	1kW - 5kW	10kW - 100kW	100kW - 2MW	2MW - 10 MW	2GW	10%
Hydroelectric	< 5kW	5kW - 100kW	1MW - 30 MW	> 30 MW	22GW	28%
Wind	2.5kW	10kW - 3MW	3MW - 20 MW	> 20 MW	1.2GW	25%
Tidal	-	-	1 MW - 20 MW	50MW – 200MW	320MW	-
Biogas	0.5kW - 5kW	10kW - 200kW	200kW - 2MW	2 - 6 MW	140MW	-

[34] *Which corresponds to halving energy intensity while multiplying GDP by 2.5*

[35] *Ratio of energy produced by a plant compared with its nominal capacity, considering variability in production.*

Renewable energy, variable production yet smooth, predictable and compensable

- Variable – Some sources of renewable electric energy have a variable production because they depend on meteorological conditions as well as the night/day cycle. It is the case for wind and sun energy. The load factor of an electric installation is the relationship between electric energy effectively produced in a given period and the energy that would have been produced had it functioned at nominal capacity during the same period. It is variable from 70% to 90% for nuclear, 50% to 80% for gas, 50% to 80% for coal (67% for Mauritius), 15% to 25% for wind energy etc.
- Smooth – Historic analysis of production of both show that wind and solar energy, despite their variability, complement each other over a period of a week or a month: deficit in production of one is general made up by greater production by the other.
- Predictable – A network manager knows how to predict the evolution in production of wind and solar energy and thus anticipates the complementary means of production to be launched.
- Compensable – The development of wind and sun energy would mean change in the level of activity of coal power plants. It can also be replaced by a variety of renewable energies such as thermal plants operating with renewable energy (bioenergy) and new marine energy (tidal, waves, hydro or ocean thermal energy). Electricity storage such as energy transfer by pumping also makes up for deficits in production of wind and sun energy. Sun and wind energy, together with non-fossil production plants and storage infrastructure for hydraulics and flexibility devices can be developed without compromising the power grid.

Converting coal power plants

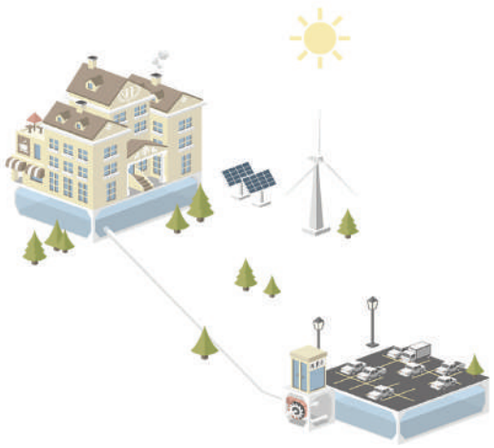
There have been several projects of late to convert coal power plants into biomass plants in the UK, in Germany as well as in Guadeloupe. The aim was to replace coal combustion by combustion of a biomass resource such as wood waste or sugarcane waste but with two conditions: renovation works necessary to allow a good combustion of biomass as well as the local availability of resources, without depriving other activities of its resources. Albioma was charged with converting a coal power plant of 34 MW in Guadeloupe into biomass so that the country's energy mix would consist of 35% of renewable energy instead of 20.5%. Such decisions should ideally go hand in hand with the priority development of RE infrastructure, decentralised if needed – sun, wind, hydro etc.

Marine energy

Marine energy offers interesting opportunities for Mauritius:

- **Tidal energy, caused by the ebb and flow of moving water can provide up to 380TWh a year, some 1.5 to 2% of the world's electricity consumption;**
- **Hydro energy, harvesting sea currents;**
- **Wave energy, produced by wave movement[36] ;**
- **Ocean thermal energy, harnessing the gradients of temperature between surface water and deep water. On great surfaces of tropical water, the difference in temperature between surface water (warmed by the sun) and deep water (hundreds of metres deep) is over 20°C. This natural phenomenon can be harnessed according to the Marine Thermal Energy process. This resource is accessible, stable and available 24/7;**
- **Osmotic energy, based on the difference in salinity between fresh water and sea water;**
- **Marine biomass energy: Biofuels from micro-algae are good substitutes for diesel and gasoline and provide ideal solutions for decarbonising the energy mix. These organisms capture atmospheric CO_2 by photosynthesis and are then transformed into biofuels by different industrial processes. The gas that is rejected is again absorbed by micro-algae and closes the carbon cycle: CO_2 does not accumulate in the atmosphere.**

Examples //



#storage/URBAN MICRO-STEPS

Nature and People First has conceived an energy storage solution that integrates seamlessly in the urban environment: the setting up of small pumped storage power stations in the basement – the undergrounds of building or parking spaces. The energy is stocked in a 100% renewable way and is right on-site of where it will be consumed. This allows a better management of consumption peaks in the networks without having recourse to other polluting energies as a way to complement supply. An integrated urban micro-step is made up of two water basins placed in an incline and linked by a penstock pipe. A pump and a turbine are added to the installation and the pump is turned on whenever there is a peak in production, thus allowing the storage of water in the basin found at the top. During peak consumption periods, the water is directed to the bottom basin, which turns the turbine on, thereby producing energy. The energy that is produced is 100% renewable, does not depend on or use fossil materials and does not generate toxic waste.

[36] *The World Energy Council has estimated at 10% the theoretical potential of the world's annual electricity demand that could be met by wave energy*

#smartgrids/BROOKLYN MICROGRID

BROOKLYN MICROGRID (BMG) is a green, shared energy project. It consists of a micro network of local energy developed by TransActive Grid and supported by the city of New York as well as Siemens. TransActive Grid is a cooperative that regroups two companies, one engaged in the development of networks while the other one is in Bitcoin. The aim of the project is to enable residents to avoid as much as possible the use of electricity produced by the traditional suppliers. Money generated by the sale of solar energy that is produced onsite stays in the community, at the same time ensuring that no energy is lost due to transportation. Brooklyn has since become a symbol of green energy via blockchain and has been replicated in several other places (including 40 projects in the United States). It has helped democratise the use of solar energy in the US and in the world.

#new economic models/REDAVIA

Redavia has brought down the initial cost of solar panels by offering the flexible rental of photovoltaic systems to people in far-off regions, in particular in East Africa and West Africa. Redavia's Fast Track Solar system is the first unsubsidised and privately financed progressive solar energy product in the world. It can be assembled onsite 85% faster than a standard system and with 85% less labour. The rental price remains fixed, making the system particularly interesting for countries and communities that depend on imported fuel with its resulting fluctuations in world prices. The company also offers subsidies in terms of solar share to people with low revenue and can work with government financing plans. The electricity produced by Redavia Rental PV is 20% to 40% cheaper than diesel-generated power and reduces the emissions by 0.7tCO_2 per kWh.

