University of Iceland Greenhouse Gas Inventory 2015

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Emissions Reduction Strategy

2016 to 2030

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Executive Summary

The global challenge of climate change is perhaps the toughest the world has faced to date. The IPCC predicts that we need to reduce global emissions to zero by 2100 (2010 base year) to be likely to limit global warming to 2°C, and avoid the worst effects of climate change (IPCC, 2014). The University of Iceland has shown strong climate leadership in commissioning the first study to assess, catalogue and reduce the greenhouse gas emissions produced by the university. This is unique in a country that historically has largely relied on its very low carbon electricity and heating supply to avoid making much progress towards greenhouse gas mitigation. In doing so the University of Iceland has begun the journey towards becoming perhaps the world's first carbon neutral university by the year 2030.

This report details the University of Iceland's greenhouse gas emissions for calendar year 2015, forecasts the 'Business as Usual' emissions predicted between 2016 – 2030, and includes four different mitigation scenarios showing how the university can decrease it's emissions over the same period. The policies to achieve these mitigation scenarios are discussed in detail, allowing policy makers to make an informed commitment to climate change mitigation, and to maximise the allocation of university investment.

The university was responsible for producing 6,677 tonnes of CO2eq greenhouse gas emissions in 2015. The majority of these emissions arise from the transportation sector, which makes up 91% of the inventory. The next largest sector is wastewater and water use (4%), with solid waste, university events and products sold on campus comprising 1-2% each. The remaining sectors contribute less than 1%. The inventory results suggest that the University of Iceland should focus on policies that address transport sector emissions reductions initially.

The business as usual forecast predicts that by 2030, the university's greenhouse gas emissions will increase to 6,713 tonnes CO2eq. This represents growth of only 0.5% over 14 years. The forecast is based on a static university population and static demand in many sectors.

The four mitigation scenarios show greenhouse gas emissions reductions of 8%, 33%, 46% and 96% against the 2015 inventory by the year 2030. The scenarios, labelled Low, Moderate, High and Best Case, involve increasing adoption of mitigation policies with increasing adoption levels. Each mitigation scenario is presented, with a detailed description of the policies implemented and adoption rates forecast in each scenario. All assumptions, sources, emissions factors and calculations are presented or referenced, so forecast models are as transparent to policy makers as possible.

The policy options available are explained, with suggestions for how the policies could be implemented efficiently based on literature and real-world success stories. The policies with the highest impact on overall greenhouse gas emissions levels are the adoption of a range of active transport (cycling and walking) support initiates, implementing car-parking fees on campus, subsidising bus fares, implementing e-commuting, tele-conferencing and online learning platforms to reduce overall travel demand and supporting the electric vehicle transition in a variety of ways.

Finally, recommendations are made for the university to repeat this inventory again in 2016, and then again every two years thereafter. The authors also detail how this report could form the first part of the University of Iceland's first submission for the AASHE STARS sustainability assessment, developed specifically for universities around the world to measure and improve the multi-dimensional sustainability of their organisation.

Introduction

This report details the first formal greenhouse gas (GHG) inventory to be completed for the University of Iceland (HI). This inventory is presented in Section I, together with a detailed account of all assumptions, data gaps and sources used to develop the inventory, in order to be as transparent in reporting as possible. As this was the first year a GHG inventory has been compiled at HI, numerous hurdles are to be expected, and every effort has been made in this report to include recommendations for future inventories, providing a platform from which future reports can build and improve upon.

Having completed the GHG inventory for 2015, the results were then combined with the available historical data to forecast a Business As Usual (BAU) GHG emissions scenario for the years 2016 to 2030. This BAU scenario is presented in Section II, with a detailed discussion of the simple methodology, assumptions and limitations involved. The base year for this BAU forecast was the year 2015, based on the inventory result from Section I.

Section III of this report develops four Emission Reduction Scenarios (ERSs), simulating policy packages available to the University that result in Low, Moderate, High and finally 'Best Case' GHG emissions reductions. These scenarios are forecast for the years 2016 to 2030, and are compared directly to the BAU forecast. Section III shows these scenarios, the impacts they are predicted to have on GHG emission at HI over the next 14 years and a detailed account of the assumptions and estimates involved in these scenario forecasts. Every effort is made here to be as transparent as possible, and the authors encourage further questions on calculations and assumptions – please see the contact details on the second page of this report.

Section IV outlines the policies available to HI policy makers to achieve any of the 4 ERS's presented. The policy packages are discussed by sector, in as much detail as the data quality allowed, in order to give policy makers some background for each ERS. This section includes some basic information on both the cost estimate and GHG reduction impact of each policy, examples of similar policies in use elsewhere (where available) and estimates of the forecast adoption rate of each policy in the 4 ERS's.

