Relocation Social Insurance

University of New South Wales: Group 3
Hiba Fatima
Osmaan Rasouli
Felix Tran
Lai Wei
Dion Zhuo

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1 Executive Summary

Storslysia has contacted Group 3 Consulting to design a social insurance program to combat the increasing economic costs of relocation due to displacement rising from catastrophic climate related events. The program outlined in this report provides both incentive-based voluntary relocation as well as involuntary displacement and damage cover. The incentives program will run for 10 years and provide ₹2000 for relocation to low-risk regions.

This incentive serves as a low-cost program aimed at reducing the overall costs incurred from natural disasters in the country due to involuntary displacement, goods replacement, material and labour costs. Under this program design, it is expected that Storslysia will have reduced overall costs from natural disasters in all forecasted emission scenarios.

2 Objectives

The proposed Relocation Social Insurance (RSI) program will address displacement issues resulting from hazard events which is particularly crucial due to a growing concern regarding global warming and climate change. The RSI program has both a proactive and reactive approach to manage displacement costs within the country. The program offers a voluntary relocation incentive payment to those who currently live in a high-risk region when they relocate to a low-risk region before a hazardous event occurs. Involuntary displacement cover is offered to relocate people who live in a property which has been significantly damaged from a hazardous event. Historic property damage costs are large and have been analysed in detail to understand potential future displacement costs which is demonstrated in Appendix A.1. With this voluntary movement, the program aims to reduce Storslysia's catastrophe-related displacement costs under all forecasted scenarios.

The RSI program is offered to the entire population of Storslysia and is designed with consideration to key demographic information. Furthermore, expected future program costs have been estimated to ensure that total costs remain below 10% of GDP. This is a key consideration which will enable the program to remain sustainable in the long run. A conservative approach has been utilised in which a high emissions scenario has high levels of inflation and a generous margin have been allocated to confidently assure that costs will not exceed this threshold.

2.1 Key Metrics

Table 1: Key Metrics of Program

Metric	Method of measurement
Fatalities per year	The annual fatalities will be recorded and monitored. If the program is running as expected, there should be less people living within high-risk areas which should result in a decreasing number of fatalities over time.

Injuries per year	The annual number of injuries will be recorded and monitored. If the program is running effectively, there should be fewer injuries over time.
Total annual program costs	The total cost of the program is expected to gradually reduce and stabilise. Total annual costs will be recorded and monitored to ensure that there is a reduction over time. Initially there will be a range of start-up expenses however as more people relocate to less risky regions there should be fewer displacement claim costs.

3 Program Design

3.1 Claim Lodgement Requirements

Table 2: Claim Lodgement Requirements of Program

Cover Type	Claim Lodgement Requirement	What is Covered?
Involuntary Displacement	Must be a citizen who is living in a property which has been damaged by an identified hazard event. Damage must render the property uninhabitable.	• Cost for relocation is provided. • Moving costs are provided.
Voluntary Displacement	Voluntary displacement cover is available to citizens living in a high-risk area (regions 1, 2 and 3) who relocate before a hazard event.	• Voluntary incentive payment provided is Ψ2000.
Property Damage	Must be a citizen who is living in a property which has been damaged by an identified hazard event. Damage does not need to render the property uninhabitable.	• Cost of repairs or rebuild of the property. The most economic option is provided.
Household Goods Damage	Must be a citizen who is living in a property which has been damaged by an identified hazard event.	• All household goods, up to 75% of the housing cost.

3.2 Coverage Limitations

Table 3: Coverage Limitations of Program

Cover Type	Limitation	Justification
Involuntary Displacement	• Program only covers the cost of a similar size property in a low-risk area is provided. • If a property has been damaged by a hazard event but is still within a liveable condition, then no displacement coverage is provided.	This maintains adequate coverage whilst avoiding unnecessary displacement claims.

Voluntary Displacement	• Only provided for owner occupied properties • The fixed incentive payment of Ψ2000 can only be claimed once by a property owner. • Households living in regions 4,5 and 6 are not eligible for this cover. • Incentive payment can only be redeemed within the first 10 years of the program.	The limitations are in place are targeted towards owners who live in areas that are high risk and therefore it is to encourage them to relocate.
Property Damage	• No coverage provided if the damage to the property occurred as a result of not being built to relevant building standards.	This avoids claims from properties in which renovations or construction are not to standard.

3.3 Policy Incentives

The program has a few key incentives embedded in its design to reduce the overall economic costs of displacement within the country. The key incentives are outlined below:

1. **Bonus relocation incentive payment**

A bonus relocation payment of Ψ2000 will be provided to those living in owner occupied properties who voluntarily relocate from a high-risk area to a low-risk area prior to a hazard event.

2. **Community disaster awareness program**

A community disaster awareness program is set up to creative awareness of the program as well as inform the community of the risks of continuing to live within regions that are deemed to be high-risk. The program will be organised by the taskforce and a variety of awareness tools will be utilised. A key tool will be holding sessions and talks at local community centres in which our environmental experts will provide key insights into the increasing number of environmental disasters and the impact of climate change.

3.4 Quantitative and Qualitative Justifications of the Program

3.4.1 Quantitative Justifications

A key quantitative objective is to reduce the overall economic impact of hazards to residential properties by controlling property damage costs. Economic cost projections over both the short- and long-term horizons demonstrate that the program has reduced total impacts of hazard events. In the conservative high emissions projection model, there is **0.3%** reduction in short-term costs and a **4.9%** reduction in long-term costs. In the less conservative scenario of low emissions, there are reductions of **0.3%** in the short term and **9.2%** in the long term. Despite short-term reductions appearing minimal in percentage terms, these in magnitude are considered substantial. In addition to this, various scenario and stress testing also demonstrate

that costs will remain below the 10% GDP threshold which enables ongoing sustainability of the program.

3.4.2 Qualitative Justifications

The proposed program is designed to achieve the two key qualitative objectives; lower hazard mortality and lower hazard-related injuries. Through voluntary relocation, there are fewer residents of high-risk regions that will endure severe hazard events. These severe events cause higher levels of mortality and injuries.

Indirectly by maintaining the health and well-being of citizens during hazard events, the program will have positive economic impacts. These include fewer people taking time off work due to injuries preventing them from being able to perform their work duties and fewer people who have been injured excessively and therefore not being able to return to work.

3.5 Short-Term and Long-Term Objectives

The program will be monitored annually to ensure that the outlined objectives are achieved. Total costs have been evaluated over the short term (first 10 years) and the long term (100-year timeframe) which are displayed in Appendix B.1 and Appendix B.2 respectively. In both timeframes expected total costs are below GDP and the program has resulted in a reduction in total property damage.

4 Pricing/Costs

4.1 Economic Costs Projections Methodology

Data cleaning has been conducted as an initial step before the modelling process. This involved truncating the data after 1960, removing two outlier hazard events and on-levelling property damage. Hazard events have also been regrouped into 7 categories based on their nature.

1. **Model historical claims type**

Fatalities and injuries are converted into monetary values of Ψ4 760 884 and Ψ203 910 respectively (Department of the Prime Minister and Cabinet, 2022). These are then used to calculate the total cost of a natural disaster by summing them with the inflation-adjusted property damages. Afterwards, an unsupervised K-means clustering is applied on the total costs to classify the historical natural disaster events into minor, medium and major severities.

2. **Model claims count**

From the K-mean's result, there are 6 major claims, 115 medium claims and 2934 minor claims, where the major type gives the highest average total cost, defined as total cost (as outlined previously) divided by the number of claims. The number of claims for each region is then modelled using a frequency projection model. The expected number of hazard events in 2020 is just a simple average of the K-mean's result. The total expected number of hazard events is subsequently allocated to each region's frequency model by claims type.

3. Model severity costs

From the correlation matrix in Appendix C.1, there is no strong correlated variables among fatalities, injuries, and on-levelled property damage. Thus, to model severity, total cost is used and is seen as "total_cost" in its empirical distribution in Appendix C.8. Based on the distribution, a GLM (family = Gamma) with log link is used to model the amounts, with a lasso penalty applied when estimating the model. The variables used in the model are region, quarter, hazard group and hazard type. Based on the GLM estimates in Appendix C.2, region 2 has the largest impact within all regions, while hazard group 5 (Hurricane/Tropical Storm) has the largest impact within all hazard groups, and the total damage occurred in quarter 4 is the most severe.