#electric mobility and storage of renewable energy /RENAULT

Renault recently launched the Advanced Battery Storage, a project that aims to construct the biggest stationary electricity storage ever built, made up of batteries from electric cars in Europe and stored in containers. Renault's objective is to be part of the integration of renewable energy into the grid. Both new and second-hand batteries are used, stored for later use. The battery network is linked to a control system that supervises the charging and the discharge linked to the grid. The stocked energy can be loaded onto the grid as soon as needed, thanks to converters found inside the containers. The battery reservoirs are stored in strategic locations that are linked to the electricity grid. Three sites are currently being used – two in France, at Renault plants and one in Germany, in a former coal power plant.

ACTION PLAN FOR MAURITIAN BUSINESSES

- Initiate and encourage efforts to revise the legal framework on decentralised energy production as this remains the main obstacle to the development of these kinds of solutions. The Utility Regulatory Authority set up in Mauritius in 2016 is an ideal platform for an intensive dialogue on the matter
- Introduce new economic models of RE investments in development projects
- Finance Research and Development on different energies for Mauritius
- Contribute to the strategic planning of sectors through the blueprint on territorial energy by sharing data on consumption, performance of the grid and potential mutualisation in industrial parks or in catchment areas
- Progressively install small and medium capacity infrastructure for decentralised energy production in the industrial, residential and tertiary parks.

BUSINESS OPPORTUNITIES FROM A NEW CLIMATE ECONOMY

The climatic situation offers an opportunity for a new climate economy. This new climate economy offers a wide range of economic and business opportunities to Mauritius in many sectors:

- Goods, inputs and services for the production of RE (wind farm, solar energy, biomass plant, marine energy, urban micro-steps, small hydropower, geothermal…)
- Products and equipment for the sequestration/ storage of carbon
- Products, machinery and services for the development of local micro-factories (printing, 3D, automation, AI, new mobile industrial solutions or kit…)
- Goods and services for energy saving, goods and services for energy management/ climate (management, measure, smart grid, blockchain….)
- Eco-products conceived for a better environmental performance throughout their lifecycle (including end-of-life): mobility, accommodation, textile, furniture, materials…
- Goods, materials, equipment and services favouring better waste management and recycling of products
- Vegetarian foodstuffs (innovative mainly), urban agriculture and vertical agriculture
- Solutions for the protection of natural resources and of oceans (coral, dam…) services and technologies to anticipate rising water (residential areas and floating structures)
- Sustainable tourism (biodiversity, local communities…)
- New climate services (offers and compensation solutions, platforms serving to facilitate local exchanges, rental solutions/deposits/delivery, third places and labour decentralisation, carbon neutral logistic)

1/ Climate and new economic models

The challenge of Climate Change also offers the opportunity to rethink goods and services that are already being offered in Mauritius. But this must be done at the time of conception of the product or service as about 80% of environmental and societal impacts of a product are determined at that time, as well as 80 to 90% of the costs of recycling (disassembling etc.)[37]

Consideration should be given to the following, from the time of conception of a product or service:

- Calculate the climatic impact of a product and substitute it with a product with lesser impact whether in terms of its composition, its production or its use, bearing its life cycle in mind
- Fight against planned obsolescence and extend warranty on consumption goods to ten years for instance and support specifically the repair sector and encourage the availability of spare parts for the products
- Reduce packaging- it's worth noting that Mauritius' importation of plastic and rubber emit as much CO_2 as imports in energy or agriculture
- Encourage customers to make optimum use of products (for example, offer repair services as part of the sale of the product and communicate on the need to fight food waste) and progressively introduce new models of consumption.

[37] *Eco conception guide, ADEME*

Examples //

#repairs /PATAGONIA

In 2015, Patagonia took the idea of circular economy to a different level when it launched its Worn Wear campaign in a bid to help its clients repair their clothes regardless of the brand. They created a repair centre in Nevada in the US with 45 technicians and another one in Portugal. A website was created and called iFixit on which were broadcast online tutorials that explained how to replace a zip, repair a drawstring or how to patch up a veste duvet.

Vans, equipped with sewing machines and the necessary repair material went all over the States as well as over Europe. It is not the first time this outdoor brand chose to disrupt the fashion industry. The American company, created in 1972, sells sports garments, mountain and surfing gear everywhere in the world. It uses organic cotton, hemp, recycled wool or polyester generated by recycled plastic. The company's founder, Yvon Chouinard decided in 1985, to donate 1% of his turnover to associations fighting for the protection of nature. He created the 1% Club For the Planet to invite other companies to join him.

#electric mobility/ TRANSITION ONE

TRANSITION ONE is a French start-up that aims to reduce the cost of electric cars for the benefit of a greater number of consumers. Instead of creating new models, the company offers refurbishment services that consist of replacing the traditional combustion engine with an electric engine and batteries for a fraction of the price of a new electric vehicle. Refurbishment also means that less space is needed in the factory as well as less energy so the transition is one that is less intensive in resources. The company currently works with six popular makes of cars but plans to extend the options of offers depending on demand.

ACTION PLAN FOR MAURITIAN COMPANIES

- Set up a "climate innovation" team that intervenes in all stages of conception of offers of goods and services, in all sectors to democratise the notion of eco-design
- Report on the climate effort 2.0 (make public the CO_2 emissions avoided thanks to efforts in innovation on offers and devise a global impact objective and the Research and Development dedicated to it).

2/ To make of Mauritius an "industrial demonstrator of the new climate economy"