Finally, all references directly cited in this report are included in the Reference section, although the bulk of the resources utilised in the development of this GHG inventory and reduction strategy are included in the separate 'Resources' folder – delivered directly to Brynhildur Davíðsdóttir, co-ordinator of the Environment and Natural Resources program at HI and co-ordinating lead at HI for this report. Within this online depository are all the files that future reviewers, HI staff/students and consultants may find useful in the development of future GHG inventory and forecast models at HI – including all spreadsheets and sources for the 2015 inventory.

Project Scope, Boundary and Timeline

This GHG Inventory and ERSs presented (henceforth, 'the Project') was compiled by the authors at the request of Brynhildur Davíðsdóttir and the University of Iceland. All data was provided to the authors by Sigurlaug Lövdahl the division of operations and resources at HÍ, except where noted otherwise, and was assumed to be correct. Communications involved 3 face to face meetings over the course of the project, and numerous email exchanges, in which the bulk of the data was received. All the emails that contain data figures for 2015 are included in the Resources online depository (henceforth, 'Resources folder').

The Project included all emissions within the following scope and boundaries

- All campuses and research centres owned by HI are included this included the main campus in Reykjavik, the Education campus in Reykjavik, the campus in Laugarvatn and a number of small research centres around the country
- All property owned by HI that are within these campuses and research centre boundaries was **included** (e.g., Stúdentagarðar)
- All other property owned or operated by HI is **not included**
- External businesses located on campus or research centre grounds, with the purpose of supplying products or services to HI staff and students is **included** (e.g., Háma)
- Information in the existing HI sustainability plan was incorporated into the inventory
- The report will consider **all Scope 1** (HI owned or controlled emissions generation), **all Scope 2** (purchased energy services) and **relevant Scope 3** (3rd party emissions for which HI is responsible) emissions within the defined Project boundary. This **included** the Scope 3 emissions relating to student and staff commuting. Further detailed discussion on included sectors is given in Section I.
- Where data is unavailable, no emissions will be included but comments to future GHG inventory compilers have been made in this report
- The GHG Inventory did not include any GHG credit activities HI may be engaged in, in line with GHGProtocol and IPCC guidelines, however these should be included in a separate section in future inventories if appropriate
- Any Land Use, Land Use Change and Forestry (LULUCF) emissions were **not included** in the inventory for 2015, as calculating these emissions within the timeframe was seen as implausible by HI staff and the authors. It is recommended, in line with the GHGProtocol and IPCC guidelines, that these emissions be calculated in future inventories and are included in a separate, individual section in the final report.

The authors and HI staff worked together to complete the Project and deliver this report in just 15 weeks. The project began on the 3rd March 2016 and the final report was delivered on by the 17th of June. It is recommended that in the future this Project be allocated a longer timeframe, with less working hours per week (ie, same staff time allocated), simply to give external parties and HI staff more time to collect the required data. There was ample time for the authors to complete the analysis and report within the 16 week period, but parties such as Félagsstofnun Stúdenta (FS) expressed that the time available for data collection was too short.

According to the GHGProtocol (see Resources) reporting frameworks, emissions are categorised as Scope 1, 2 or 3 as described above. This classification is not discussed further in this report as it appears to add no further value to the discussion. The sectors have been categorised by scope in the inventory spreadsheet, which is available in the Resources folder if categorisation is desired.

In addition, this report **does not** follow the GHGProtocol guidelines. The major departure from the suggested procedure is in the calculation of CO2eq emissions, rather than specific GHG emissions, such as methane, nitrous oxide and hydro-fluorocarbons. This is largely because of restrictions in both the data available and unique emissions factors (EFs) for Iceland, given its low carbon stationary energy supply. It was also due to the limited time available in the compilation of this report. However, the GHGProtocol's guiding principles (relevance, completeness, consistency, transparency and accuracy), scope and boundary definitions, reporting structure have been followed in most instances. The authors **do not**, however, make any claims that this report complies with the GHGProtocol report guidelines. It is recommended that future GHG inventory compilers work together with HI staff to achieve data completeness and accuracy, so that the guidelines may be adhered to in following years.

Section I: University of Iceland Greenhouse Gas Inventory

The University of Iceland was responsible for emitting 6,677 tonnes of carbon dioxide equivalent (CO2eq) GHG emissions in 2015. See Figure 1 for the sectorial breakdown of these emissions. 91% of total GHG emissions were from the transport sector, which is somewhat unsurprising given Iceland's low carbon electricity and heating supply. The next largest sectors were solid waste and water at 4%, university held events at 1.7% followed by waste generated and products produced on university campuses at nearly 1.5%. All CO2eq emissions calculations use the IPCC 100 year Global Warming Potential (GWP) equivalents (IPCC, 2007). The total GHG emissions from each sector are listed in Table 1, rounded to the nearest tonne.

