Policy Paper

2+2 = 4, CO2 + 2°C = €€
Doing the Maths: The Economic Cost of Climate Change to Europe

VOCAL EUROPE

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Policy Paper Objective

'Money talks' is a well-known expression dating back to the 5th century B.C., and attributed to Euripides[1]. Some 2,000 years later Erasmus spoke of "the talking power of money" (*Adagia*, 1532). These expressions reference the power money has always exerted over those who call the shots. For years now, we have heard people calling on the world's policymakers to wake up and smell the coffee when it comes to climate change. The problem is that when climate experts talk, policymakers turn a deaf ear. By focusing on the cost of climate change it is hoped that policymakers will finally sit up and listen to the one thing they hear talking: money. If people see how much climate change is going to cost themselves and the world, it is hoped that they would change their practises and policy accordingly and become more environmentally friendly.

This policy paper will analyse how climate change will cost the European Union around €240 billion a year if global temperatures increase by more than 2°C[2].The paper will examine the economic cost of climate change in reference to the welfare cost estimates of extreme weather events both in Europe and globally. Europe is seen as the leader in tackling climate change (12 of the past 24 Conference of the Parties (COP), have taken place in European cities[3]), but climate change is not a European problem, it is a global problem and requires a worldwide solution. The costs of climate change loom large in the not-so-distant future and should make us realise combatting climate change has to be a priority. In the world we live in, money speaks loudly. Let's listen to it and take action. Divestment, pollution abatement and sustainable policies will not only save money and slow down climate change but will also be globally economically beneficial.

1. Background

1.1 Climate Change - the situation at present.

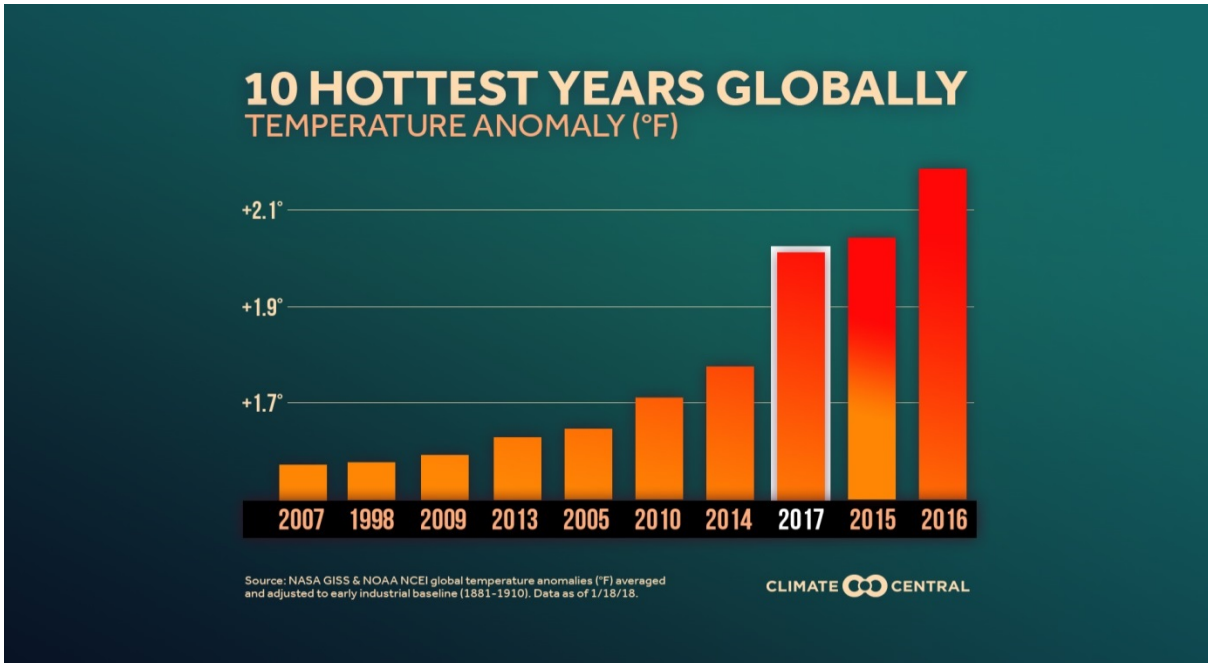
As 2019 begins, 2018 is still leaving a bad taste in our mouths. 2018 was recently reported as the 4th warmest year since records began, making the last 4 years the 4 warmest years ever recorded in human history[4]. Average global air temperatures were 14.7°C in 2018, just 0.2°C off 2016's peak average, this trend is expected to continue with 2019 predicted to be hot as well. This global warming of the climate is caused by human activity.

Climate change is the catch-all term for the shift in worldwide weather phenomena associated with an increase in global average temperatures. Global temperatures have been rising for many decades. Scientists are in agreement that this unprecedented global warming of the earth's climate is being caused by human activities such as burning fossil fuels, deforestation and harmful agricultural practices.

These activities emit carbon dioxide (CO_2) and other harmful greenhouse gases into our atmosphere. These gases absorb sunlight and solar radiation that have bounced off the earth's surface. Normally, this radiation would escape into space—but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter[5]. This is also known as the greenhouse effect. There are individuals and nations that blindly deny that climate change exists but 97% of climate scientists[6] agree that climate-warming trends over the past century have been caused by

[1] https://www.dictionary.com/browse/money-talks
[2] Compared to 2005 recorded levels.
[3] https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop
[4] https://www.cbc.ca/news/technology/2018-temperatures-copernicus-climate-change-report-1.4968286
[5] Natural Resources Defence Council https://www.nrdc.org/stories/global-warming-101
[6] NASA https://climate.nasa.gov/scientific-consensus/

human activities, and most of the world's leading scientific organizations have issued public statements advocating the message that climate change is real and dangerous.



Climate Central 2018

1.2 The Stakes are High and the Chips are Down

COP 21 and COP 24 (held in Paris and Katowice, respectively) were instrumental in leading the fight against climate change. The COPs are ensuring that all governments measure, report on and verify their emissions-cutting efforts. This is key as it ensures all countries are held to proper standards and will find it harder to wriggle out of their commitments[7]. However, these achievements have been dampened by new and old critics coming to the fore, paticularly US President Donald Trump who pulled the US out of the Paris agreement last year stating that it was a 'bad deal'.

Today, we are faltering. Where once the world was united in limiting temperature increase to 1.5ºC, Donald Trump has started a division and allowed for doubt to grow. In fact U.S. carbon dioxide emissions rose an estimated 3.4 percent in 2018[8], instead of decreasing to meet its Copenhagen 2005 Accord 17% reduction target. The U.S's lax environmental commitment has acted as a signal to several countries to slow down on their emission-cutting efforts. Brazil's newly-elected president Jair Bolsanaro has said Brazil won't host the next COP meeting and has promised to open the Amazon rainforest to agribusiness at a time when emissions should be reducing in accordance with the Paris Agreement, which sets out a 26% reduction from 2005 CO_2 levels. Deforestation for agricultural purposes is especially harmful as it turns a natural carbon sink into a source of emissions.