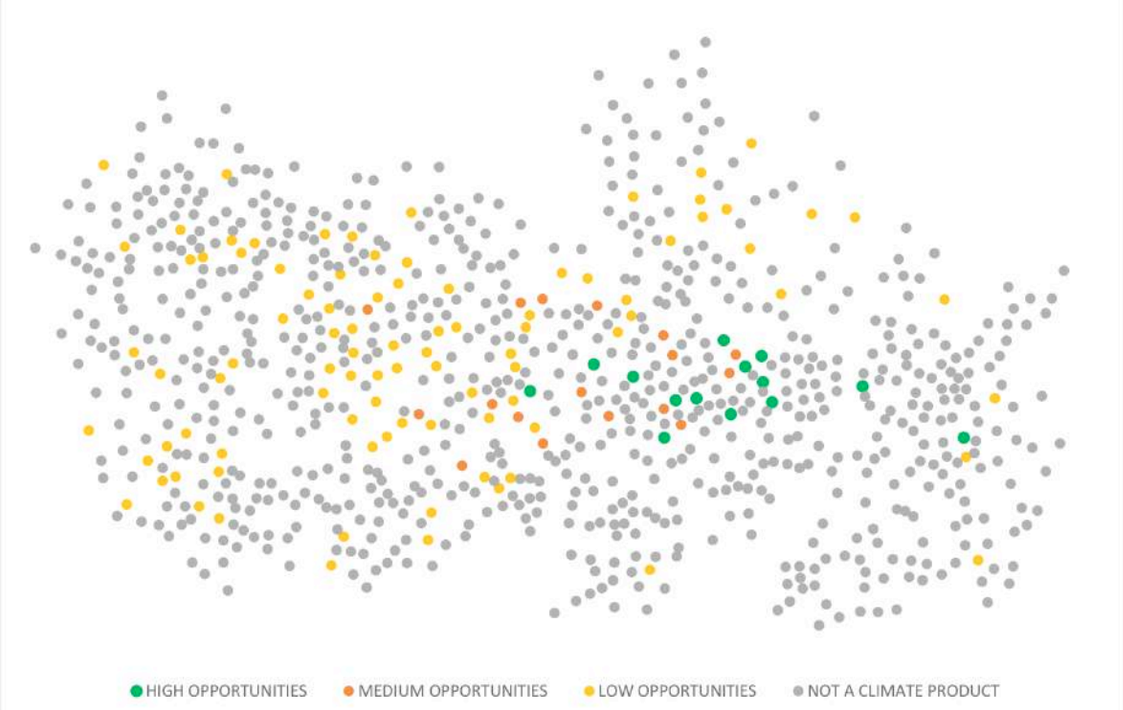
Reaching climate neutrality means going through a number of industrial innovations and this in turn, could constitute a new productive and untapped potential. This productive potential would cover a number of sectors and products and would represent roughly 10% of the array of products sold on the international market.

Industrial sectors linked to energy transition as potential opportunity sectors for Mauritius can be identified by modelling an index representing the capacity of Mauritius to diversify its activities by creating new sectors of production of goods either not produced locally or produced in limited quantity. This is done by identifying the link between the new product and the expertise it would require and that Mauritius already has (having already created a number of jobs in the sector).

There are about 15 products that seem relevant in terms of the diversification of the Mauritian industrial market towards neutrality in seven main sectors.

Of note is the fact that these products are linked to the great climate challenges of the country, as identified earlier, i.e development of RE, bioclimatic building, development of new industrial capacity (micro and recycling), especially in metallurgy and increased food security combined with a reduction in the consumption of meat-based products:

- Components of equipment for the production of renewable energy: big metal or plastic parts
- Products linked to the energy performance of buildings; construction materials with high inertia and thermal isolation material
- Building materials for wood construction
- Medium-sized metal reservoirs for carbon sequestration
- 3D production of metallic parts
- Alternative packaging for foodstuffs
- Processed vegetarian foods.



Mapping representing 900 products listed and indexed according to their productive link (same processes, same inputs…) In colour are the opportunity potential for Mauritian businesses.

The challenge for the economic players is to progressively explore these new opportunities in the context of the evolution of their industrial tools, the renovation of their offers and their investment in Research and Development towards climate neutrality.

3

INTRODUCE AND ENCOURAGE THE CONCEPT OF "CARBON OFFSET" IN MAURITIUS AND THE INDIAN OCEAN

3

"CARBON OFFSET" IN ITS DIFFERENT FORMS

Numerous companies and individuals have already decided to act in their everyday lives to reduce their carbon footprint. These efforts are nonetheless insufficient to meet the climate challenge. Even with the more advanced strategies, we will always be responsible for residual emissions. "Voluntary carbon offset" is a complementary solution to the objective of reducing emissions: one tonne of CO_2 emitted in one place can be offset in another place by the absorption or the avoidance of the emission of one tonne of CO_2, thanks to sustainable development projects.

1/ Buying carbon credits on the voluntary carbon market

The carbon offset market came about following the COP3 in 1997 when the very notion of carbon offset was defined: a player could finance a project that reduces or captures GHG emissions and receive in exchange, a certificate attesting to the quantity of GHG emissions that has been avoided or captured and that is credited to him or her. The market is a mix between a regulated market and a voluntary market. This peculiar structure has developed organically over the years and the voluntary structure applies more to some sectors/activities or some geographical zones.

The voluntary offset mechanism allows companies to finance projects through a third party broker. Several platforms exist and they connect project owners to companies wanting to offset their footprint. The carbon credit market, although still marginal, representing about 1% of the global carbon market, is dynamic and boasts of a wide selection of projects. Two main brands currently support the market: VCS and Gold Standard[38], both created by NGOs.
These brands manage the carbon credit register, representing the marketplace of the voluntary offset, and certify to buyers that the credit delivered is unique, that the emissions have really been avoided or sequestrated permanently, in a measurable and verifiable manner and that the additionality criteria has been met[39].
For every carbon offset project, a baseline scenario is defined and the reduction of emissions through the project is translated into carbon credit. Because the transactions and the conformity of the voluntary market are not regulated, it would make sense to deal with better-established platforms such as Climate-seed (see inset) that offer robust guaranties on the projects that they host.

Carbon offset projects can be classified into two main categories:

- Those that seek to **avoid** emissions through change in sectorial practices, through the development of renewable energy, a more rational use of energy, mobility, sustainable agriculture or by protecting existing sinks through the preservation of forests;

- Those that seek to **capture** the emissions in natural sinks or artificial ones, thus allowing "negative" emissions: reforestation, agro-forestry, restauration of mangroves, methane capture etc.

In 2017, 38% of all voluntary carbon offset credit were related to RE projects, 27% to forestry, 16% to state of the art facilities, 11% to methane capture projects and 6% to projects linked to mobility, mainly in Asian countries and in North America, financed by European and American economic players[40].

The price of carbon credit varies depending on geographical location, the year, but also the type of project. The current price of one tonne of CO_2 varies between USD2 and 20, an average of 1.6 euro/tCO_2eq for a renewable energy project and 6 euros/tCO_2eq for an agro-forestry project.

The prices remain well below climatic reality and the Stern-Stigliz commission believes that the price of carbon should be of at least 50 to 100 euros/t in 2030 to be able to efficiently reduce Greenhouse gases emissions[41].

[38] *State of the Voluntary Carbon Markets 2017, Bloomberg and Ecosystem Marketplace*
[39] *The additionality criteria aims to ensure that a compensation project cannot be realised without the sale of carbon credit.*
[40] *Bloomberg and Ecosystem Marketplace, "State of the Voluntary Carbon Markets"*
[41] *Carbon Pricing Leadership Coalition, Report on Carbon Prices (2017)*

The voluntary market is being structured progressively – (for example, national labels such as the Low Carbon label in France, project platforms, dedicated investment funds etc.).