4. Model future inflation

For the inflation, as it is a time series data, an ARIMA method was selected to do the projection. From the analysis shown in Appendix C.3, the sample PACF drops suddenly inside the confidence interval after lag 1. This suggests the data can be fit with an AR(1).

The short-term inflation is selected by the 10-year average of the AR(1) projection. The AR(1) gives an estimation of 3.595% for long term inflation. The final long-term inflation is selected at 6.595% to allow for the future uncertainty.

4.2 Projection Results

4.2.1 Economic costs without the program

To project the economic costs that would be incurred without the program, the following components have been considered:

- The claims costs including injuries, fatalities and property damage caused by future hazard events are projected using GLM.
- A 75% margin on top of the claim costs is added for replacing household goods.
- Due to possible demand change, the price for material and labour will increase, and thus a 50% margin is added on top of the claim costs.
- Involuntary movement costs to temporary housing, caused by destruction of houses.

4.2.2 Economic costs with the program

To project the economic costs with the program in place, the following additional items have been taken into consideration:

- The incentive program encouraging people to relocate from high-risk areas to a low-risk areas will incur an incentive cost.
- Benefits from voluntary relocation scheme as there is a reduction in exposure will lead to a cost reduction.

Figure 1: Short-Term Economic Costs Under Different Scenarios

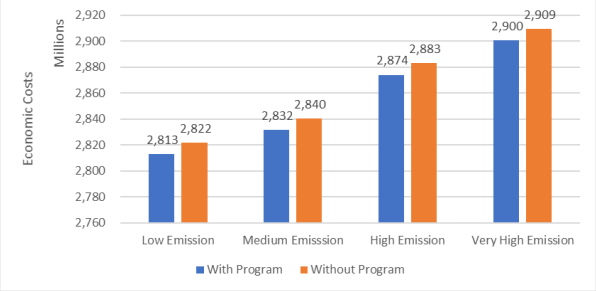
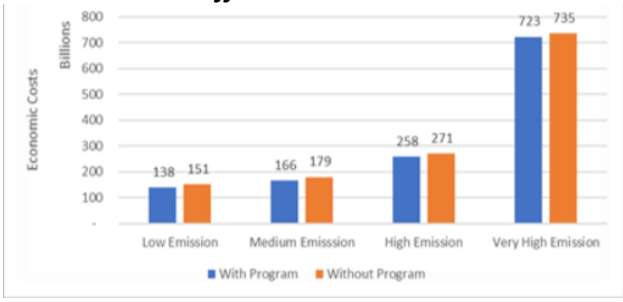


Figure 2: Long-Term Economic Costs Under Different Scenarios



- For the short-term economic costs, a 10-year time frame is used, which was calculated as a simple average of 2020 economic costs and the projected 2030 economic costs (Appendix C.4 and Appendix C.5). From the short-term graph on the left above, with program will incur relatively smaller costs compared to the long term for any future scenarios. From the long-term graph on the right above, the very high emission gives a larger cost due to an exponential impact from the future inflation. For the long-term projection, the economic costs saving from with program is more obvious than the short term (Appendix C.6). This is because the exposure reduced in high-risk areas will decrease the total involuntary displacement costs and the implicit total saving increases over time.

4.3 Economic Capital Requirements

To determine the economic capital needed with a high-level degree of certainty, a worst-case scenario estimation has been conducted. This scenario takes into consideration a 20% reduction in GDP for all years, a 10% decrease on the reduction of involuntary costs with program and a very high emission scenario assumed. From Appendix C.7, it can be seen that for both long term and short term, the costs are still within 10% of GDP. The economic costs needed for the short term is around 2.9 billion and for the long term is around 729 billion.

5 Assumptions

5.1 Key Assumptions

- Fatalities and injuries have a monetary value of ₱4 760 884 and ₱203 910 respectively.

Studies have found an estimate for societal values in preventing death and the value of a year of life. As of 2022, the value of statistical life is AUS$5.3m and the value of statistical life year is AUS$227,000 (Department of the Prime Minister and Cabinet, 2022).

The currency values are then converted with the provided, and publicly available exchange rate information from date 3rd March 2023. This therefore allows the combination and comparison between deadly and damaging natural disasters.

- The severity of natural disasters follows clusters based on their total severity value, where this includes fatalities, injuries, and property damage.

Natural disaster can be universally classified based on their total key statistics such as fatalities or economic damage (Caldera & Wirasinghe, 2021). Following from the previous assumption, fatalities and injuries are included with property damage to calculate total severity value.
This leads to distributing the natural disasters data and allowing for severity classifications to be determined by the data clustering, of which determines the proportioning of minor, medium and major events.

- 1% of populations in region will relocate under the program.

In comparison with multiple other relocation programs, it was examined that a small number of households undertake the program (Bower & Weerasinghe, 2021). Thus, 1% is chosen to be in-line with the contemporary results.
Additionally, greater premium pricing in risky areas and the populations' understanding of the climate risk impacts causes voluntary relocation to be a viable option over not moving.
This allows for the forecasting of costs under the relocation program and overall level of cost reduction.

- The voluntary relocation leads to a 20% reduction in involuntary movement costs.

When relocating people in risky areas to lower risk areas, there is an expected decrease in the number of people affected by natural disasters overall.
With consideration of all natural disasters, relocation will thus play a large role in a community's long-term recovery (Bodine, Tracy & Javernick-Will 2022), and thus the 20% reduction is chosen to reflect this.

5.2 Additional Assumptions

- Only data from the past 50 years was considered as relevant.
- The distribution of natural disaster severity closely fits a GLM with family Gamma.
- The provided future projection was assumed to cover all possible scenarios, with the very high emissions being the worst possible scenario for natural disasters.
- Additional costs of natural disasters (i.e. material, labour, housing, relocation, household goods replacement) are at the maximum possible level and are constant.
- Relocation costs are only applicable towards owner-occupied houses and population.
- Houses are uninhabitable after a percentage of damage, and thus a larger number of houses are affected per natural disaster than just the property damage against house prices.

6 Risk and Risk Mitigation Strategies

6.1 Quantitative and Qualitative Program Risks

Table 4: Quantitative Risks and Mitigation Strategies

Quantitative Risk	Description of Risk	Mitigation Strategy

Market Risk	The rise in repairs and construction costs as a result of an increase in demand for building materials and labour after a hazard event.	The proposed voluntary relocation program offers incentive payments and property-related coverage reducing the risk of paying last-minute prices in disaster periods. A future property mitigation grant program could be considered upon regular program reviews. This would entail reinforcement requirements for hazard-prone homes.
Underwriting Risk	Incorrect risk profiling and inaccurate claims management.	A conservative approach of a 5% risk buffer has been applied to avoid underestimating costs. The margin will ensure that objectives are achieved even when minor underwriting risks are incurred.

Table 5: Qualitative Risks and Mitigation Strategies

Qualitative Risk	Description of Risk	Mitigation Strategy
Environmental (Catastrophe) Risk	Severe changes in environmental conditions or instances of catastrophic events.	If catastrophic risk proves to be problematic over time, excess of loss reinsurance and the implementation of a self-insurance program will reduce the impacts of this risk moving forward. The self-insurance program could entail the use of pension fund savings as a disaster relief instrument (Guo & Narita 2018).
Social Risk	Negative social attitudes towards the program may decrease participation for voluntary relocation.	A recurring review could be undertaken to gain insight on public opinion. This review can also allow input from key leaders of community groups, enabling a sense of community involvement in natural disaster management.
Relocation Risk	The risk that can occur in the event that more than one region is simultaneously affected by a natural disaster.	Flexible relocation programs can be initiated, relocating to either single or multiple sites depending on the nature of the hazard.