The US, Russia, Saudi Arabia and Kuwait joined forces at COP 24 to water down the urgent statements produced in the UN's infamous *Intergovernmental Panel on Climate Change (IPCC)* report[9]. This report is one of the loudest clarion calls from the scientific community, warning us that

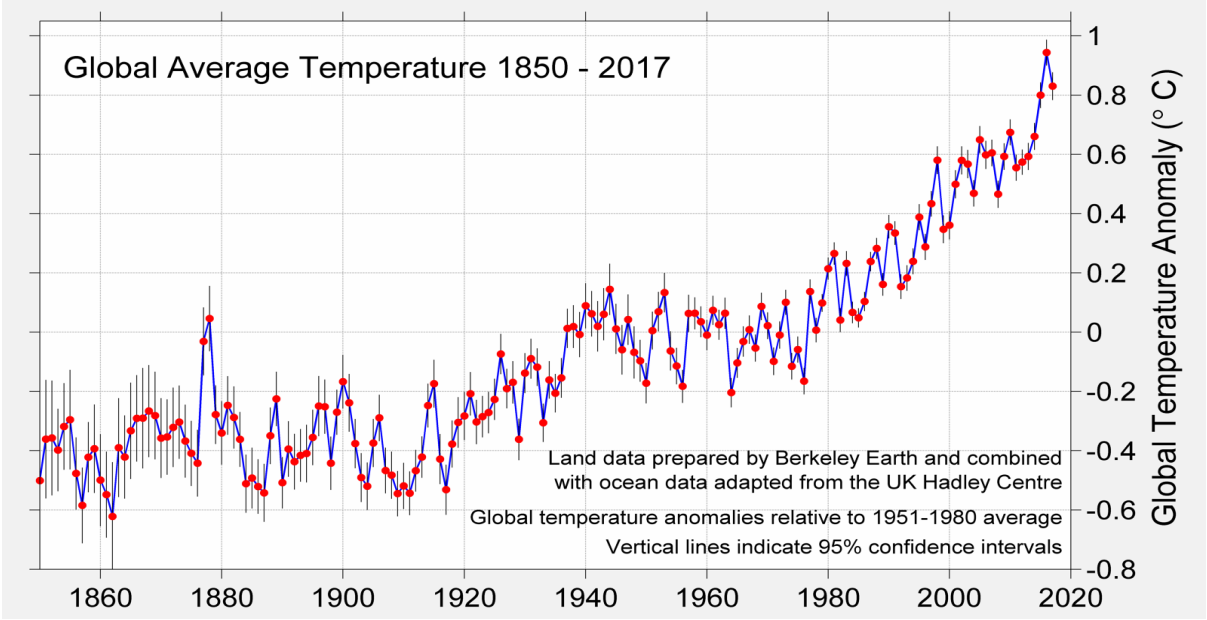
[7] https://www.theguardian.com/environment/2018/dec/16/what-was-agreed-at-cop24-in-poland-and-why-did-it-take-so-long

[8] The Washington Post https://www.washingtonpost.com/national/health-science/us-greenhouse-gas-emissions-spiked-in-2018--and-it-couldnt-happen-at-a-worse-time/2019/01/07/68cff792-12d6-11e9-803c-4ef28312c8b9_story.html?noredirect=1

[9] https://www.theguardian.com/environment/2018/dec/16/what-was-agreed-at-cop24-in-poland-and-why-did-it-take-so-long

we only have 12 years for global warming to be kept to a maximum of 1.5°C as compared to the preindustrial era (the world is currently already 1°C warmer than preindustrial levels). Temperature increases beyond this, even of half a degree, will significantly worsen the risks of floods, extreme heat and poverty for hundreds of millions of people. Bob Ward, of the Grantham Research Institute on Climate Change, said the final document was "incredibly conservative" because it did not mention the likely rise in climate-driven refugees or the danger of tipping points that could push the world on to an irreversible path of extreme warming[10].

At the current level of commitments, the world is on course for a disastrous 3°C of warming. Currently, global average temperatures are 1°C above pre-industrial levels and rising at 0.17°C per decade[11]. Furthermore, carbon catching technology is far away from becoming reality, so there is no acceptable environmental situation where countries can continue to emit at their current rate.



Berkely Earth Time Series

Johan Rockström, co-author of the worrying Hothouse Earth study[12], states that Domino-effect climate events could move the Earth into a 'hothouse' state. A domino-like cascade of melting ice (+0.9°C), warming seas, weakening carbon sinks (+0.25°C) shifting currents and dying forests (+0.11°C) could push the Earth into a 'hothouse' state beyond which human efforts to reduce emissions will be increasingly futile[13]. Warming temperatures could release new sources of greenhouse gases and destroy the Earth's ability to absorb carbon or reflect heat. Once the runaway-hothouse is started it can't be stopped, resulting in many species facing extinction.

Although the EU stood defiant against Trump's anti-climate rhetoric by coming forward with improved GHG targets, the EU is not entirely perfect either; Norway plans oil exploration in the

[10] https://www.theguardian.com/environment/2018/oct/08/global-warming-must-not-exceed-15c-warns-landmark-un-report
[11] https://www.theguardian.com/environment/2018/aug/06/domino-effect-of-climate-events-could-push-earth-into-a-hothouse-state?CMP=share_btn_tw
[12] Steffen.W et al. (2018) "Trajectories of the Earth System in the Anthropocene' Harvard University, Cambridge, MA. PNAS https://www.pnas.org/content/115/33/8252
[13] https://phys.org/news/2018-08-earth-hothouse-state.html

Arctic[14], Britain is pushing ahead with gas fracking[15], and the German government wants to tear down Hambach forest to dig for coal. Europe is and will continue to be affected by more frequent floods and droughts – which would yield falling crop yields, the spread of disease-carrying bugs, fiercer hurricanes and much more.

1.3 **Some cause for Optimism - Will it be enough to turn the tide?**

Encouraging progress was made in Poland as the world agreed on a rule book to implement the Paris agreement. The EU (which accounts for about 10% of global GHG emissions) has stuck by the Paris agreement and has set its own European Emission Targets (EET) for each Member State to reach. To ensure fairness the targets (ranging from 0% to -40%)[16] are adjusted to reflect cost-effectiveness for those Member States with an above average GDP per capita. The target's progresses are evaluated annually by the European Commission and failure to make the required progress will incur large fines. The emissions trading system (EU ETS) has been specifically created to help Member States achieve their targets.

The system sets a limit to overall emissions from covered installations which is reduced each year, thus creating a valuable currency and making the action of polluting (or not polluting) a tradable commodity[17]. Within this limit, companies and member states can buy and sell emission allowances as needed via auctions. Each allowance gives the holder the right to emit one tonne of CO_2[18]. Auctioning is the most transparent method of allocating allowances and puts into practice the principle that the polluter should pay. This 'cap-and-trade' approach gives companies the flexibility they need to cut their emissions in the most cost-effective way. It is seen to be working as the European Commission's 2018 Q3 reports[19] indicated ETS allowance prices reached record highs for the last decade, increasing from 5Eur/t to 21Eur/t. This means the cost of polluting is increasingly making fossil fuels a less attractive source of energy and renewables all the more desirable.