It is also expected to gain in momentum throughout this decade as more and more private enterprises as well as public institutions commit to carbon neutrality. An increase in the number of projects that receive financing as well as better financial valuation of the CO_2 per tonne is also expected.

ClimateSeed, a platform for carbon offset projects with positive impact

ClimateSeed is a social business launched during the 2018 Global Social Business Summit, with support from Professor Yunus, Peace Nobel Prize winner.

ClimateSeed offers a digital platform that connects project owners with projects that aim to reduce emissions to organisations that seek to offset their greenhouse gas emissions while contributing to the UN Sustainable Development Goals. The platform proposes a range of voluntary carbon offset projects in 22 countries around the world, including the Indian Ocean region, and guarantees the traceability of the credit as well as the positive impact of the projects, both on the climate challenges and the selected SDGs (for example, poverty reduction, protection of the flora and fauna, gender equality etc). Contribution to emission reduction projects is done by way of buying certificates of Verified Emissions Reductions (VER). The prices practiced by the platform are transparent and guarantees a reinvestment of the profits to help the projects.

2/ Climate funds

Several trustworthy climate funds such as the Green Climate Fund, the Livelihoods Carbon Fund etc, were created in the 2010s in view of pooling together in a common portfolio the resources of several investors for the development of carbon-offset projects. These funds are responsible for the selection, the audit and the follow-up of projects that have been financed. The fund may also pre-finance NGOs for the setting up of large scale projects. Returns on investment are mainly in the form of carbon credit, depending on the results of the financed project portfolio.

Livelihoods Carbon Fund – financing NEW AGRICULTURAL PRACTICES

The Livelihoods Carbon Fund was created in 2010 by ten investors, including Danone, Schneider Electric, Voyageurs du Monde, Michelin etc – companies that wished to have a sustainable impact while offsetting their carbon footprint or by transforming their supply chain. The fund aims to finance different carbon offsetting projects – the restoration of ecosystems, agro-forestry and rural energy – with a view to reinforce food security for rural communities and increase revenues of small farmers, be it in Asia, Africa or Latin America. The companies involved in Livelihoods bring their expertise, share the development risks and follow up on the projects over a period of ten to 20 years. In exchange for the financial risks it is carrying, Livelihoods receives carbon credits over ten to 20 years, depending on the results of the projects. This is made possible thanks to the commitment made by the investors on the long term. The Carbon Fund #1, created in 2011 has enabled the financing of nine projects to the tune of 40 m euros in investment and the sequestration of 10 million tonnes of CO_2 over 20 years. Launched in 2017, the Carbon Fund #2 aims to raise 100 m euros in investment and to sequester 25 million tonnes of CO_2 over the next 20 years.
http://www.livelihoods.eu/fr/

3/ Result-based Climate Finance

Yet another type of investment is the Result-based Climate Finance (RBCF). The RBCF works on the assumption that funds are only paid to the beneficiary once the expected results – in terms of climate - have been achieved. The Green Climate Fund is a good example. The fund collected USD96.5 M for Reducing Emissions from Deforestation and Forest Degradation (REDD) in Brazil only after having verified the sequestration of 18.8MtCO_2eq in 2014-2015. The sum is then reinvested in new attenuation funds, with the promise of future payments. The RBCF is flexible in the choice of projects it chooses to finance and they range from low emission technology to carbon capture but payment is only guaranteed once results are confirmed. There aren't many projects that meet the criteria and many of them do not have access to initial financing that would allow them to bring the desired results.

4/ “Internal” offset through insetting

Insetting is the act of offsetting one’s carbon footprint within one’s own value chain, as opposed to classic carbon offsetting where the projects aren’t directly linked to the activities of the company. Insetting projects allow for the reduction of the carbon footprint at the very heart of the process of value creation of companies. The idea is to transform the economic model and rethink the chains and manufacturing processes. Projects could consist for instance, of the development of agro-forestry by suppliers of coffee or to the plantation of medicinal plants in source countries by a cosmetic manufacturer. This creates social and environmental impacts that go to the heart of the brand’s activity. The idea is that the projects allow companies to balance out an equilibrium with the ecosystem on which they depend, by engaging in relevant compensation projects.

The International Platform for Insetting (IPI): Blockchain at the service of integrated compensation

A multi-stakeholder platform, the International Platform for Insetting (IPI) – www.insettingplatform.com – was created in order to pool together the efforts of companies and of operators committed to this action. The platform regroups a variety of organisations such as AccorHotels, Chanel, Guerlin, Kering, L’Oréal, Nespresso as well as NGOs, certifiers such as the World Wildlife Fund (WWF) France, Vivo Plan and Ecocert, climate project developers such as Climate Partner, South Pole Carbon or the PUR project.

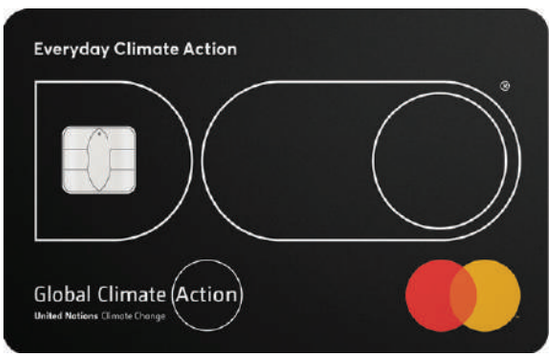
The IPI have chosen to widen the scope of their activities and not to limit insetting to carbon and to aim at generating positive and measurable impacts on water, the soil, biodiversity, the economy, and society. To this end, a standard, the Insetting Programme Standard has been developed and it allows companies to have their Insetting programmes certified and to record the generated impact in a blockchain register.

5/ New ways of carbon offset for the consumer: the carbon card

“Carbon cards” for individuals are currently being developed (and have been since the 90’s). But civil society’s increase in awareness in terms of climate responsibility is giving the effort a new boost. Scandinavia has in fact taken the lead with Swedish company Doconomy (founded in 2018) launching a mobile application and a credit card, in partnership with MasterCard. The application enables users to visualise the CO_2 emissions generated by each transaction and to offset them, going as far as being able to set a limit to any operation, so as not to exceed a given threshold.

The application was launched in 2019. It used a conversion based on the Aland index, created by one of Doconomy’s shareholders, the Bank of Aland, based in Finland and in Sweden. The index calculates CO_2 emitted for every euro spent in each spending sector (clothes, restaurants, bakery, hotel, cinema…) based on the emissions of companies in each sector. Fully informed about their carbon footprint, Doconomy clients can then pay a compensation. The app suggests options – to invest in UN-certified projects or in sustainable development funds. A premium bank card is expected to be launched soon and will be called “DO Black”. The card will enable its user to choose a threshold of greenhouse gas emission, exceeding which, the transactions will be disallowed.