6.2 Likelihood and Severity Heat Map

Table 6: Risk Heat Map

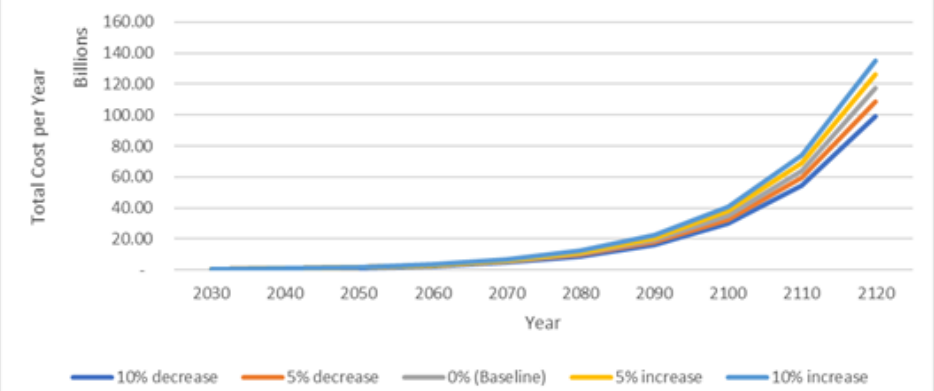
		Risk Likelihood		
		Unlikely	**Possible**	**Likely**
Risk Severity	**Low**	Underwriting Risk	Social Risk	
	Medium	Relocation Risk		Market Risk
	High	Environmental Risk		

6.3 Sensitivity Analysis

As the program's main focus is to relocate people to safer regions, the main highlight of the sensitivity analysis was on the total cost proportion of each contributing region to understand sensitivities to relocation changes.

The model demonstrates that region 2 is at the most risk of accumulating the highest costs. Assuming that the proportion of cost changes from region 2 evenly affects the other regions, the total costs of the program increase at a rising rate if region 2 is victim to a larger proportion of costs. Thus, reallocating the original proportion of region 2 costs (23.38%) costs to other regions would alleviate total costs, being the most favourable outcome.

Figure 3: Effect of Region 2 Proportion Changes on Long-Term Costs (High Emissions Scenario)



6.4 Without and Without Program Cost Comparison

Regarding the sensitivity implications with and without the program, the program will decrease economic costs in the short term if the number of households voluntarily relocating is controlled. Within the short-term, the program will be break-even with involuntary costs if there is a 12% increase in the incentive payment value or number of expected households participating. Thus, the program may suffer from large surges in voluntary relocation in the short term. However, in the long run, these households would reap the benefits of voluntary relocation, which would see lower chances of incurring involuntary costs evident in Appendix D.1. Thus, the program would incur less economic costs than without the program in the long run with a high level of certainty.

6.5 Program Costs in Comparison to GDP

Worst-case scenario projections and sensitivity testing results clearly show that program costs will not exceed 10% of GDP with a high level of certainty. Short-term and long-term projections remain below the GDP constraint for all four emission scenarios. An extreme stress test has been conducted such that the base model maximises total costs. This scenario is displayed in Appendix D.2 and reveals that the total cost of the program would still not breach the 10% GDP threshold. It can be concluded that the GDP threshold would only potentially be breached in the unlikely event that the cost benefits of voluntary relocation begin to diminish at a rapid rate or if the program is revised such that excessive government expenditure on incentives exceeds the GDP constraint.

7 Data and Data Limitations

7.1 Data Sources

The three data sources, all provided from the Society of Actuaries and where future emissions data originated from IPCC's SSP Scenarios for Future Atmospheric CO2 Concentrations, Worldwide Population, and GDP, were:

1. *Historic hazard event data:* Historic hazard event data was used to develop thresholds for hazards to be classified as minor, medium, or major for purpose in the emissions model. This was done using a traditional observation method, as well as K-means clustering and a GLM model. The inflation metrics were used to realise the value of past disaster costs for a more accurate interpretation of them.

2. *Demographic data:* Demographic data was used for preliminary analysis of Storslysia's demographic in conjunction with hazard data. Figures such as the "GDP" and "Temporary Housing cost with disaster (per person per month) were used more in program development and projections of the insurance costs and outcomes.

3. *Emissions data:* The number of minor, medium, and major hazard events found using the historic hazard event data was implemented in the model of emissions data to develop a conservative future world scenario to be used in hazard projection for the purpose of voluntary and involuntary insurance programs for Storslysia. Additionally, the growth rate of world GDP per capita was used as a proxy for the growth rate of Storslysia's GDP.

Limited external data was used, such as an estimate of the value of a statistical life year (in AUD). This was used to more completely model the total cost of disasters and to create a more conservative scenario that still meets the program objectives. Additionally, the US exchange rate data was used to convert this value of a statistical life from AUD to USD, and then from USD to Storslysia's local currency.

7.2 Data Limitations

There was a small amount of missing data those of which were filled in with standard imputation methods. Additionally, limited demographic data was available, usually only 2-3 years making it difficult to explore long term trends. Lastly, future emissions data was given on a decadal basis, meaning that figures for the years in between that could not be derived in some other way had to be estimated using a simple linear average assumption between decades.

The conclusions and projections discussed in this report are deemed to be accurate and reasonable however are dependent on the accuracy and sensibility of the data provided. The data provided, for example, cannot provide a range of exact future world scenarios with probabilities, and hence our results may then be considered as best estimates of future outcomes.

APPENDIX

APPENDIX A – OBJECTIVES

A.1: Table 7 – Historic hazard costs

Hazard	1	2	3	4	5	6	Grand Total
Coastal		8,788,392					8,788,392
Coastal/ Flooding		113,525					113,525
Coastal/ Flooding/ Severe Storm/Thunder Storm/ Wind	167,661	178,998	182,099	177,878	157,926	187,458	1,052,020
Coastal/ Hurricane/Tropical Storm/ Severe Storm/Thunder Storm/ Wind		9,541,131					9,541,131
Coastal/ Hurricane/Tropical Storm/ Wind		1,141,695					1,141,695
Coastal/ Severe Storm/Thunder Storm		1,203,391					1,203,391
Coastal/ Severe Storm/Thunder Storm/ Wind		11,916,507					11,916,507
Coastal/ Wind		494,827					494,827
Drought	1,745,205	1,894,493	1,921,676	1,605,887	1,726,590	1,655,000	10,548,851
Drought/ Heat	90,651,042	98,955,262	91,577,899	84,407,291	89,603,643	95,616,180	550,811,317
Flooding	281,851,414	427,893,536	466,823,904	337,886,016	6,717,455	7,155,838	1,528,328,163
Flooding/ Hail	7,567						7,567
Flooding/ Hail/ Wind	76,977						76,977
Flooding/ Lightning	79,981	84,890	3,997	3,973	4,218		177,059
Flooding/ Lightning/ Severe Storm/Thunder Storm	3,774,757	26,985	421,985	26,903	27,105		4,277,735
Flooding/ Lightning/ Wind	822,956						822,956
Flooding/ Severe Storm/Thunder Storm	5,781,858	1,280,581	884,280	1,626,569	46,797	19,491	9,639,576
Flooding/ Severe Storm/Thunder Storm/ Wind	39,225	37,048	35,085	34,241	121,459	34,563	301,621
Flooding/ Wind	207,102	341,552	207,746	224,280	199,472	225,750	1,405,902
Fog		217,925					217,925
Hail	1,354,501	10,144,823	1,360,522	1,319,134	8,842,978	1,312,626	24,334,584
Hail/ Lightning	24					25	49
Hail/ Lightning/ Severe Storm/Thunder Storm	42,846						42,846
Hail/ Lightning/ Severe Storm/Thunder Storm/ Wind	2,571,374	2,281,238	2,837,693	2,860,546	3,052,476	2,128,207	15,731,534
Hail/ Lightning/ Wind	163,996	135,001	112,823	118,251	85,976	27,305	643,352
Hail/ Severe Storm/Thunder Storm	100,901	85,609	787,765	38,875		8,250	1,021,400
Hail/ Severe Storm/Thunder Storm/ Wind	14,557,461	310,751	247,312	1,373,053	70,104	1,567	16,560,248
Hail/ Severe Storm/Thunder Storm/ Wind/ Winter Weather	16,033	16,188	18,341	17,316	18,874	15,957	102,709
Hail/ Tornado		1,629,347					1,629,347
Hail/ Tornado/ Wind			8,380				8,380
Hail/ Wind	1,146,398	32,184	105,310	30,072	46,943	17,764	1,378,671
Heat	1,830	1,743	1,804	1,596	1,612	1,808	10,393
Hurricane/Tropical Storm	5,415,787	11,048,489,762	433,397,720	540,823,968	3,093,954,840	3,509,763	15,125,591,840
Hurricane/Tropical Storm/ Severe Storm/Thunder Storm		2,381,419					2,381,419
Landslide			-				-
Lightning	26,874,261	28,759,139	71,899,014	11,773,252	27,646,390	529,947	167,482,003
Lightning/ Severe Storm/Thunder Storm	7,783,957	72,079	91,798	82,145	-		8,029,979
Lightning/ Severe Storm/Thunder Storm/ Wind	1,037,629	29,365	1,042,543	81,254	222,806	7,588	2,421,185
Lightning/ Tornado/ Wind					8,510		8,510
Lightning/ Wind	368,334	181,639	301,254	148,365	230,173	93,831	1,323,596
Severe Storm/Thunder Storm	5,281,155	11,740,655	19,544,298	2,331,069	2,948,927	363,047	42,209,151
Severe Storm/Thunder Storm - Wind		199,559	13,392,449	29,766	156,442	121,760	13,899,976
Severe Storm/Thunder Storm/ Wind	46,502,362	68,312,183	129,208,339	31,314,045	24,526,728	16,694,455	316,558,112
Severe Storm/Thunder Storm/ Wind/ Winter Weather	170,400	181,479	173,622	183,012	176,293	157,375	1,042,181
Severe Storm/Thunder Storm/ Winter Weather	248,621	240,051	254,862		241,537	268,708	1,253,779
Tornado	113,348,756	223,127,858	180,144,443	26,923,754	40,627,761	39,134,441	623,307,013
Tornado/ Wind		84,831			73,902		158,733
Wildfire	358,336	802,581,529	357,304	363,448	351,176	357,391	804,369,184
Wind	12,556,236	4,022,840	18,407,619	18,415,911	23,879,146	419,060	77,700,812
Wind/ Winter Weather	1,851	130,100,826	1,052,176	1,101,397	778,294	1,613	133,036,157
Winter Weather	232,382,317	64,666,357	6,455,854	6,268,789	6,875,033	7,261,958	323,910,308
Grand Total	857,491,111	12,963,919,193	1,443,261,916	1,071,592,056	3,333,421,586	177,328,726	19,847,014,588