EU Member States Greenhouse Gas Emission Reduction Targets			
2020 Targets		**2030 Targets**	
Cut in Greenhouse Gas **Emissions** (from 1990 levels)	20%	Cut in Greenhouse Gas **Emissions** (from 2005 levels)	At least 40%
EU Energy from **Renewables**	20%	EU Energy from **Renewables**	At least 27%
Improvement in **Energy Efficiency**	20%	Improvement in **Energy Efficiency**	At least 27%

EU Climate Policies[20]

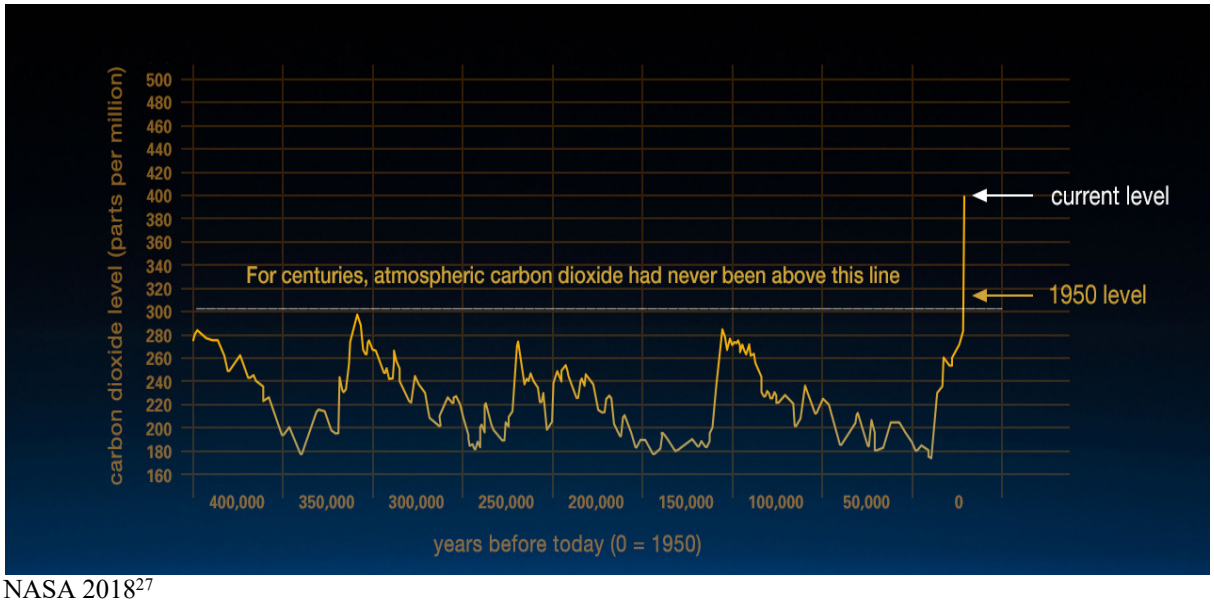
Overall, the EU is ranked 16th out of 60 nations in the annual Climate Change Performance Index report[21] (CCPI) by Germanwatch. The CCPI evaluates the climate protection performance of 60 countries, responsible for over 90% of global energy-related CO_2 emissions. Most EU countries rank

[14] https://euobserver.com/energy/140648
[15] https://www.theguardian.com/environment/2018/oct/05/cuadrilla-confirms-plan-resume-controversial-fracking-drive-lancashire
[16] https://ec.europa.eu/clima/news/member-states-emission-reduction-targets-2021-2030-adopted_en
[17] https://ec.europa.eu/clima/policies/effort/proposal_en
[18] https://ec.europa.eu/clima/sites/clima/files/factsheet_ets_en.pdf
[19] https://ec.europa.eu/energy/sites/ener/files/documents/quarterly_report_on_european_electricity_markets_q3_2018.pdf
[20] https://ec.europa.eu/clima/policies/strategies/2020_en and https://ec.europa.eu/clima/policies/strategies/2030_en
[21] https://germanwatch.org/sites/germanwatch.org/files/CCPI2019_Results.pdf

highly on the scale with Sweden ranked number one. Ireland (48th) ranked the worst amongst the EU states.

Not only are people beginning to fully realise that climate change affects us but people are beginning to take action[22]. Interestingly, more young people are worried about the climate than their older counterparts. This is evidenced by children all over the world suing[23] their governments for promoting fossil fuels despite the knowledge that CO_2 emissions are a primary cause of global warming[24]. Naturalist Sir David Attenbourough attended COP 24 and the World Economic Forum warning world leaders that we are damaging the world beyond repair and that "it's difficult to overstate the climate change crisis."[25]

In Belgium students and pupils have protested weekly in Brussels for climate action. Since December their numbers have swelled from 3000 to 35,000.[26] Similar student protests are taking place the world over. This weekly protest is planned to continue until politicians create a binding climate plan that states that they aim to limit global warming to below 1.5°C. Collectively, the lawsuits and the protests are creating new precedents that bolster activism—and may, in the long term, help alter the way governments think about their responsibility to protect citizens against climate change.



NASA 2018[27]

2. State of play

> "Climate change is a result of the greatest market failure that the world has seen"
> -Sir Nicolas Stern.

[22] https://pursuit.unimelb.edu.au/articles/what-do-gen-x-and-gen-y-worry-about-most-climate-change
[23] https://qz.com/1334102/kids-around-the-world-are-suing-governments-over-climate-change-and-its-working/
[24] https://affaire-climat.be/fr/the-case
[25] https://www.irishtimes.com/business/technology/david-attenborough-warns-leaders-of-damaging-world-beyond-repair-1.3766737
[26] https://www.demorgen.be/binnenland/enorme-opkomst-klimaatspijbelaars-12-500-jongeren-nemen-deel-aan-mars-in-brussel-b20ff3d7/
[27] Increasing Carbon dioxide in the atmosphere creates a greenhouse effect that causes global temperature to rise to historic levels.

Climate change is occurring due to carbon pollution, yet currently most businesses don't have to pay to pollute despite the fact that pollution negatively affects people. Normally when such negative external costs exist the market reacts accordingly and puts a price on the activity. However, because

there is no price for pollution, it becomes a negative externality. The creation of *pay to pollute certificates* or *carbon taxes* are methods governments can introduce to create a market for pollution and in effect internalize the negative externality. The IPCC report stated that carbon pollution would have to be cut by 45% by 2030 and reduced to zero by 2050. This would require carbon prices that are three to four times higher than current prices to stop climate change.

2.1 Economic Costs of Climate Change

There are a variety of ways that climate change will have an economic impact — some are gradual changes such as increased cooling costs for buildings, while others are more dramatic, akin to Superstorm Sandy or the 2003 heatwave in Europe, which killed thousands.[28] The costs of these storms are immense — Hurricane Katrina racked up damages estimated at $100 billion or more.

Assessing the economic cost of climate change can be a difficult undertaking as so many factors have to be taken into account. The climate is all around us and no-one is immune to its effects. Measuring the damage of extreme weather events is a good method of estimating the costs of climate change, however the greatest cost and also the hardest to measure is the loss of a human life. For some the cost of climate change is not yet noticeable; others such as farmers and fishermen have already seen it impact their daily lives. The future cost of climate change is uncertain, but we can look at the costs of climate change over recent years and then compare it to the cost of avoiding it instead.

Two metrics of economic impacts are used when assessing the cost of climate change: gross domestic product (GDP) and welfare changes. GDP is the value of a country's annual production of all goods and services, whilst welfare refers to the utility or satisfaction obtained by households from consumption. This two are closely-linked; the higher the consumption the higher the welfare.[29]

2.2 European Severe Weather Damage

Between 1980 and 2013 extreme climate events cost Europe €400 billion, according to the European Environment Agency.[30] The three worst-affected countries in absolute terms were Germany (€79bn), Italy (€60bn) and France (€53bn).