See https://doconomy.com/en



AVOIDED EMISSIONS

Induced, avoided and negative emissions: toward triple accounting – Net Zero initiative

Carbon credit does not differentiate between negative emissions and avoided emissions. And yet when carbon neutrality is the goal, the difference between the two can be substantial: financing a project to "avoid" additional emissions (like developing renewable energy) doesn't affect the climate in the same way as financing negative emissions (like supporting a reforestation project). There are three distinct carbon "accounting" for companies: induced emissions in the company's direct perimeter, emissions that the company avoids and emissions that it absorbs. This triple carbon accounting approach that has been officialised by the network of companies, Net Zero Initiative, defines neutrality in a stricter sense. Though not finalised yet, the approach encourages companies to:

1. **Reduce their carbon footprint inside their own perimeter in a way that's compatible with the objective of 2°C;**
2. **Contribute to the decarbonisation and the preservation of existing carbon sinks, outside of the company's perimeter;**
3. **Finance new carbon sinks (ideally new carbon sinks should be financed to the tune of what it would cost to offset the emissions that have not been reduced).**

See the NetZeroInitiative methodology: http://www.netzero-initiative.com/fr

1/ Avoided emissions from financing of projects aimed at decarbonising the economy

There are several types of carbon-offset projects that can be developed in view of decarbonising the economy, especially in developing countries:

- Development of RE projects: for instance, the building of solar or wind farms on a large scale to ensure adequate supply to the population, especially in the rural areas
- Cooking fires: wood remains the main energy source for many developing countries and cooking fires from wood not only produce toxic fumes that affect women and children but are also the cause of death of millions of people around the world. Solar cookers, biogas or LPG cookers represent a cleaner source of energy in households
- Access to drinking water: Restoring boreholes is a good way of supplying clean water to communities, eliminating the need to boil water, hence, saving wood for heating, avoiding carbon emissions, and reducing pollution by indoor fires.

2/ Emissions avoided by preservation of carbon sinks and biodiversity conservation

The REDD (Reducing of Emissions from Deforestation and forest Degradation) mechanism was created by the United Nations Framework on Climate Change at the conference of the parties in a bid to give economic incentives to large tropical forested countries to avoid deforestation and forest degradation. A financial value is attributed to the carbon that is stocked in forests, thus offering financial incentives to limit or reduce deforestation and to invest instead in alternatives that are more sober in carbon, for a sustainable development. Preservation can also be achieved through the development of new sectors centered on the valorisation of biomass to feed local industries that use wood, hence avoiding deforestation.

NEGATIVE EMISSIONS

Negative emissions are emissions that have been absorbed outside of the atmosphere and stocked in carbon sinks (oceans, forests etc). The development of additional carbon sinks is important because existing ones are fragile and are subject to considerable variability every year. Businesses that wish to achieve some kind of carbon neutrality would be well advised to finance the development of new carbon capture projects. These carbon sinks represent natural resources of immense value to Mauritius; these reservoirs of biodiversity are valuable tools to attenuate the effects of climate change.

There are different ways of capturing and sequestrating carbon outside of the atmosphere. Natural carbon sinks are perhaps the best-known ones but research now shows that we can develop industrial technologies for the absorption of CO_2 and deploy them on a large scale.

1/ Negative emissions due to an increase in the number of carbon sinks[42]

► Marine absorption and photosynthesis by algae:

The ocean is the biggest active carbon sink of the planet: CO_2 that is absorbed is naturally dissolved as the marine flora (plankton and algae) "consumes" CO_2 as fuel for photosynthesis. Controlled cultivation of algae can thus eliminate the dissolved carbon and protect the ocean from acidification. The potential for sequestration by the cultivation of marine algae is estimated to be about 15tCO_2/ha a year at a cost of 71 to 86 USD/tCO_2. Once cultivated the algae then decomposes on the ocean floor, allowing for a long-term sequestration of carbon on the floor level. Another option is to use algae as a non-combustible product (potentially for cosmetics or food production). Part of the carbon would then be released in the atmosphere throughout the life cycle of the product

► Coastal vegetation – mangroves:

Mangrove forests are precious coastal ecosystems that can rapidly capture a large quantity of CO_2 thanks to their rapid growth. They are biological shields for coastal regions and give shelter to numerous species of fish, crustaceans and molluscs. Carbon capture is done through photosynthesis and underground sequestration is done through settling of biomass. The cost of planting mangroves varies from country to country but a cross sectional study shows that the average cost would be 786 USD/ha for new mangroves in developing countries

► Terrestrial vegetation – forests:

Vegetation growth absorbs atmospheric CO_2 through photosynthesis and retains the carbon in the form of biomass. The accumulation of carbon in the biomass after reforestation varies greatly according to environmental conditions but it has been estimated to be between 1 and 35 tCO_2/ha per year. Projects in tropical climates have the highest potential of sequestration in that range, at a cost of 0.5 to 7 USD/tCO_2

► Geological sequestration of carbon – forest floors

The surface soil is a vast carbon sink that can directly capture atmospheric CO_2 and sequestrate the carbon derived from organic matter. The soil can capture 1.5 to 3 times more carbon than vegetation if unperturbed by deforestation.

[42] *https://ars.els-cdn.com/content/image/1-s2.0-S096098221930886 3-mmc1.pdf] ; http://statsmauritius.govmu.org/English/Publications/Documents/2019/EI1468/Env_Yr18.pdf*
[https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg3_full_report-1.pdf]
[http://maps.oceanwealth.org/mangrove-restoration/]
Global Forest Watch Interactive Map. Accessed 29/11/2019. [https://www.globalforestwatch.org/map]
The World Bank (2012). Carbon Sequestration in Agricultural Soil. Washington DC, USA. -[http://documents.worldbank.org/curated/en/751961468336701332/pdf/673950REVISED000CarbonSeq0Web0final.pdf]
Leung, D.Y., Caramanna, G., & Maroto-Valer, M. M. (2014). An overview of current status of carbon dioxide capture and storage technologies. Renewable and Sustainable Energy Reviews, 39, 426-443.
Fernández, F. A., Sevilla, J. M. F., & Grima, E. M. (2019). Costs analysis of microalgae production. In Biofuels from Algae (pp. 551-566). Elsevier.

2/ Negative emissions by an increase in natural and artificial carbon sinks

► Capture of carbon at source

There are technologies that enable CO_2 capture at the source of the emissions (energy installations and manufacturing sites). These technologies use a combination of mechanical and chemical processes to separate CO_2 from the gas that is emitted. Several techniques can be applied to recover CO_2 before it is rejected in the atmosphere – in fact, it can be done at the very source of emission of a highly emitting industrial process (e.g. electric plants, cement plants etc). These methods allow the capture of up to 90% of all CO_2 emissions linked to onsite combustibles and cost between 78 and 124 USD/tCO_2. The carbon is then injected deep in basins of geological storage or transformed as new products like carbon fibre, ink, additives for concrete, methanol or even plastic.