APPENDIX B – PROGRAM DESIGN

B.1: Table 8 – Short term economic costs

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP	Results
2021	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,344,835,574,803	PASS
2022	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,394,558,101,524	PASS
2023	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,446,119,016,304	PASS
2024	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,499,586,289,758	PASS
2025	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,555,030,405,573	PASS
2026	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,612,524,453,426	PASS
2027	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,672,144,225,333	PASS
2028	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,733,968,315,566	PASS
2029	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,798,078,224,255	PASS
2030	29,347,525	79,612,454	14,579,033	7,122,257	3,173,822	1,076,443	134,911,534	1,864,558,464,833	PASS
Total	293,475,246	796,124,545	145,790,329	71,222,568	31,738,222	10,764,433	1,349,115,342	15,921,403,071,375	

B.2: Table 9 – Long term economic costs

Long term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP	Results
2030	82,629,110	216,945,481	43,225,792	20,562,641	82,629,110	2,979,685	448,971,819	2,456,236,066,686	PASS
2040	159,048,763	416,939,878	83,665,002	39,777,894	159,048,763	5,733,707	864,214,007	4,651,986,475,032	PASS
2050	303,029,095	793,742,830	160,142,819	75,998,850	303,029,095	10,977,039	1,646,919,728	8,810,626,330,831	PASS
2060	575,555,954	1,506,418,716	305,958,038	145,116,268	575,555,954	21,040,560	3,129,645,492	16,686,879,198,419	PASS
2070	1,084,913,806	2,835,497,311	580,459,346	274,517,869	1,084,913,806	39,724,280	5,900,026,417	31,604,102,469,791	PASS
2080	2,016,060,637	5,263,394,112	1,085,473,030	512,242,394	2,016,060,637	74,409,466	10,967,640,275	59,856,566,410,316	PASS
2090	3,708,065,219	9,657,047,249	2,010,770,959	947,900,541	3,708,065,219	137,393,606	20,169,242,793	113,365,299,516,325	PASS
2100	6,788,774,300	17,645,811,538	3,708,679,184	1,744,376,564	6,788,774,300	251,872,251	36,928,288,137	214,708,124,858,484	PASS
2110	12,423,046,182	32,232,558,662	6,830,226,941	3,205,305,384	12,423,046,182	464,000,645	67,578,183,996	406,646,293,680,084	PASS
2120	22,724,507,481	58,798,934,646	12,580,551,894	5,892,892,425	22,724,507,481	849,833,082	123,571,227,009	770,167,446,028,137	PASS
Total	49,865,630,546	129,367,290,424	27,389,153,005	12,858,690,831	49,865,630,546	1,857,964,320	271,204,359,673	1,628,953,561,034,100	

APPENDIX C – PRICING/COSTS

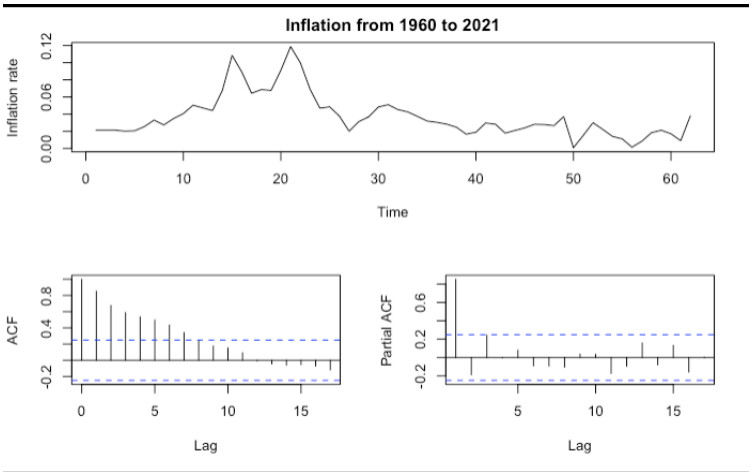
C.1: Table 10 – Correlation matrix

```
  Correlation Matrix of Fatality, Injury, and onlevelled Property Damage
            Fatalities Injuries OnLevel.PD
Fatalities 1.00000000 0.157821 0.05689171
Injuries   0.15782101 1.000000 0.30003602
OnLevel.PD 0.05689171 0.300036 1.00000000
```

C.2: Table 11 – GLM

GLM (family = Gamma) witl Log link	
Variables	**GLM Estimates**
(Intercept)	4.17237
Year	- 0.00062
Region1	-
Region2	0.00801
Region3	- 0.06329
Region4	- 0.04316
Region5	- 0.04421
Region6	- 0.03659
Quarter1	-
Quarter2	0.01560
Quarter3	0.03166
Quarter4	0.04078
Hazard.Group1	-
Hazard.Group2	- 0.12450
Hazard.Group3	- 0.01958
Hazard.Group4	- 0.17566
Hazard.Group5	0.06029
Hazard.Group6	- 0.05496
Hazard.Group7	- 0.03468
TypeMajor	-
TypeMedium	- 0.00345
TypeMinor	- 0.44188

C.3: Figure 4 – Inflation



C.4: Tables 12 – Economic costs projections

Table 1.1: Short Term Economic Costs (Low Emission) with program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	134,483,557,480	PASS
2022	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	139,455,810,152	PASS
2023	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	144,611,901,630	PASS
2024	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	149,958,628,976	PASS
2025	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	155,503,040,557	PASS
2026	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	161,252,445,343	PASS
2027	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	167,214,422,533	PASS
2028	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	173,396,831,557	PASS
2029	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	179,807,822,425	PASS
2030	61,702,113	163,820,611	31,687,098	15,198,389	6,657,019	2,231,120	281,296,350	186,455,846,483	PASS
Total	617,021,126	1,638,206,110	316,870,981	151,983,893	66,570,194	22,311,195	2,812,963,499	1,592,140,307,137	

Table 1.2: Short Term Economic Costs (Medium Emissions) with program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	134,483,557,480	PASS
2022	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	139,455,810,152	PASS
2023	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	144,611,901,630	PASS
2024	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	149,958,628,976	PASS
2025	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	155,503,040,557	PASS
2026	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	161,252,445,343	PASS
2027	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	167,214,422,533	PASS
2028	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	173,396,831,557	PASS
2029	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	179,807,822,425	PASS
2030	62,123,669	164,893,728	31,877,822	15,309,821	6,712,591	2,243,983	283,161,612	186,455,846,483	PASS
Total	621,236,692	1,648,937,276	318,778,217	153,098,208	67,125,905	22,439,825	2,831,616,123	1,592,140,307,137	