2018 really hit home how climate change loads the dice against us by taking naturally occurring weather events and amplifying them. We now have attribution studies that show how much more likely or stronger extreme weather events have become as a result of human emissions. For example, wildfires in the EU now burn nearly twice the surface area they would without climate change. Forest fires now occur in the once fire-free Arctic circle in Sweden[31] and almost 40% more rain fell during Hurricane Harvey[32] than would have otherwise. In early 2018 Europe suffered from extreme cold weather christened the 'Beast from the East' and caused by a blast of cold Siberian winds. The effects were deadly, particularly for homeless people, of whom 23 died in Poland.[33] The following July, Europe suffered a heatwave, where temperatures reached 45°C in Portugal[34] and

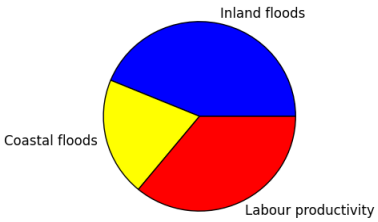
[28] https://www.e-education.psu.edu/earth103/node/717
[29] https://ec.europa.eu/jrc/en/news/global-energy-and-climate-outlook-2018-published
[30] http://www.eea.europa.eu/highlights/climate-change-poses-increasingly-severe
[31] https://www.theguardian.com/world/2018/jul/18/sweden-calls-for-help-as-arctic-circle-hit-by-wildfires
[32] https://www.theguardian.com/science/2019/jan/06/katharine-hayhoe-interview-climate-change-scientist-crisis-hope
[33] https://www.bbc.co.uk/news/world-europe-43247205
[34] https://www.theguardian.com/environment/ng-interactive/2018/dec/21/deadly-weather-the-human-cost-of-2018s-climate-disasters-visual-guide

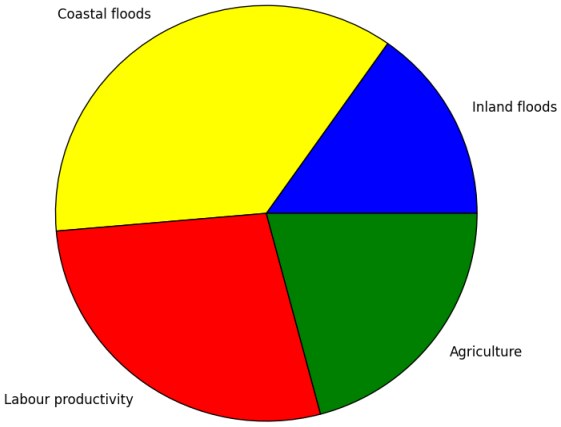
caused drought and forest fires across the continent. The Portuguese wildfire affected 0.12%[35] of the nation's GDP and caused €56 million[36] worth of damages. The single most costly natural catastrophe was the flooding that hit Europe in 2002 (€20bn), followed by 2003's heatwave (€16bn). [37]

If temperatures in Europe rise by 2ºC increase the continent could suffer around *€120 billion annual losses* (1.2% of current GDP). An increase of 3+ºC could result in *€240 billion annual losses*[38] (1.9% of current GDP). At *€105 billion annual investment* needed per year between 2021-2050[39], the cost of abatement is lower than the cost of not acting. The most recently reported incremental economic losses for extreme weather events in Europe was €14 billion[40] in 2017, compared to €7.6 billion per year in the 1980s. This economic cost prediction is worldwide. In the US the total costs to address the impact of rising temperatures will increase by 50% between now and 2027; rising to $360 billion annually or almost $1 billion a day, according to the Universal Ecological Fund[41].

As climate change affects so many aspects of our lives, this paper breaks down the future economic damage to the most vulnerable areas:

Distribution of climate impacts under the 2oC scenario (left) and high warming scenario (right)





JRC[42]

2.3 Future Climate-related Damage and Costs - Sector breakdown

2.3.1 Fluvial Floods

River Floods are the most prevalent extreme weather disaster in Europe. . It is predicted that future trends will see more rainfall in Central and Northern Europe (leading to more severe flooding) and less in Southern Europe (leading to more droughts).[43] Under the higher warming scenario >2ºC,

[35] European Commission (2018), 'Assessment of the 2018 Stability Programme for Portugal' https://ec.europa.eu/info/sites/info/files/economy-finance/22_pt_sp_2018_assessment.pdf
[36] https://www.bbc.com/news/world-europe-44438505
[37] https://www.euractiv.com/section/climate-environment/news/cost-of-climate-change-grows-steadily-in-europe/
[38] European Joint Research Centre(2014) 'Climate impacts in Europe' http://publications.jrc.ec.europa.eu/repository/bitstream/JRC87011/reqno_jrc87011_final%20report%20ready_final3.pdf
[39] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans
[40] https://www.munichre.com/en/reinsurance/business/non-life/natcatservice/index.html
[41] https://www.bloomberg.com/news/articles/2017-09-27/climate-shocks-may-cost-u-s-1-billion-a-day-as-planet-heats-up
[42] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC113810/kjna29456enn_jrc113810.pdf
[43] https://ec.europa.eu/jrc/en/news/more-floods-and-water-scarcity-ahead-there-still-time-mitigate-their-severity

welfare losses due to flooding could triple from €5bn in welfare losses today to €15bn.[44] Most damage would affect residential buildings (around 80%), followed by agriculture and capital assets. The total GDP loss in the EU will reach €2.7bn (0.02%) in the 2030s (≤2ºC) and almost €4.5bn (0.04%) in the

2080s/>2ºC. In absolute terms, the welfare losses would be approx. 3x the GDP losses; this can be explained by the large weight of residential damages in the overall direct damage which directly affects households' consumption rather than production (GDP).

2.3.2 Heatwaves

Humans don't tend to work best in extreme heat. Scientific evidence proves that hotter temperatures cause humans to have fewer children, work less, be stressed more, in addition to decreasing production.[45]. In the absence of climate change, extreme heat waves in Europe would be expected to occur only once every several hundred years instead by 2050 it would occur every 2 years if global warming continues[46].

Southern European countries – particularly Spain, Greece, Cyprus, Italy and Turkey – are projected to face increased water shortages. Increasing droughts will lead to water scarcity, higher evaporative demands and reduced hydropower resources in the Mediterranean region. This is likely to have knock-on effects on agriculture, energy, transport and food security. Dr. Levent Kurnaz (Boğazici University) suggests, for example, that without climate intervention southern Turkey will experience average temperatures of 45ºC-50ºC by 2050, eventually becoming a desert after 2100. Streamflow droughts will have an impact on cooling-water intake for industrial and energy production activities, irrigation water availability, critical environmental flow conditions, as well as hydropower potential[47]. Additionally, further over-abstraction of groundwater– beyond renewable capacity – could lead to critically low groundwater levels and increased pumping costs to extract water for surface use. The number of people affected by water shortages could rise to €295 million. Forest fires as a result of extreme heat will also become more frequent in the future, only decreasing thereafter as a result of the majority of at-risk trees already being burned[48].

Analysing the economic consequences of changes in energy demand for heating and cooling in the residential sector in Europe show that demand would increase in southern Europe for cooling but heating demand in Northern and Central Europe would reduce. Thus, the north of Europe would actually experience welfare gains of €6bn in the ≤2ºC scenario.