► Direct capture in the air

The systems for direct capture of air can in theory be used anywhere but are more efficient if placed near an elevated concentration of CO_2, like in an industrial park. This technology makes use of big fans that pump the atmospheric air through chemical filters to separate the CO_2. Its cost has been estimated at around 94 to 232 USD/tCO_2. This process is useful in particular when there is a need to capture CO_2 that has been emitted in the atmosphere by sources that are so diffused that capture at source is not an option.

► Bioenergy with carbon capture and storage (BECCS) [43]

Bioenergy comes from different sources like biomass, bioethanol, biogas derived from waste, sewage sludge and manure. BECCS uses organic waste a renewable source of energy and then captures the carbon at the time of combustion through a capture at source process. The combination of the two processes leads to a cleaner and more productive technology than the alternative that would consist of letting the sources generate greenhouse gasses by combustion or natural decomposition. BECCS also offers a system of fuel consumption that could potentially be negative in carbon: cultivation of biomass (bagasse or microalgae), captures CO_2 during growth and the carbon is then recaptured after combustion. This allows the efficient elimination of CO_2 from the atmosphere. The captured carbon can be stored in geological basins for long-term sequestration or be pumped to feed industrial algae farms for a circular carbon cycle. Depending on the combustible substance and the sector, the cost of BECCS varies between 15 and 400 USD/tCO_2 captured and sequestrated. This technology also raises an important matter with regards to the use of agricultural land– what should be used for food production and what should be used for the production of biofuel.

[43] *Bio-energy with carbon capture and storage*

Technology for the future: Algae-based urban bioreactors

Algae's capacity for absorbing CO_2 is believed to be one of the most powerful technological solutions to limit the presence of greenhouse gases in the atmosphere. As algae grow more rapidly than trees, they absorb CO_2 much faster as well. Making use of AI, start-ups and industrial companies have now developed a new generation of bioreactor that optimises the process of photosynthesis as well as the capacity of algae to capture carbon. Each reactor (the size of a cupboard) can capture the equivalent of a forest area of 4,000m^2 (1.2 to 2 tonnes of CO_2) over the course of one year. Once maturity is reached, the machine restores the algae in the shape of pallets similar to the ones used in hockey games, and these can be used for several enterprises – food production, biochar, biofuel, etc. In a few years, every tertiary building, every factory, every public space, every roof of every building could well be equipped with one or several of these equipment.
See: https://www.hyoergiant.com/green/.

In brief, the methods and techniques of sequestration and capture are currently being developed in many sectors. They constitute real environmental, economic and social opportunities. The potential sequestration and its costs are however uneven.

Comparison of the performance of the different carbon sinks

	Sequestration process	Carbon sinks	Sequestration potential (tCO_2/ha/year)	Estimated average cost (Rs/tCO_2)
Low Tech	Cultivation of marine algae	Biomass and ocean	15	3 147
	Plantation and restoration of mangroves	Biomass and soil	593	49
	Reforestation	Biomass and soil	39,4	256
	Agroforestry management	Soil	4,4	237
	Agro ecological management of agricultural	Soil	2,7	950
High Tech	CO_2 capture at source	Industrial	-	3 700
	Direct air capture	Industrial	-	5 966
	BECCS	Industrial	28,5	7 320

"CARBON SINKS" STRATEGY FOR MAURITIUS AND THE INDIAN OCEAN

1/ Natural ecosystems on the decline despite their essential role in fighting Climate Change

The most efficient mechanisms to capture and sequestrate carbon dioxide from the atmosphere are the planet's natural carbon sinks, which are terrestrial vegetation, the ocean and the soil. The problem is that these systems in Mauritius have known severe degradation these past decades because of deforestation, the acidification of oceans and intensive agricultural practices. A 2014 study by the Indian Ocean Commission shows that Mauritius has on average lost 15% of its natural ecosystem (up to 52.6% in urban districts like Port Louis between 2000 and 2010).

Human intervention to restore and reinforce the capacity of carbon sinks is imperative to fight Climate Change. And yet, the reinforcement of these natural ecosystems is also a source of opportunity, representing investments that will preserve existing sectors like tourism and allow the emergence of new markets as well as bring complementary revenue to local populations.

2/ The potential of carbon sinks in Mauritius and the Indian Ocean

In order to face the climate crisis and reinforce its vision of a sustainable economy, Mauritius will have to invest in the development of local carbon sinks found in the Indian Ocean region.

The zone has a great diversity of natural sinks: agroforestry, the restoration of mangroves, the cultivation of algae and the agro ecological management of soils all show potential:

► Reforestation and agro-forestry

In 2018, the 47,028 ha of forest that cover Mauritius absorbed about 7% of the country's 2017 emissions. 4726 ha are recorded as abandoned fields and in theory, these could be converted into a forest plantation, bearing in mind that young trees can capture a higher quantity of CO_2. Intensive agro-forestry management of soils could also increase the storage capacity of soils. The reforestation of 4,726 ha of available land would mean the creation of new forest and an increase in the sequestration rate of the soil to 4.4. tCO_2/ha/year.

► Restoration of mangroves

Mauritius has the perfect climate for mangroves but large parts of them have been lost because of Climate Change and the change in the use of land. A recent study shows that there are currently 26 ha of mangroves that could be easily restored throughout Mauritius' coastline. This would bring the total capture capacity of the mangroves in Mauritius to some 437,000 tCO_2/year (8.7% of 2017's emissions).

► Agro ecological management of soils

According to the data contained in the Global Forest Watch, the agricultural soils of Mauritius contain about 20tCO_2/ha. Some 40% of all land is currently being used for cultivation that has low carbon density in the soil: investing in responsible agricultural practices will have a significant impact on the challenges of Climate Change[44]. (See inset)

Agricultural practices and climate

The establishment of responsible agricultural practices allows for a positive impact on climate in many ways:

- **The introduction of new agricultural techniques such as sustainable agriculture or biological agriculture allows the reduction of greenhouse gases emissions, namely the consumption of synthetic fertilisers (high carbon impact for the production of the fertiliser and on its uses by liberating the nitrogen dioxide) and of fuels by less mechanisation or the introduction of crop rotation (for example, the role of legumes in the amount of oxides in the soil);**
- **The implantation of new hedges and the development of agro-forestry, thus allowing the storage of carbon in the soils. Some practices and changes in the use of land also have an impact, for instance the conversion of some cultivations in permanent prairies, the extension of temporary prairies or crop rotation[45].**

[44] *Regional studies from the World Bank show that the use of natural and biological fertilisers in Africa can add on average 1.2tCO_2/ha/year and that the use of cultivation cover can add 1.5tCO_2/ha/year*

[45] *https://www.ecologique-solidaire.gouv.fr/sites/default/files/Méthode%20élevages%20bovins%20et%20grandes%20cultures%20%28Carbon%20Agri%29.pdf*

The table below shows that if all the natural carbon sinks (excluding marine ones) were developed to the maximum just in Mauritius, the absorption potential would cover around 16% of all Mauritian emissions in 2017.