Table 1.3: Short Term Economic Costs (High Emission) with program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	134,483,557,480	PASS
2022	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	139,455,810,152	PASS
2023	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	144,611,901,630	PASS
2024	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	149,958,628,976	PASS
2025	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	155,503,040,557	PASS
2026	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	161,252,445,343	PASS
2027	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	167,214,422,533	PASS
2028	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	173,396,831,557	PASS
2029	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	179,807,822,425	PASS
2030	63,028,325	167,400,743	32,354,430	15,535,222	6,807,046	2,281,839	287,407,605	186,455,846,483	PASS
Total	630,283,246	1,674,007,433	323,544,302	155,352,220	68,070,462	22,818,390	2,874,076,053	1,592,140,307,137	

Table 1.4: Short Term Economic Costs (Very High Emission) with program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	134,483,557,480	PASS
2022	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	139,455,810,152	PASS
2023	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	144,611,901,630	PASS
2024	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	149,958,628,976	PASS
2025	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	155,503,040,557	PASS
2026	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	161,252,445,343	PASS
2027	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	167,214,422,533	PASS
2028	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	173,396,831,557	PASS
2029	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	179,807,822,425	PASS
2030	63,630,548	168,918,825	32,641,494	15,692,744	6,863,895	2,295,162	290,042,668	186,455,846,483	PASS
Total	636,305,484	1,689,188,250	326,414,935	156,927,439	68,638,954	22,951,620	2,900,426,682	1,592,140,307,137	

Table 2.1: Long Term Economic Costs (Low Emission) with program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	79,976,686	209,785,217	41,891,128	19,888,975	79,976,686	2,878,246	434,396,938	245,623,606,669	PASS
2040	135,887,859	372,190,860	69,984,634	36,579,101	135,887,859	5,259,439	755,789,751	465,198,647,503	PASS
2050	240,974,487	660,618,471	125,189,045	65,667,052	240,974,487	9,439,103	1,342,862,646	881,062,633,083	PASS
2060	419,519,220	1,149,411,290	219,369,434	115,552,800	419,519,220	16,576,037	2,339,948,001	1,668,687,919,842	PASS
2070	720,431,541	1,974,783,249	380,107,029	201,630,921	720,431,541	28,759,039	4,026,143,319	3,160,410,246,979	PASS
2080	1,223,206,628	3,358,521,508	651,146,880	348,001,948	1,223,206,628	49,347,841	6,853,431,433	5,985,656,641,032	PASS
2090	2,062,633,772	5,661,727,056	1,106,811,174	596,774,561	2,062,633,772	83,816,158	11,574,396,494	11,336,529,951,633	PASS
2100	3,488,552,961	9,602,107,313	1,888,841,377	1,028,318,990	3,488,552,961	143,936,770	19,640,310,372	21,470,812,485,848	PASS
2110	5,935,560,640	16,376,759,353	3,237,299,080	1,783,837,944	5,935,560,640	248,336,118	33,517,353,776	40,664,629,368,008	PASS
2120	10,162,652,626	28,076,787,273	5,584,671,347	3,110,535,995	10,162,652,626	427,824,255	57,525,124,123	77,016,744,602,814	PASS
Total	24,469,396,419	67,442,691,591	13,305,311,128	7,306,788,288	24,469,396,419	1,016,173,007	138,009,756,852	162,895,356,103,410	

Table 2.2: Long Term Economic Costs (Medium Emissions) with program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	80,819,799	211,931,450	42,272,576	20,111,838	80,819,799	2,903,972	438,859,434	245,623,606,669	PASS
2040	141,169,633	386,939,339	72,656,565	37,947,605	141,169,633	5,473,870	785,356,644	465,198,647,503	PASS
2050	260,476,531	713,285,054	134,951,677	70,443,493	260,476,531	10,169,869	1,449,803,155	881,062,633,083	PASS
2060	470,867,369	1,287,539,048	245,766,791	128,261,061	470,867,369	18,442,119	2,621,743,757	1,668,687,919,842	PASS
2070	830,456,135	2,270,783,898	436,929,826	229,141,003	830,456,135	32,773,975	4,630,540,971	3,160,410,246,979	PASS
2080	1,438,642,455	3,937,903,236	763,432,567	401,714,778	1,438,642,455	57,579,382	8,037,914,873	5,985,656,641,032	PASS
2090	2,465,796,232	6,754,310,149	1,317,743,914	698,769,353	2,465,796,232	99,625,642	13,802,041,522	11,336,529,951,633	PASS
2100	4,212,757,968	11,544,552,561	2,268,076,618	1,210,974,338	4,212,757,968	171,927,435	23,621,046,887	21,470,812,485,848	PASS
2110	7,225,229,791	19,824,011,159	3,921,067,870	2,113,438,047	7,225,229,791	297,852,363	40,606,829,021	40,664,629,368,008	PASS
2120	12,442,249,232	34,186,413,686	6,798,140,405	3,693,503,161	12,442,249,232	518,079,129	70,080,634,846	77,016,744,602,814	PASS
Total	29,568,465,143	81,117,669,581	16,001,038,808	8,604,304,677	29,568,465,143	1,214,827,756	166,074,771,109	162,895,356,103,410	

Table 2.3: Long Term Economic Costs (High Emission) with program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	82,629,110	216,945,481	43,225,792	20,562,641	82,629,110	2,979,685	448,971,819	245,623,606,669	PASS
2040	148,679,302	406,796,745	76,459,505	39,777,894	148,679,302	5,733,707	826,126,456	465,198,647,503	PASS
2050	283,389,863	774,532,251	146,495,974	75,998,850	283,389,863	10,977,039	1,574,783,838	881,062,633,083	PASS
2060	538,360,245	1,470,034,854	280,111,606	145,116,268	538,360,245	21,040,560	2,993,023,778	1,668,687,919,842	PASS
2070	1,014,467,019	2,766,588,122	531,507,514	274,517,869	1,014,467,019	39,724,280	5,641,271,823	3,160,410,246,979	PASS
2080	1,882,637,997	5,132,883,604	992,760,744	512,242,394	1,882,637,997	74,409,466	10,477,572,203	5,985,656,641,032	PASS
2090	3,455,369,510	9,409,866,970	1,835,178,594	947,900,541	3,455,369,510	137,393,606	19,241,078,732	11,336,529,951,633	PASS
2100	6,310,181,450	17,177,664,632	3,376,116,154	1,744,376,564	6,310,181,450	251,872,251	35,170,392,502	21,470,812,485,848	PASS
2110	11,516,615,609	31,345,912,178	6,200,369,438	3,205,305,384	11,516,615,609	464,000,645	64,248,818,863	40,664,629,368,008	PASS
2120	21,007,773,971	57,119,671,194	11,387,633,744	5,892,892,425	21,007,773,971	849,833,082	117,265,578,387	77,016,744,602,814	PASS
Total	46,240,104,076	125,820,896,032	24,869,859,065	12,858,690,831	46,240,104,076	1,857,964,320	257,887,618,399	162,895,356,103,410	