It is important to note that the warmer weather will also affect Winter. Since the mid-1980s, snowfall has been decreasing considerably in the northern hemisphere, particularly in mountain regions. Some Alpine regions have lost an average of four meters in snow depth over the past 30 years. One good measure of economic cost is ski-tourism where millions are spent on snow cannons and harmful chemicals to add snow to their slopes. ESPN estimates that resorts spend in the region of $500,000 and $3.5 million a season on artificially maintaining their slopes.[49] Many ski resorts at lower altitudes in the Alps are expected to have very little snow left within the next decade or so.[50]

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[44] Szewczyk, W., Ciscar, J.C., Mongelli, I., Soria, A., JRC PESETA III project: Economic integration and spillover analysis, EUR 29456 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97422-9, doi:10.2760/514048, JRC113810

[45] https://www.carbonbrief.org/state-of-the-climate-2018-set-to-be-fourth-warmest-year-despite-cooler-start

[46] https://www.metoffice.gov.uk/news/releases/2018/2018-uk-summer-heatwave

[47] https://ec.europa.eu/jrc/en/publication/impact-changing-climate-land-use-and-water-usage-europe-s-water-resources-model-simulation-study

[48] https://www.wri.org/

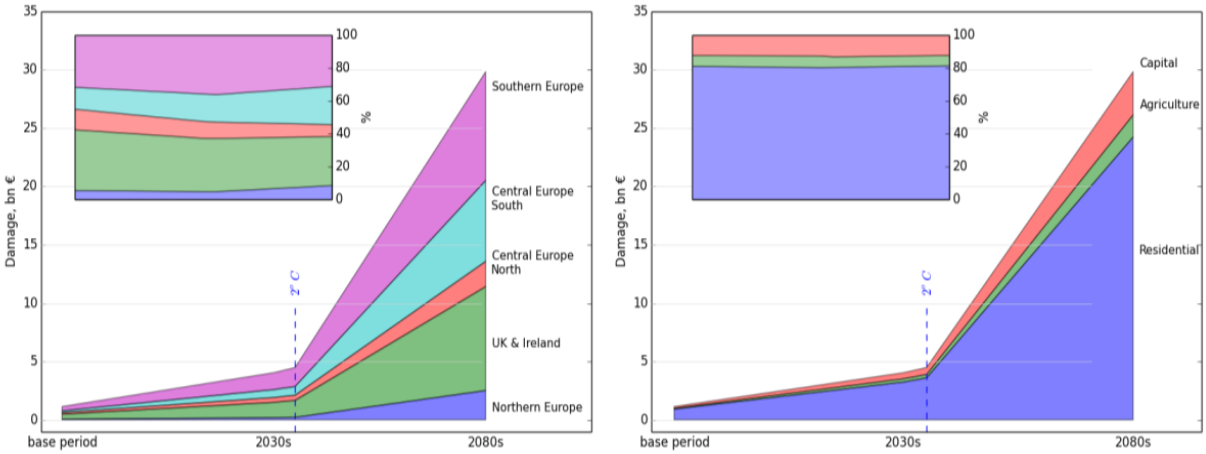
[49] http://www.espn.com/action/freeskiing/story/_/id/8809682/cost-snowmaking

[50] Schoeneich, P. and de Jong, C. (2009). Changes in the Alpine environment. How will the Alpine environment be tomorrow? *Journal of Alpine Research*, 96, 4. pp. 65-76.

2.3.3 Coastal Floods:

Coastal flooding poses serious risks to the EU and its 66,000km coastline.[51] Sea levels have risen by 16-21cm in the past 120 years and may rise by another 100cm over the next 80 years, threatening €1trn of coastal property. Every coastline on the planet is naturally subject to erosion. Beach nourishment is a short-term strategy used in the EU to combat the natural loss of sand and protect coastal property. However, this creates a sense of false security; more money is invested and more houses are built in these coastal 'risk zones', thereby causing countries and coastal communities to suffer far greater economic consequences due to coastal flooding.[52] As sea levels rise, coastal flooding and erosion occur more frequently and with increasingly devastating effects. At the ≤2°C warming scenario welfare losses would measure €4bn; this increases significantly to €35bn in the >2°C warming scenario (8x greater losses).

The regions with the highest damage would be the UK, Ireland and Southern Europe, with a combined total of around 60% of total EU coastal damage. Most damage would impact residential buildings (80%), capital assets (15%) and agriculture (5%).



EU Joint Research Center 2018

Total GDP loss in the EU would equate to €1.1-1.3bn (0.01%) in the 2030s/≤2°C and almost €10.8bn (0.09%) in the 2080s/>2°C. As is the case for river flooding, coastal flooding would also cause welfare losses approximately three times the GDP losses. Ultimately, Europe is continuing to engage in this coastal development paradox despite evidence that it will become impossible to provide the infrastructure[53] necessary to maintain it.

2.3.4 Agriculture

Agriculture produces around 10% of total greenhouse gas emissions. A warming climate will cause a global spill-over of damages via international trade to impact agriculture across geographical borders. For instance, climate-induced reduction in agricultural production in one country will lead to an increase in imports and a decrease in exports of agricultural goods, with major implications[54] for trade partners. The magnitude of the spill-over effect would depend on: (1) the severity of climate impacts on the world's regions, and; (2) the intensity of trade between those regions and the EU. Because of strong world market integration agriculture it will be one of the worst-hit areas when it comes to spill-over effects.

[51] https://www.cia.gov/LIBRARY/publications/the-world-factbook/fields/2060.html
[52] https://ec.europa.eu/jrc/en/news/more-floods-and-water-scarcity-ahead-there-still-time-mitigate-their-severity
[53] *http://www.climatecentral.org/news/ocean-at-the-door-new-homes-in-harms-way-zillow-analysis-21953*
[54] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC113810/kjna29456enn_jrc113810.pdf

Climate Impacts	GDP Effects €bn		Welfare Effects €bn	
	EU	Rest Of World	EU	ROW
Agriculture	19.5	14.5	20	11.1
Labour productivity	45	10.1	50	3.4
River floods	6.1	2.86	15.3	1.2
Energy	-2.55	0.04	-6.8	-0.2
Total	**68.05**	**27.5**	**78.5**	**15.5**

Global transboundary effects (high warming), €bn

The climate impacts for agriculture in the >2°C scenario could yield welfare losses of €20bn with an average 10% reduction in crop yield and a 0.16% reduction in GDP. There would be a clear North-South gradient regarding damages, increasing when moving towards Southern Europe. It is believed that at 2°C climate shock in itself will be treated as a production factor which farms will have to adapt to. Unfortunately, valuable non-market environmental/ecosystem services such as bees' pollination and habitats which sustain agriculture were not assessed, as those economic damages are difficult to estimate.