If added to those in the Indian Ocean, the potential of carbon sinks, including marine culture, would be remarkable.

Sequestration process	Carbon sinks	Sequestration potential (tCO_2/ha/year)	New exploitable surface (ha)	New sequestration capacity (tCO_2/year)	Potential sequestration capacity in % of 2017 emissions
Cultivation of marine algae	Biomass and ocean	15	-	-	-
Plantation and restoration of mangroves	Biomass and soil	593	26	15 418	0,4
Reforestation	Biomass and soil	39,4	4 726	186 204	4,7
Agroforestry management	Soi	4,4	47 048	207 011	5,2
Agro ecological management of agriculture	Soi	2,7	80 547	217 477	5,4
TOTAL				626 110	15,7%

Low carbon label – to encourage local offset projects

Label Bas Carbone (Low carbon label) was created in 2019 by the French ministry of ecological transition and solidarity together with several institutional and sectorial partners, with the objective of contributing to achieving France's climate objectives. It proposes a new framework for labelling and offers new financing perspectives for local emission reduction projects, especially those driven by local authorities, companies and even citizens. It aims to accompany the ecological transition on a regional level in all sectors - forestry, agriculture, transport, building etc, by labelling the various projects – change of practices, introduction of new technologies or change or behaviour. The procedure for labelling is straightforward, centralised and supervised by the authorities, through a dedicated platform. Four projects have so far been certified while many more are going through the process.

3/ From a mind-set of planting to a conservation mind-set

Conservation projects help disadvantaged producer communities protect their forests and develop profitable and sustainable activities that highlight the value of the services rendered by the forests. These activities also help to revive the population's pride and ensuing responsibility toward the forests, converting them into "caretakers of nature". But that's not all these activities do – they also increase the value of the forest and the life within – seed mining, ecotourism, use of plants, beekeeping etc. This would make the forest interesting and profitable and would guarantee its protection from deforestation. Yet another incentive would be to increase the value of the zones that have already been deforested, through agro-forestry and/or an increase in agricultural yields. The aim is to reduce the need felt by local communities to deforest more. All the projects are developed by and for the communities that live in the zones and the buffer area. They are mainly disadvantaged communities made up of small farmers.

4/ Linking carbon sinks and adaptation to Climate Change

Carbon sinks not only have an important role to play in attenuating the effects of Climate Change, they also constitute an essential factor of Climate Change adaptation. Additionally, they determine the resilience of a territory in its ability to fight the consequences of Climate Change, the effects of which are already being felt. It is a fact that Climate Change has already exceeded +1°C of mean warming compared to pre-industrial temperatures and that it will keep on rising. Despite efforts to reduce emissions and even if Climate Change is limited to +1.5°C, Mauritius will still feel the negative consequences of Climate Change on its ecosystems and its economy: floods, decline in yields, and increase in frequency of cyclones etc…

On top of capturing CO_2, natural carbon sinks constitute solutions for resilience and adaptation, to the extent that they could even limit the damage caused by Climate Change. Forests and forest floors that are managed in an ecological manner will better resist the changes in climatic conditions; they create micro-climates, give stability to the floor and allow a better management of floods by absorbing and retaining water. Mangroves, for their part, constitute a natural and protective barrier against cyclonic swells, violent winds, floods and beach erosion. They can also reduce the economic cost of cyclones by 20%. The restoration of natural sinks should be seen as a double-win – limiting the effects of Climate Change and providing resilience against its consequences.

[46] *https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/storm-surge-reduction-by-mangroves-report.pdf*

5/ Link between increase in carbon sinks and community development: case studies in Kenya

Kenya has a variety of interesting compensation projects that could inspire Mauritius since the challenges and potential are similar in nature – agricultural diversification, protection of forest ecosystems and mangrove restoration, all the while contributing to the local economy.

Kibuyuni Farmers

Faced with a decline in fish stock, the Kibuyuni community resorted to the cultivation of marine algae with the help of a local NGO and the Kenya Coastal Development Programme. In 2010, the year it was launched, the project had 27 members with 300 strings of planting areas each. Just four years later, in 2014, the number of farmers had increased to 50. In 2015, the community exported its algae for the very first time – 41.5 tonnes went to Belgium for USD 12,500. Since then, exports to China, Ireland and Malaysia have substantially increased. In 2019, the company received an order for 100 tonnes of marine algae for USD20,000. The Food and Agriculture Organisation (FAO) has financed training and equipment to accompany the development of added-value products; farmers have now started to produce soaps, lotions, biscuits, cakes, shampoo, fruit juice and jams for the national and international markets.

TIST programme – reforestation in small groups

This programme encourages landowners to plant trees by paying them a fixed amount for each tree that lasts more than six months, with a bonus for indigenous ones. The projects are managed and financed by a profit-making company that uses the model to sell carbon credit at USD8/tCO_2 on the international market. The company keeps 30% of the revenues while the remaining 70% is shared between arborists, based on their respective contribution to the sequestration of carbon. More than 10 million trees have been planted between 2005 and 2013. The farmers have indicated that the financing programme has helped them to invest in their land by planting fruit trees and by developing other avenues such as beekeeping and seed nurseries.

Vanga Blue Carbon project: mangroves restoration

This project has for aim the restoration of 5.5. ha of mangroves while sustaining the subsistence means of three fishing villages on the southern coast of Kenya. Initial financing came from the United Nations Environment Programme (UNEP) and international NGOs but the financing system is currently sustaining itself through the sale of carbon credit. The climate objective is to capture at least 93,000 tCO_2 over 20 years. A healthy mangrove stimulates local aquaculture and hence, the economy. Revenues generated by the carbon credit are then reinvested to develop new activities like honey production and ecotourism.

Checklist for financing of sequestration project

Businesses need to consider the following factors if they wish to finance carbon sequestration projects:

- **Reduce before offsetting:** There are still some uncertainties associated with carbon sequestration so the priority should be for the company to reduce its scope 1, 2 and 3 emissions to a maximum before resorting to carbon offsetting.