Table 2.4: Long Term Economic Costs (VeryHigh Emission) with program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	83,833,557	219,981,645	43,799,919	20,877,684	83,833,557	3,006,331	455,332,694	245,623,606,669	PASS
2040	158,625,911	433,880,642	81,397,380	42,214,975	158,625,911	6,120,103	880,864,923	465,198,647,503	PASS
2050	329,913,758	900,114,901	170,135,062	87,490,937	329,913,758	12,729,504	1,830,297,922	881,062,633,083	PASS
2060	704,515,204	1,919,384,291	364,919,530	186,081,452	704,515,204	27,245,197	3,906,660,877	1,668,687,919,842	PASS
2070	1,538,300,023	4,179,306,204	800,955,884	405,013,478	1,538,300,023	59,524,831	8,521,400,443	3,160,410,246,979	PASS
2080	3,393,980,262	9,197,868,439	1,776,827,504	891,186,272	3,393,980,262	131,385,959	18,785,228,698	5,985,656,641,032	PASS
2090	7,424,985,104	20,076,852,507	3,909,588,755	1,947,567,736	7,424,985,104	288,524,695	41,072,503,900	11,336,529,951,633	PASS
2100	15,870,547,269	42,842,341,749	8,409,758,421	4,164,967,524	15,870,547,269	619,082,714	87,777,244,946	21,470,812,485,848	PASS
2110	33,163,350,830	89,340,895,809	17,687,355,220	8,720,022,970	33,163,350,830	1,298,505,207	183,373,480,867	40,664,629,368,008	PASS
2120	68,002,264,859	182,880,031,051	36,521,968,372	17,934,250,397	68,002,264,859	2,676,637,962	376,017,417,499	77,016,744,602,814	PASS
Total	130,670,316,777	351,990,657,240	69,766,706,047	34,399,673,426	130,670,316,777	5,122,762,502	722,620,432,770	162,895,356,103,410	

C.5: Tables 13 – Without program economic costs projections

Table 3.1: Short Term Economic Costs (Low Emission) without program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	134,483,557,480	PASS
2022	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	139,455,810,152	PASS
2023	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	144,611,901,630	PASS
2024	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	149,958,628,976	PASS
2025	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	155,503,040,557	PASS
2026	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	161,252,445,343	PASS
2027	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	167,214,422,533	PASS
2028	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	173,396,831,557	PASS
2029	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	179,807,822,425	PASS
2030	60,590,858	165,849,419	30,713,138	15,817,200	6,903,728	2,307,889	282,182,231	186,455,846,483	PASS
Total	605,908,576	1,658,494,186	307,131,381	158,172,005	69,037,282	23,078,885	2,821,822,315	1,592,140,307,137	

Table 3.2: Short Term Economic Costs (Medium Emissions) without program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	134,483,557,480	PASS
2022	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	139,455,810,152	PASS
2023	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	144,611,901,630	PASS
2024	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	149,958,628,976	PASS
2025	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	155,503,040,557	PASS
2026	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	161,252,445,343	PASS
2027	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	167,214,422,533	PASS
2028	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	173,396,831,557	PASS
2029	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	179,807,822,425	PASS
2030	61,012,414	166,922,535	30,903,862	15,928,632	6,959,299	2,320,752	284,047,494	186,455,846,483	PASS
Total	610,124,142	1,669,225,351	309,038,617	159,286,319	69,592,994	23,207,515	2,840,474,939	1,592,140,307,137	

Table 3.3: Short Term Economic Costs (High Emission) without program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	134,483,557,480	PASS
2022	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	139,455,810,152	PASS
2023	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	144,611,901,630	PASS
2024	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	149,958,628,976	PASS
2025	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	155,503,040,557	PASS
2026	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	161,252,445,343	PASS
2027	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	167,214,422,533	PASS
2028	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	173,396,831,557	PASS
2029	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	179,807,822,425	PASS
2030	61,917,070	169,429,551	31,380,470	16,154,033	7,053,755	2,358,608	288,293,487	186,455,846,483	PASS
Total	619,170,696	1,694,295,509	313,804,702	161,540,332	70,537,551	23,586,080	2,882,934,869	1,592,140,307,137	

Table 3.4: Short Term Economic Costs (Very High Emission) without program

Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	134,483,557,480	PASS
2022	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	139,455,810,152	PASS
2023	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	144,611,901,630	PASS
2024	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	149,958,628,976	PASS
2025	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	155,503,040,557	PASS
2026	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	161,252,445,343	PASS
2027	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	167,214,422,533	PASS
2028	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	173,396,831,557	PASS
2029	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	179,807,822,425	PASS
2030	62,519,293	170,947,633	31,667,534	16,311,555	7,110,604	2,371,931	290,928,550	186,455,846,483	PASS
Total	625,192,934	1,709,476,326	316,675,335	163,115,551	71,106,042	23,719,309	2,909,285,497	1,592,140,307,137	

Table 4.1: Long Term Economic Costs (Low Emission) without program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	77,754,176	213,842,832	39,943,208	21,126,598	77,754,176	3,031,784	433,452,773	245,623,606,669	PASS
2040	142,047,998	390,018,910	73,500,869	38,923,095	142,047,998	5,550,232	792,089,102	465,198,647,503	PASS
2050	252,641,479	694,383,894	131,848,616	70,106,457	252,641,479	9,989,850	1,411,611,776	881,062,633,083	PASS
2060	441,615,910	1,213,361,287	231,982,324	123,960,809	441,615,910	17,619,125	2,470,155,364	1,668,687,919,842	PASS
2070	762,281,551	2,095,901,298	403,995,203	217,555,262	762,281,551	30,734,593	4,272,749,458	3,160,410,246,979	PASS
2080	1,302,468,423	3,587,912,947	696,389,868	378,161,844	1,302,468,423	53,089,442	7,320,490,946	5,985,656,641,032	PASS
2090	2,212,751,590	6,096,182,803	1,192,499,099	653,895,873	2,212,751,590	90,902,559	12,458,983,513	11,336,529,951,633	PASS
2100	3,772,868,491	10,424,944,451	2,051,129,959	1,136,503,855	3,772,868,491	157,358,054	21,315,673,300	21,470,812,485,848	PASS
2110	6,474,039,826	17,935,171,139	3,544,665,419	1,988,734,588	6,474,039,826	273,755,349	36,690,406,149	40,664,629,368,008	PASS
2120	11,182,504,881	31,028,340,120	6,166,807,597	3,498,599,843	11,182,504,881	475,966,987	63,534,724,309	77,016,744,602,814	PASS
Total	26,620,974,324	73,680,059,682	14,532,762,163	8,127,568,223	26,620,974,324	1,117,997,974	150,700,336,690	162,895,356,103,410	

Table 4.2: Long Term Economic Costs (Medium Emissions) without program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	78,597,289	215,989,065	40,324,656	21,349,461	78,597,289	3,057,510	437,915,269	245,623,606,669	PASS
2040	147,329,772	404,767,390	76,172,800	40,291,598	147,329,772	5,764,663	821,655,995	465,198,647,503	PASS
2050	272,143,523	747,050,477	141,611,248	74,882,898	272,143,523	10,720,616	1,518,552,285	881,062,633,083	PASS
2060	492,964,059	1,351,489,045	258,379,681	136,669,069	492,964,059	19,485,207	2,751,951,120	1,668,687,919,842	PASS
2070	872,306,144	2,391,901,947	460,817,999	245,065,345	872,306,144	34,749,530	4,877,147,110	3,160,410,246,979	PASS
2080	1,517,904,250	4,167,294,676	808,675,556	431,874,673	1,517,904,250	61,320,982	8,504,974,386	5,985,656,641,032	PASS
2090	2,615,914,050	7,188,765,895	1,403,431,839	755,890,664	2,615,914,050	106,712,043	14,686,628,541	11,336,529,951,633	PASS
2100	4,497,073,497	12,367,389,699	2,430,365,200	1,319,159,203	4,497,073,497	185,348,718	25,296,409,815	21,470,812,485,848	PASS
2110	7,763,708,977	21,382,422,945	4,228,434,210	2,318,334,691	7,763,708,977	323,271,594	43,779,881,394	40,664,629,368,008	PASS
2120	13,462,101,487	37,137,966,533	7,380,276,656	4,081,567,009	13,462,101,487	566,221,861	76,090,235,032	77,016,744,602,814	PASS
Total	31,720,043,048	87,355,037,672	17,228,489,843	9,425,084,613	31,720,043,048	1,316,652,724	178,765,350,947	162,895,356,103,410	