2.3.5 Labour Productivity

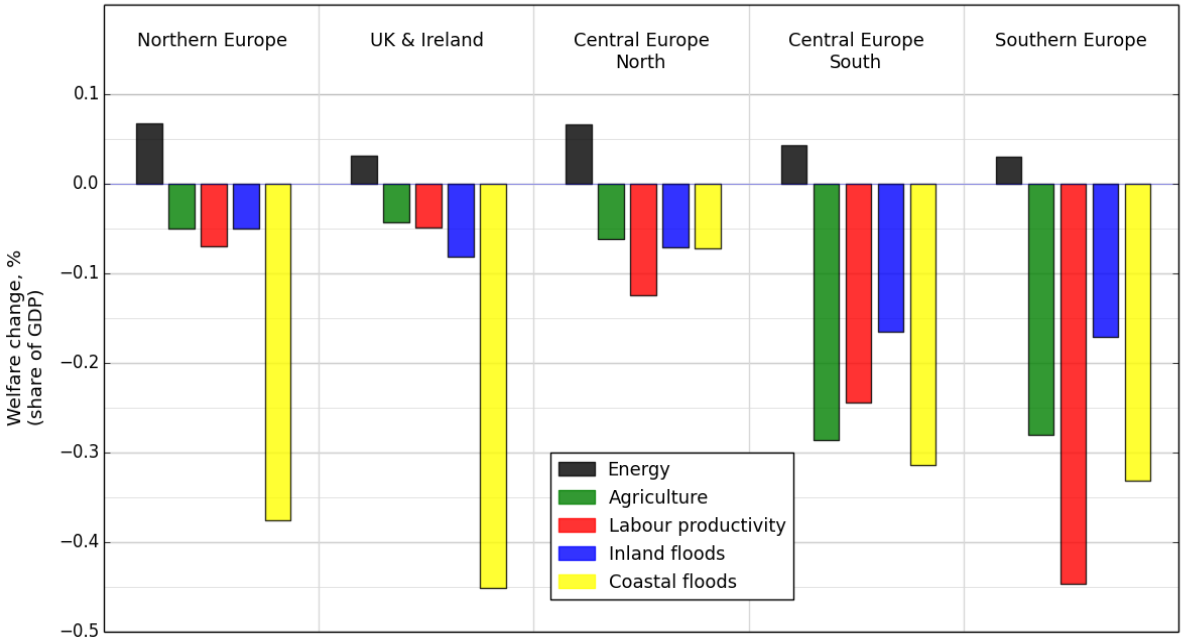
As previously stated, extreme weather conditions will impact labour productivity in Europe. In the >2°C scenario, annual welfare losses could rise to €27bn, whereas ≤2°C would limit losses to €7bn. Productivity in sectors such as construction and agriculture where work is carried out outside under the sun would bear the brunt of the negative repercussions. ≤2°C it is predicted labour productivity will fall to an EU average of 9.7% and slump to 17.9% in Southern Europe.[55]

2.3.6 Mortality:

Between 1981-2010 the annual average of heatwave-related deaths was 2,692. This figure is expected to rise by a factor of 20 at ≤2°C warming to an average 57,674; and skyrocket by a factor of 50 to 132,150 deaths per year at >2°C warming.

This bleak statistic is economically calculated using the Value of Statistical Life (VSL) method multiplied by the number of premature deaths. The assumed VSL is 1.14 million euro/person (2007; same value for all member states). Therefore, welfare losses could be as high as €150bn (>2°C) or €66bn (≤2°C). Again the North-South gradient trend reflects higher losses in Southern Europe. Indeed, in most sectors Southern Europe would see the highest EU-wide welfare losses as a result of climate change.

[55] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC113810/kjna29456enn_jrc113810.pdf



Geography of impacts for the 3+°C high warming scenario (without health impacts)

3. Recommendations:

There is no denying climate change will lead to economic costs. These 'costs of inaction' provide key inputs to the policy debate on climate risks, mitigation and adaptation. The European Commission works to make the European economy more climate-friendly with both mitigation and adaptation policies. Mitigation policies aim to reduce greenhouse gas emissions and so produce benefits in terms of avoiding climate-related damage; adaptation policies are deployed to minimize the expected impacts.

Climate change is a long-term trend superimposed over natural variability that isn't going away. To stabilise climate change, we have to eliminate our carbon emissions. The EU currently emits nearly 40 billion metric tons of carbon dioxide annually. To slow down/stop global warming and the high frequency of extreme weather events, we must reduce the amount of CO_2 being emitted into the atmosphere. This will have to be done both at an EU and the individual level.

3.1 Recommendations - EU Level

In November, the EU announced its new grand strategy to combat climate change. It plans to provide additional investment to the tune of €175bn-€290bn to cut carbon emissions in Europe. "With this strategy Europe will be the first major economy to reach net-zero emissions by 2050," EU Climate and Energy Commissioner Miguel Arias Canete said[56].

The strategy includes many building blocks to reaching that target ranging from energy-efficiency measures, developing zero-emission buildings, smart infrastructure renewable-energy sources. Transport is responsible for around 23% of greenhouse gas emissions, and the strategy urges us to change our behaviour from using private transportation to availing of low-carbon public transport, shared mobility, zero-carbon mobility (biking, walking). It also stresses increasing the efficiency of transport systems through digital technologies and smart pricing.

The EU has already cut emissions by 22% between 1990-2017, while growing its economy 57% over the same period. The EU would need to reach global annual decarbonisation rates of 6.1% per year

[56] http://www.europeantransportforum.eu/mediaroom/the-eus-latest-zero-emissions-plan-will-cost-billions-but-it-could-save-the-planet/

and 9.0% per year over 2015-2050 to stay under 2°C and 1.5°C, respectively. It has promised to slash emissions by 40 per cent by 2030 and is on track to meet that goal. Today, Europe spends €266bn/yr on energy imports.[57] In a climate-neutral Europe, energy imports would fall by over 70 per cent. The money saved (€2-3trillion up to 2050) could be invested into modernising our economy instead and would help EU GDP grow up to 2% by 2050. Going carbon-neutral will spur investments in European clean-energy solutions worth around €300bn euros[58] in addition to bringing health benefits of around €200 billion.

3.1.1 EU Needs to Take more Action

Carbon taxes and the ETS scheme already play a central role in current climate policies. However, to improve the competitiveness of its Member States, the EU needs to further utilize the costs and opportunities presented by green tax reforms. This includes shifting away from subsidising fossil fuels and labour taxation towards energy or carbon taxation. One such strategy should be *embedded environmentalism*,[59] which compensates individuals who will be most affected by environmental regulations, such as coal workers. We need an ambitious post-2020 biodiversity strategy to halt and reverse nature loss by mainstreaming climate and biodiversity protection into key economic sectors like agriculture, water, development, and energy policies.

Key mitigation options involve expanding the use of renewables and improving energy efficiency. More specifically, increased use of renewable energy sources would account for 27% of the emission reductions, non-CO_2 abatement for 20%, improved energy efficiency for 17%, and electrification of final energy demand and land use both for 10%[60]. The JRC estimate overall that achieving the 1.5°C temperature objective would come at a relatively small mitigation cost to the overall global economy of 1.3% of global GDP in 2050 which is less than the equivalent of one week of economic activity lost for a given year. Now that the EU has put forward its grand strategy it is also up to the member states to continue to meet their emission targets, which as seen in the CPI is not the case for all Member States. France's wind power sector, for example, has not approved a single project since late 2017[61] and while we pat ourselves on the back for having roughly 1,600 e-buses on the road in Europe today, the Chinese city of Shenzhen completely electrified its fleet of 16,000 buses in 2018[62]. Furthermore, upgrading old pre-existing windfarms would require less wind turbines, produce more energy and also yield better returns for energy producers.