- **Verify the reliability of the project:** If going through a platform or a fund, it is important to verify the selection criteria used by the intermediary. The efficiency of carbon absorption is a crucial element but it's not enough - the company needs to ensure that its investment is in fact going to finance additional "negative" emissions that would not exist without the investment in question. Several carbon offset credit certification programmes guarantee the impact of the projects, including the Clean Development Mechanism Gold Standard (it strictly follows the rules of the Kyoto protocol), the Verra Verified Carbon Standard, which is as rigorous in following protocol but more flexible in terms of a greater number of smaller scale yet innovative projects and the Vivo Certificate Plan, specialised in natural carbon sinks and agricultural projects.

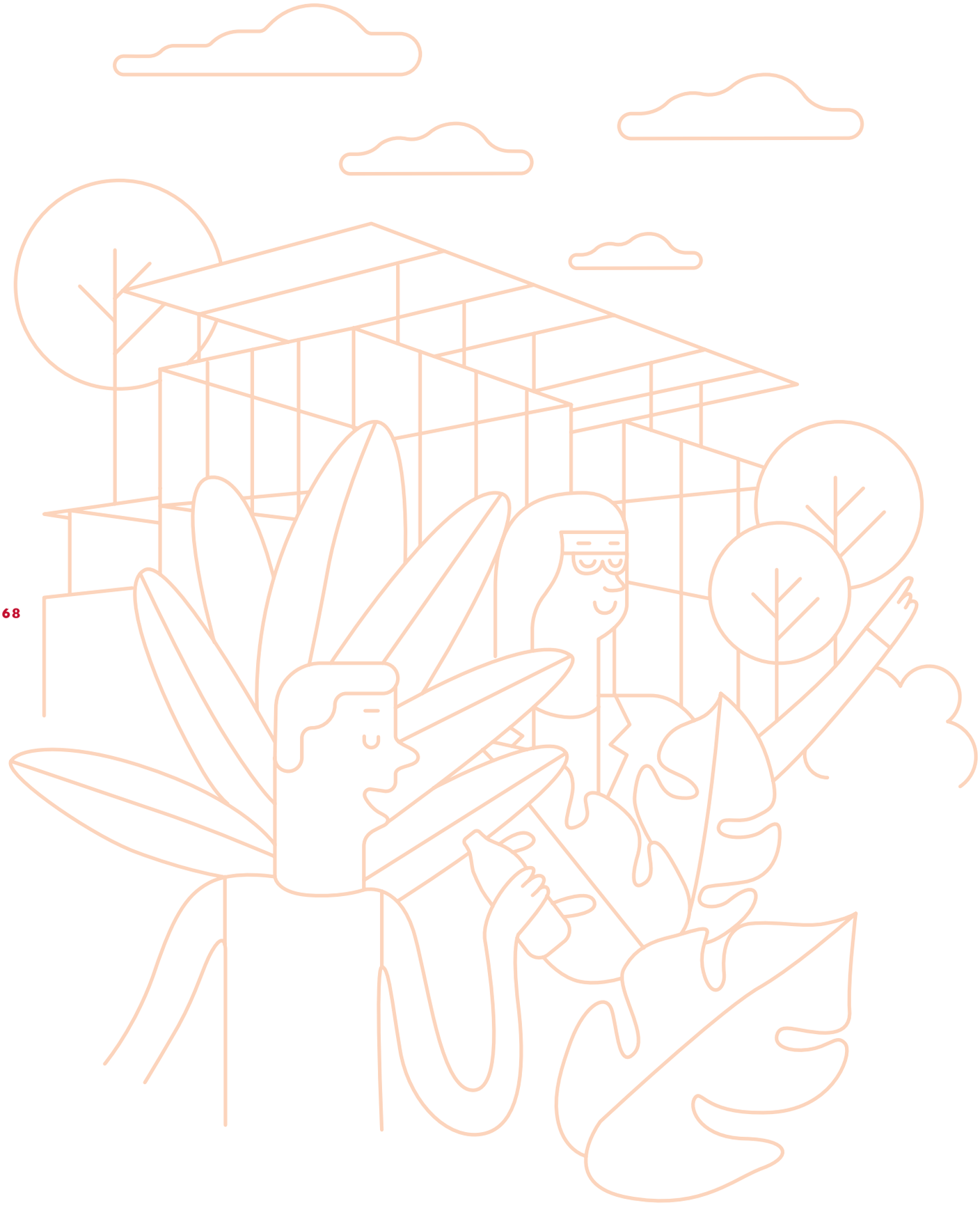
- **Making a positive impact on local communities:** Carbon absorption projects, in particular those that require changes in the use of land, can affect the subsistence means of communities and their economic development. It is therefore essential that those projects are carried out with local communities, not against or in spite of them.

GOING FURTHER: TOWARDS THE ADAPTATION OF MAURITIUS TO CLIMATE CHANGE

Climate Change is a paradoxical phenomenon: it is generated by our lifestyles inherited from the industrial revolution and by our collective aspiration for development, and at the same time it constitutes a threat to our prosperity, to the stability of our societies and to individual and collective security. It is the biggest challenge humans have faced and it requires an urgent reinvention of a vision for a cleaner, fairer and more equitable development. And yet, it is also an opportunity for developing more circular, more distributed and more local economic models, thus accelerating the transition to renewable energy and developing new products and services that are part of the new climate economy.

As we start understanding the alarming consequences of climate change and the disasters that could unfurl, it becomes clear that while efforts towards mitigation are absolutely necessary to avoid a runaway climate system, it will not protect us from the first negative effects that have already been triggered.

As explained earlier in this report, natural carbon sinks (forests, mangroves, agro-ecological soil management) make it possible to strengthen the island's resistance to the adverse effects of climate change. But other avenues will have to be to be explored, such as floating structures, which can constitute an answer to many challenges (rising waters, erosion, ocean pollution, food and energy self-sufficiency, etc.). In all cases, a reflection must be undertaken to imagine and deploy more robust infrastructures, flexible layouts, ingenious and more inclusive designs.



**Mauritian companies,
today, more than ever,
you hold the key
to tomorrow in your hands.
The path of carbon neutrality
is the only possible path
for the future of future
generations of our island,
of our planet.**

**Let's start actions that will
reduce and offset emissions
today. This is the only way
to make our country
the bearer of the new climate
economy and no longer
a victim of the climate crisis.**

VISIT : KLIMA.MU

This study has been carried out UTOPIES©
February 2020

Authors:
Elisabeth Laville, Arnaud Florentin, Annabelle Richard, Arthur Vétu, Haily Tran

Graphic conception:
Claire Mesguich
Graphic design:
Michel Barréteau
Illustrations:
James Rajabally

Acknowledgments:
Mickaël Apaya, Renaud Bettin, Louis Monnier and Pierre Viard

Printed on recycled paper


MCB