Table 4.3: Long Term Economic Costs (High Emission) without program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	80,406,600	221,003,097	41,277,873	21,800,263	80,406,600	3,133,223	448,027,654	245,623,606,669	PASS
2040	154,839,442	424,624,795	79,975,741	42,121,888	154,839,442	6,024,500	862,425,807	465,198,647,503	PASS
2050	295,056,854	808,297,673	153,155,545	80,438,255	295,056,854	11,527,787	1,643,532,968	881,062,633,083	PASS
2060	560,456,935	1,533,984,851	292,724,496	153,524,277	560,456,935	22,083,648	3,123,231,141	1,668,687,919,842	PASS
2070	1,056,317,029	2,887,706,171	555,395,688	290,442,211	1,056,317,029	41,699,834	5,887,877,962	3,160,410,246,979	PASS
2080	1,961,899,792	5,362,275,044	1,038,003,733	542,402,289	1,961,899,792	78,151,066	10,944,631,716	5,985,656,641,032	PASS
2090	3,605,487,328	9,844,322,717	1,920,866,519	1,005,021,852	3,605,487,328	144,480,007	20,125,665,750	11,336,529,951,633	PASS
2100	6,594,496,980	18,000,501,770	3,538,404,736	1,852,561,429	6,594,496,980	265,293,535	36,845,755,429	21,470,812,485,848	PASS
2110	12,055,094,795	32,904,323,964	6,507,735,777	3,410,202,029	12,055,094,795	489,419,875	67,421,871,236	40,664,629,368,008	PASS
2120	22,027,626,226	60,071,224,041	11,969,769,994	6,280,956,273	22,027,626,226	897,975,814	123,275,178,573	77,016,744,602,814	PASS
Total	48,391,681,980	132,058,264,122	26,097,310,100	13,679,470,767	48,391,681,980	1,959,789,288	270,578,198,237	162,895,356,103,410	

Table 4.4: Long Term Economic Costs (VeryHigh Emission) without program

Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	81,611,047	224,039,260	41,851,999	22,115,307	81,611,047	3,159,869	454,388,529	245,623,606,669	PASS
2040	164,786,051	451,708,692	84,913,615	44,558,969	164,786,051	6,410,896	917,164,274	465,198,647,503	PASS
2050	341,580,750	933,880,324	176,794,634	91,930,343	341,580,750	13,280,251	1,899,047,052	881,062,633,083	PASS
2060	726,611,894	1,983,334,288	377,532,420	194,489,460	726,611,894	28,288,284	4,036,868,240	1,668,687,919,842	PASS
2070	1,580,150,033	4,300,424,253	824,844,057	420,937,819	1,580,150,033	61,500,386	8,768,006,582	3,160,410,246,979	PASS
2080	3,473,242,057	9,427,259,879	1,822,070,493	921,346,167	3,473,242,057	135,127,559	19,252,288,212	5,985,656,641,032	PASS
2090	7,575,102,921	20,511,308,254	3,995,276,680	2,004,689,047	7,575,102,921	295,611,096	41,957,090,919	11,336,529,951,633	PASS
2100	16,154,862,798	43,665,178,887	8,572,047,003	4,273,152,389	16,154,862,798	632,503,998	89,452,607,874	21,470,812,485,848	PASS
2110	33,701,830,016	90,899,307,596	17,994,721,560	8,924,919,615	33,701,830,016	1,323,924,437	186,546,533,240	40,664,629,368,008	PASS
2120	69,022,117,114	185,831,583,898	37,104,104,622	18,322,314,245	69,022,117,114	2,724,780,694	382,027,017,686	77,016,744,602,814	PASS
Total	132,821,894,682	358,228,025,330	70,994,157,083	35,220,453,361	132,821,894,682	5,224,587,470	735,311,012,608	162,895,356,103,410	

C.6: Tables 14 – Short and long-term projections comparison with and without program

Table 5.1: Short Term Total Economic Costs (10 Years)								
Region	With Program				Without Program			
	Low Emission	Medium Emisssion	High Emission	Very High Emission	Low Emission	Medium Emisssion	High Emission	Very High Emission
Region 1	617,021,126	621,236,692	630,283,246	636,305,484	605,908,576	610,124,142	619,170,696	625,192,934
Region 2	1,638,206,110	1,648,937,276	1,674,007,433	1,689,188,250	1,658,494,186	1,669,225,351	1,694,295,509	1,709,476,326
Region 3	316,870,981	318,778,217	323,544,302	326,414,935	307,131,381	309,038,617	313,804,702	316,675,335
Region 4	151,983,893	153,098,208	155,352,220	156,927,439	158,172,005	159,286,319	161,540,332	163,115,551
Region 5	66,570,194	67,125,905	68,070,462	68,638,954	69,037,282	69,592,994	70,537,551	71,106,042
Region 6	22,311,195	22,439,825	22,818,390	22,951,620	23,078,885	23,207,515	23,586,080	23,719,309
Total	2,812,963,499	2,831,616,123	2,874,076,053	2,900,426,682	2,821,822,315	2,840,474,939	2,882,934,869	2,909,285,497
Compared to withour program	-0.315%	-0.313%	-0.308%	-0.305%				

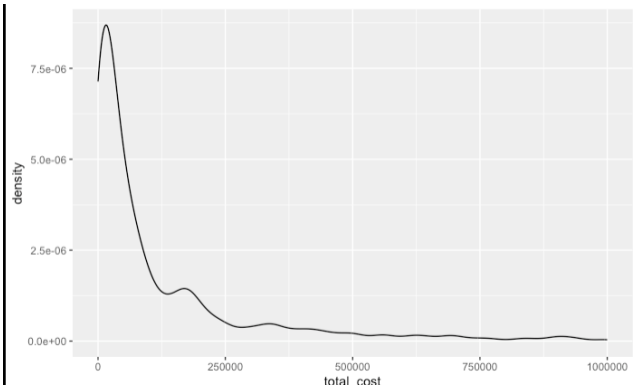
Table 5.2: Long Term Total Economic Costs (100 Years)								
Region	With Program				Without Program			
	Low Emission	Medium Emisssion	High Emission	Very High Emission	Low Emission	Medium Emisssion	High Emission	Very High Emission
Region 1	24,469,396,419	29,568,465,143	46,240,104,076	130,670,316,777	26,620,974,324	31,720,043,048	48,391,681,980	132,821,894,682
Region 2	67,442,691,591	81,117,669,581	125,820,896,032	351,990,657,240	73,680,059,682	87,355,037,672	132,058,264,122	358,228,025,330
Region 3	13,305,311,128	16,001,038,808	24,869,859,065	69,766,706,047	14,532,762,163	17,228,489,843	26,097,310,100	70,994,157,083
Region 4	7,306,788,288	8,604,304,677	12,858,690,831	34,399,673,426	8,127,568,223	9,425,084,613	13,679,470,767	35,220,453,361
Region 5	24,469,396,419	29,568,465,143	46,240,104,076	130,670,316,777	26,620,974,324	31,720,043,048	48,391,681,980	132,821,894,682
Region 6	1,016,173,007	1,214,827,756	1,857,964,320	5,122,762,502	1,117,997,974	1,316,652,724	1,959,789,288	5,224,587,470
Total	138,009,756,852	166,074,771,109	257,887,618,399	722,620,432,770	150,700,336,690	178,765,350,947	270,578,198,237	735,311,012,608
Compared to withour program	-9.195%	-7.641%	-4.921%	-1.756%				

C.7: Tables 15 – Worst case scenario projections for capital requirements

Table 6.4: Short Term Economic Costs (Very High Emission) with program									
Short term economic costs	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2021	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	107,586,845,984	PASS
2022	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	111,564,648,122	PASS
2023	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	115,689,521,304	PASS
2024	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	119,966,903,181	PASS
2025	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	124,402,432,446	PASS
2026	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	129,001,956,274	PASS
2027	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	133,771,538,027	PASS
2028	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	138,717,465,245	PASS
2029	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	143,846,257,940	PASS
2030	64,443,683	171,272,115	33,105,634	16,002,149	6,987,250	2,333,546	294,144,378	149,164,677,187	PASS
Total	644,436,826	1,712,721,154	331,056,342	160,021,495	69,872,498	23,335,464	**2,941,443,778**	1,273,712,245,710	