3.2 Recommendations - Individual Level

COP 24 and recent articles have revealed that nation states are not reaching their national emission reduction targets yet the COP is targeting the wrong perpetrators. 100 or so corporations are responsible for 71% of global carbon emissions[63] and the wealthiest 10% of the global population is responsible for 50% of consumption emissions.[64] Astonishingly, you only need a total wealth of under €88,000[65] to be in the world's wealthiest top 10%. Reports have recommended that we move

[57] https://ec.europa.eu/jrc/en/geco Global Energy and Climate Outlook 2018: Sectoral mitigation options toward a low-emissions economy
[58] https://www.bloomberg.com/technology
[59] https://ec.europa.eu/jrc/en/research-topic/costs-and-benefits-climate-policies
[60] https://ec.europa.eu/jrc/en/research-topic/climate-change-mitigation
[61] https://www.euractiv.com/section/energy-environment/news/the-brief-the-future-is-theirs-unless-we-destroy-it-first/
[62] https://www.euractiv.com/section/transport/opinion/eu-needs-clean-vehicle-procurement-rules-to-boost-e-mobility-in-cities/
[63] https://www.theguardian.com/sustainable-business/2017/jul/10/100-fossil-fuel-companies-investors-responsible-71-global-emissions-cdp-study-climate-change
[64] https://policy-practice.oxfam.org.uk/publications/extreme-carbon-inequality-why-the-paris-climate-deal-must-put-the-poorest-lowes-582545
[65] Credit Suisse 'Global Wealth Report' http://publications.credit-suisse.com/tasks/render/file/index.cfm?fileid=77A4E912-A32D-8E84-CC8C21144CEE52E2

past "national action plans"[66] and start to act immediately against these two groups largely responsible for climate change. If the wealthiest 10% reduced their consumption to the level of the average European, we would see a 30% cut in global emissions.[67]

Even if we were able to extract carbon from the carbon from the air and save the environment, deep down humans at their core are not sustainable creatures. We hoard objects and naturally live excessive lives. We damage the world around us as long as there is a financial incentive behind it. We need to raise awareness about and address our consumer society and its deeply-ingrained habits.

What can we do to make *more* people care about climate change? To motivate people to take action, it's important to connect climate change to something tangible, like air pollution and health problems. This approach has been successful in China, where public opinion has shifted in favour of clean energy after experiencing the effects of air pollution due to coal-burning. People need to be informed about and provided with solutions, like installing solar panels on their rooftops or buying an electric car. People need a sense of hope, they need to be shown that no singular, individual action is in vain or too small.[68] They need to realise that there is light at the end of the tunnel and that making sure that we get closer to it and that future generations can actually reach it is something worth striving for, here and now. Many simple measures can be taken on an individual basis to reduce one's carbon footprint; most are well-documented and well-known, e.g. recycling, reducing waste, voting for an environmentally-focused leader in the upcoming EU-elections, having fewer children. Here are some more recommendations the average citizen can implement in their everyday lives to contribute to lowering carbon emissions.

3.2.1 Cut out/down flying

With the opening of 2 new mega airports in Beijing and Istanbul, 2019 is set to be one of the cheapest years for flights as competition brings down the price. Carbon taxes for airlines are only expected to take effect from 2020. The temptation to fly will therefore be strong for the consumer in 2019 but he/she would do well to consider alternatives. Taking a train produces 50% less carbon than an airplane (collectively planes produce about 3 percent of total global emissions).[69] If taking a plane is unavoidable, fliers can now calculate and offset their carbon emissions by donating to environmental charities such as https://www.carbonfootprint.com/carbonoffset.html or https://www.terrapass.com/.

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3.2.2 Trees

Scientists from Yale and 23 other universities estimated that the earth has three trillion trees.[70] At first glance, this seems like an enormous number. However, scientists also found out that humans have already destroyed 46% of the Earth's tree-cover. The study shows that we lose around 15 billion trees per year due to deforestation. Every euro spent restoring degraded forests equates to €27 in economic benefits.

Trees are very easy to plant and have major environmental benefits, extracting and storing CO_2 and other greenhouse gases from the atmosphere. On average, each tree stores 10 kg of CO_2/year, a figure that increases in the tropics. Trees regulate precipitation and form a part of the water cycle. One large tree can take up to 370 litres of water out of the ground and release it into the atmosphere in a single day[71].

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[66] https://theconversation.com/climate-action-must-now-focus-on-the-global-rich-and-their-corporations-108943?fbclid=IwAR0_8BfsLrvZFRpuU1RpNNQcVIhvkMMh5BpV-gSHxMXGyQFMVUyyV5XDWeU

[67] https://www.democracynow.org/2018/12/11/scientist_kevin_anderson_worlds_biggest_emitters

[68] https://www.theverge.com/2018/3/29/17173166/climate-change-perception-gallup-poll-politics-psychology

[69] https://www.mnn.com/green-tech/transportation/blogs/plane-train-or-automobile-which-has-the-biggest-footprint

[70] Crowther.T.W et al. (2015) "Mapping tree density at a global scale". Macmillan Publishers Ltd. doi:10.1038/nature14967.

[71] https://www.plant-for-the-planet.org/en/about-us/trees-are-amazing

Air pollution is responsible for 400,000 premature deaths every year[72]. Trees could help us reduce this sobering figure as they filter and clean the air. A single tree can take in up to 5kg of air pollutants a year and produce up to 130 kg of oxygen over the same period.
Green infrastructure (trees, parks, greenways) and investment can provide cost-effective natural solutions to flooding, air pollution, and recreation in addition to increasing the economic value of housing. Globally, nature provides services worth around €110 trillion a year, therefore it is in everyone's interests to defend nature in order to helps tackle climate change and ensure food security.

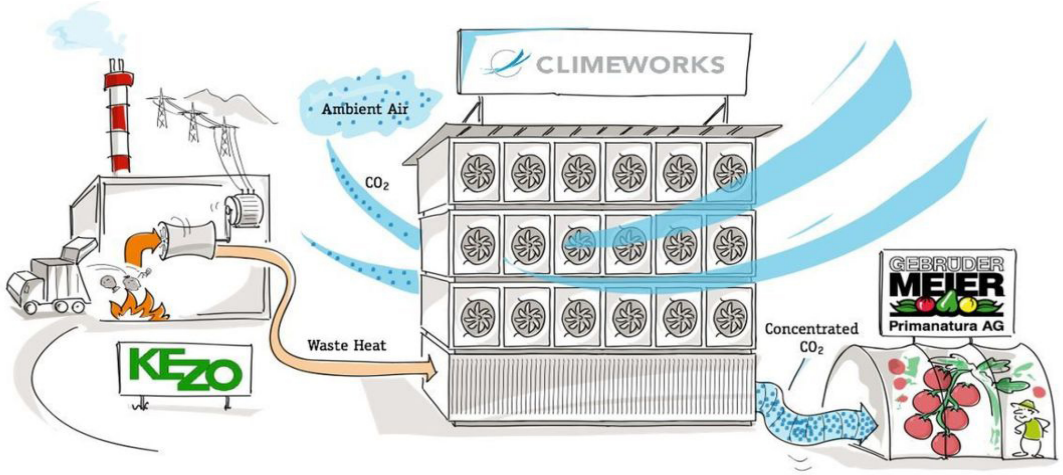
3.2.3 Biodiversity

Around 15 billion worth of Europe's agricultural production depends on pollination by insects and around 4.4 million jobs in the EU depend directly on healthy ecosystems. Some of the EU's fastest growing sectors are in the green economy. Biodiversity is the variety of life on our planet, it underpins our wellbeing and economy. More than 80% of Europe's crops and wild plants need pollinators, like bees, in order to bear fruit and seeds. Nature's invisible services are free and often taken for granted yet they are priceless, precious and vulnerable. Natural ecosystems such as forests, grasslands or wetlands are under pressure from intensive agriculture, urban sprawl, pollution, invasive species and above all climate change.[73] Naturally-occurring ecosystems maintain soil fertility, recycle waste, regulate the climate, provide us with medicines and purify water and air (ocean plants produce more than half of the oxygen in our atmosphere).