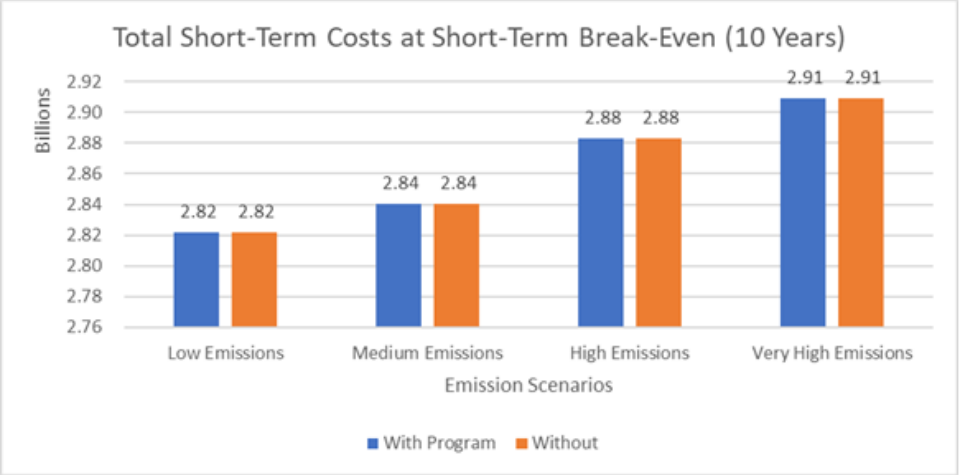
Table 7.4: Long Term Economic Costs (Very High Emission) with program									
Long term ec	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	GDP Constraint	Results
2030	85,459,826	224,688,226	44,728,200	21,496,496	85,459,826	3,083,100	464,915,673	196,498,885,335	PASS
2040	161,705,981	442,794,667	83,155,498	43,386,972	161,705,981	6,265,500	899,014,599	372,158,918,003	PASS
2050	335,747,254	916,997,613	173,464,848	89,710,640	335,747,254	13,004,878	1,864,672,487	704,850,106,466	PASS
2060	715,563,549	1,951,359,290	371,225,975	190,285,456	715,563,549	27,766,740	3,971,764,559	1,334,950,335,873	PASS
2070	1,559,225,028	4,239,865,229	812,899,970	412,975,648	1,559,225,028	60,512,608	8,644,703,512	2,528,328,197,583	PASS
2080	3,433,611,159	9,312,564,159	1,799,448,998	906,266,220	3,433,611,159	133,256,759	19,018,758,455	4,788,525,312,825	PASS
2090	7,500,044,013	20,294,080,381	3,952,432,717	1,976,128,391	7,500,044,013	292,067,895	41,514,797,410	9,069,223,961,306	PASS
2100	16,012,705,034	43,253,760,318	8,490,902,712	4,219,059,957	16,012,705,034	625,793,356	88,614,926,410	17,176,649,988,679	PASS
2110	33,432,590,423	90,120,101,702	17,841,038,390	8,822,471,292	33,432,590,423	1,311,214,822	184,960,007,053	32,531,703,494,407	PASS
2120	68,512,190,986	184,355,807,475	36,813,036,497	18,128,282,321	68,512,190,986	2,700,709,328	379,022,217,593	61,613,395,682,251	PASS
Total	131,748,843,253	355,112,019,058	70,382,333,806	34,810,063,394	131,748,843,253	5,173,674,986	728,975,777,750	130,316,284,882,728	

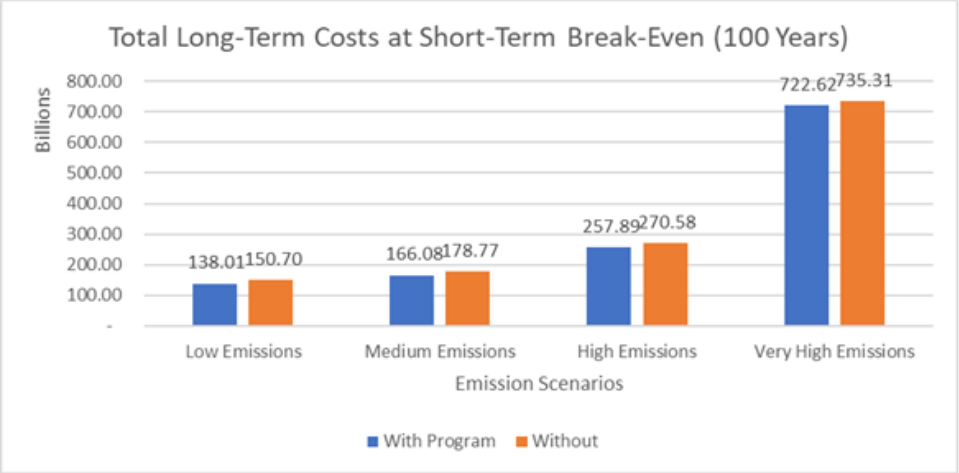
C.8: Figure 5 – Empirical Distribution of total severity costs



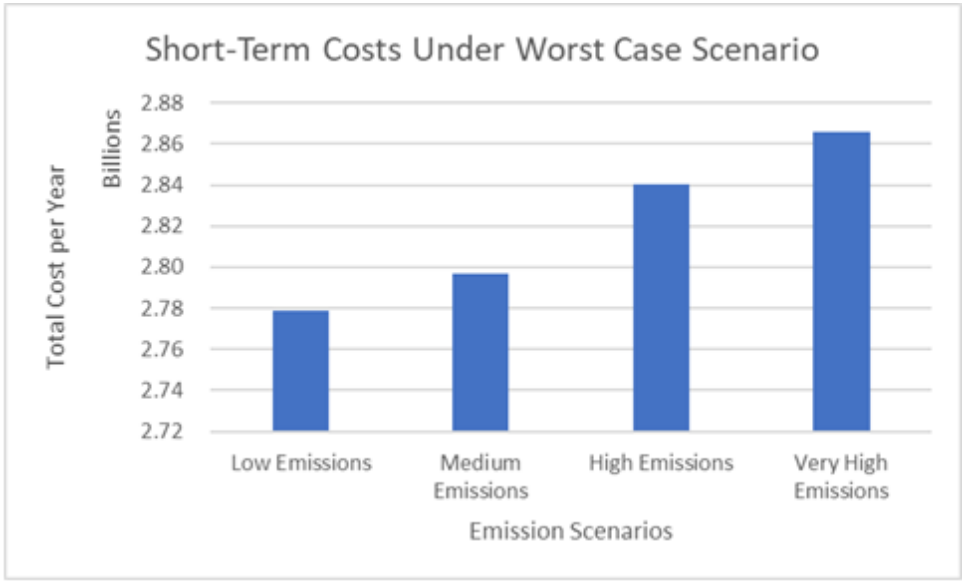
APPENDIX D – RISK AND RISK MITIGATION STRATEGIES

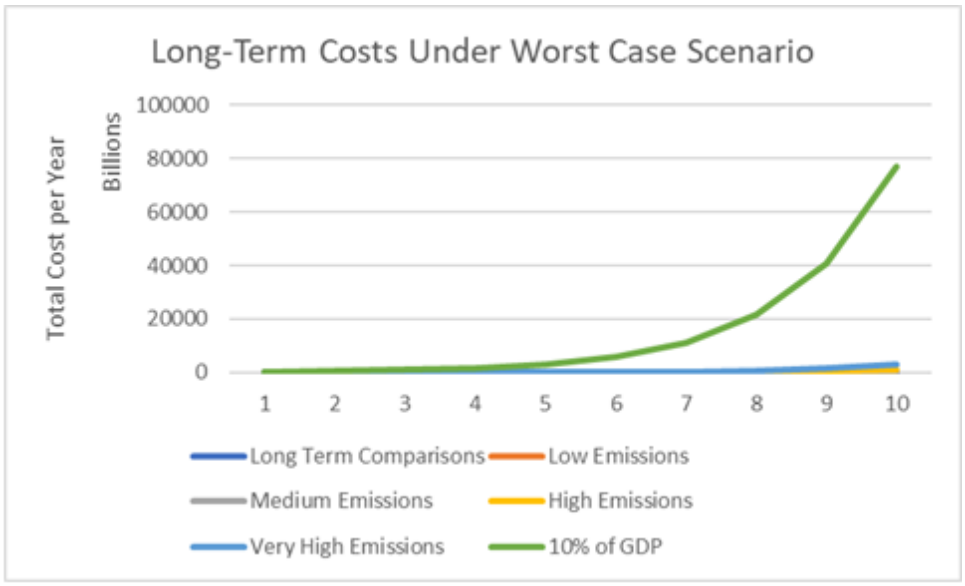
D.1: Figures 6 – Cost comparison with and without the program if short-term costs of program break-even with short-term costs without the program





D.2: Figures 7 – Worst case scenario costs by emissions type





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