We could not live without these ecosystems. The EU's Natura 2000 and EU Birds and Habitats Directives are at the heart of European biodiversity conservation efforts. Together they protect more than 27,000 protected sites (totalling 1million km^2 or 18% of the EU's land mass). Natura 2000 management costs are around €6 billion a year yet it provides benefits estimated to be worth €200-300 billion a year.[74] Individuals can assist conservation and protection efforts by not dumping, recycling more and reducing our meat intake, especially for beef.

Catching it out of thin air:
Direct Air Capture (DAC) is a technology that could pull us back from the brink. DAC consists of machines that work like a tree does, sucking CO_2 out from the air, but at a faster rate than one tree. It also uses less water and has a smaller physical footprint.

(climeworks.com)



[72] https://www.eea.europa.eu/publications/air-quality-in-europe-2017
[73] http://www.wwf.eu/campaigns/living_planet_report_2018/
[74] DG Environment (2018) 'Nature and biodiversity - What's in it for me?'
https://publications.europa.eu/en/publication-detail/-/publication/d2484fb9-e45b-11e6-ad7c-01aa75ed71a1

Climeworks[75] is a Swiss company that utilizes DAC technologies to chemically remove carbon dioxide from the air and put it to other uses such as producing stone, gas or boosting crop growth. Converting CO_2 into stone has been the only process that verifiably achieves negative carbon emissions. It is mixed with water and injected 700 meters underground[76] where it fuses with basalt rock to form new minerals, which form at a vastly quicker rate of 2 years instead of thousands of years. This ensures that the carbon doesn't escape back into the atmosphere for millions of years. At pilot scale DAC captures only 50 metric tons CO_2 from the air each year, about the same emitted by 10 Indian households or a single US household.[77]

Bioenergyinternational.com

Although DAC sounds like a good investment, the cost of removing carbon is still too expensive ($600-800 to capture one ton of carbon dioxide).[78] It is generally recommended to spread risk over several ideas. It would be more aesthetically pleasing to see a line of trees on the roadside rather than a line of small DAC plants. Scientists stress that looking towards DAC technology was not the right direction to go as it does nothing to discourage humans from continuing to pollute at our current rate. Other large-scale man-made technological interventions to "fix" the climate crisis are moving up on the political agenda,[79] including ocean fertilisation, carbon dioxide removal, marine cloud brightening, cirrus cloud thinning and ground-based albedo modification. This paper believes the ideal solution would be a three-pronged approach consisting of tree nourishment, DAC, and most importantly reducing CO_2 emissions via divestment, renewable energy investment and applying a carbon tax.

4. Conclusion:

As the saying goes 'When money talks, the world listens'. Today, people should definitely be listening to climate change. Current temperatures already shave off about a quarter of a point (0.25) of World GDP every year and may bite off 23% by the end of the century.[80] We are very much the frog in the boiling water; - the earth is warming exponentially and creating some of the largest extreme weather events incurring serious economic cost to the world. Humans are in danger of getting used

[75] http://www.climeworks.com/co2-removal/
[76] https://qz.com/1100221/the-worlds-first-negative-emissions-plant-has-opened-in-iceland-turning-carbon-dioxide-into-stone/
[77] https://qz.com/1100221/the-worlds-first-negative-emissions-plant-has-opened-in-iceland-turning-carbon-dioxide-into-stone/
[78] https://qz.com/1407687/climeworks-has-opened-a-third-plant-capturing-carbon-dioxide-from-the-air/
[79] https://www.theguardian.com/environment/2018/oct/08/geoengineering-global-warming-ipcc
[80] https://www.bloomberg.com/news/articles/2017-09-27/climate-shocks-may-cost-u-s-1-billion-a-day-as-planet-heats-up

to extreme weather events and losing the sense of urgency, which unfortunately is the exact argument that climate change deniers make. Their rhetoric claims that the world's climate always changes and this is normal despite the scientific evidence.

Climate change is no longer subtle, where once it seemed distant. Today, most people can point to a specific way climate change affects their daily lives.[81] "The world's weather is becoming more extreme before our eyes - the only thing that can stop this destructive trend from escalating is a rapid fall in carbon emissions.[82] "The world is yet to have that 'Oh S**t!' moment where we would finally see a ramp up of resources to cut emissions similar to the Manhattan Project, the moon race or the Zika Virus resulting in serious progress being made. The EU's investment strategy is likely to work as markets help where beliefs do not — if renewable energy remains cheap, even sceptics are likely to use it. The price of batteries has fallen 18% in 2018 after a 26% reduction in 2017[83] and solar energy is the fastest-growing power source around the world.

Ultimately, countries need to stick to their NDCs (Nationally Determined Contributions) and decarbonisation pledges made in the Paris Agreement, and extend them beyond 2030. Setting climate targets will always be a political question as well as a scientific one. But it's an undeniably sensible aim to keep global warming within the narrow window that has sustained human civilisation for the past 11,000 years.[84] The IPCC has mapped out four pathways whereby we can limit global warming to 1.5°C, through different combinations of land use and technological change. Reforestation is essential to all of them as are shifts to electric transport systems and greater adoption of carbon capture technology. We have 12 years to prevent a climate catastrophe.[85] Never before has the threat of irreversible damage been so close. As this paper has shown, reducing our emissions could save billions of euros, but, perhaps more importantly, it could also save billions of lives.[86]

[81] https://www.theguardian.com/science/2019/jan/06/katharine-hayhoe-interview-climate-change-scientist-crisis-hope

[82] An excellent website to check out is Co2.Earth. They work with Mauna Loa Observatory, Hawaii to give daily updates of the atmospheric CO_2 count parts per million (ppm). This is the life vitals of the Earth. This number continues to rise every day contributing to global warming. As of January our atmospheric carbon particles were 410.47 (ppm), a number that has not stopped increasing in over 70 years.

[83] https://www.transportenvironment.org/newsroom/blog/what-car-co2-deal-means

[84] http://theconversation.com/we-cant-know-the-future-cost-of-climate-change-lets-focus-on-the-cost-of-avoiding-it-instead-108051

[85] Thank You Aisling. www.google.com

[86] There is a vast uncertainty permeating the biophysical and economic analyses. While it provides a good general overview, it can also offer a misleading perspective of the EU climate damages because the list of climate impacts is incomplete. Some of the PESETA climate impacts, have not been integrated into the economic framework (e.g. habitat losses) ecosystem services losses, unknown catastrophic consequences of climate tipping points, climate-migration, and health impacts.

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