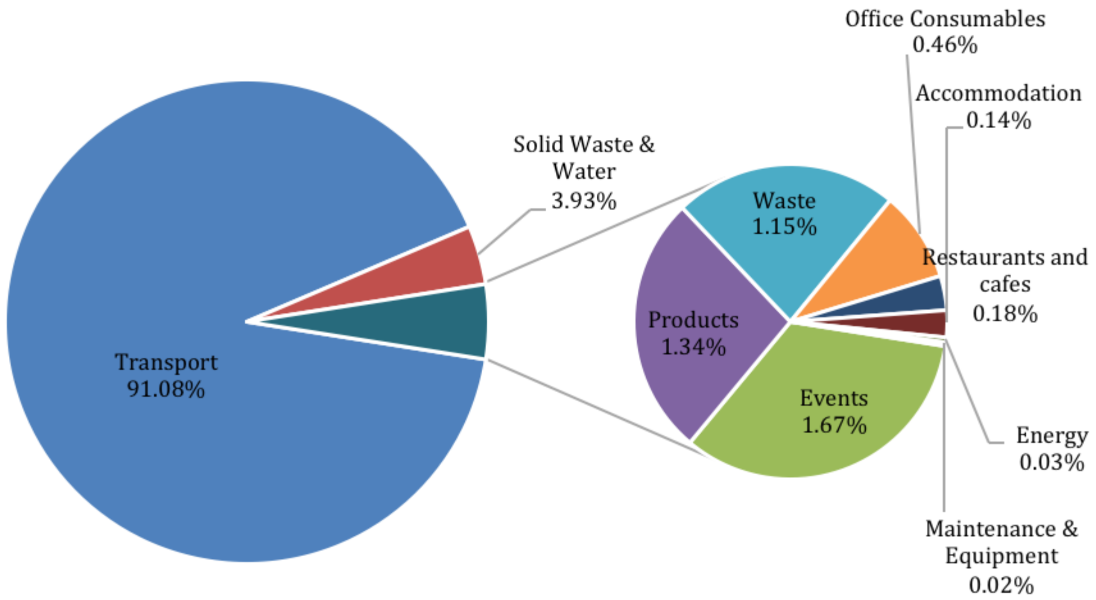

Figure 1: Sectorial breakdown of GHG emissions for the year 2015

Table 1: GHG emissions for each sector in 2015

Sector	**Tonnes CO2eq**
Transport	6,098
Solid Waste & Water	264
Events	93
Products	90
Waste	77
Office Consumables	31
Restaurants and cafes	12
Accommodation	9
Energy	2
Maintenance & Equipment	1
Postage/freight	0
Fugitive emissions	0
Construction	0
TOTAL	6,677

The 13 sectors covered in the inventory are thought to account for all emissions at HI, with the exception of those discussed below and emissions related to Land Use, Land Use Change and Forestry (LULUCF). This category was not reported on in the 2015 inventory, primarily because data was not collected for land use changes. It should be noted that as this is the first inventory completed at HI and as such it is likely additional sources of GHG emissions will be discovered and included in the following year, particularly in 2016. The emissions sources included in each sector are listed in Table 2, which is colour coded. Green categories represent well reported and sufficient data gathered for the inventory. Orange categories had some but insufficient data collected, and red categories had no data available for this inventory.

Table 2: Sectors and subsectors in the 2015 inventory

Transport	International and national flights	**Solid Waste & Water**	Cold water purchased
	University owned vehicles		Waste water produced
	Privately owned vehicles where University paid fuel	**Accommodation**	Electricity purchased
	Commuting		Heat/Hot water purchased
	National Bus, Taxi, Rental Car use		Waste collection in accommodation
Maintenance & Equipment	Grounds equipment		Electricity use by Day Care
	Fuel use by Equipment		Heat/Hot water use by Day Care
Energy	Purchased electricity	**Fugitive emissions**	Refrigerant used in cooling units and air conditioners
	Emissions from natural gas use on campus	**Construction**	Materials purchased for infrastructure projects
	Heat/Hot water purchased		Fixtures and permanent products purchased
Waste	Waste landfilled	**Events**	Food
	Waste recycled plastic, paper and metals		Energy use
	Waste composted		Product Use
	Chemical Waste	**Postage/freight**	Air freight
	Industrial Waste		Road freight
Restaurants & cafes	Waste landfilled, composted and recycled		Post
	Gas cooking and other fuel use		Pickup service
	Disposable dishes and products	**Products**	Bookstore products sold
	Food Sold	**Office Consumables**	Products purchased
			Paper use

There are a number of key points to note in these major sectors. Firstly, the final inventory **does not include** the construction sector, including maintenance related emissions embodied in furniture products and building materials. Only ISK data was available for this sector, which in this case was insufficient to estimate emissions accurately enough to be included (Daviðsdóttir, 2016). However, very rough estimates put the embodied emissions from construction at around 3700 tonnes, or about 60% of the total inventory amount for 2015. As such, it may be that the 2015 inventory is grossly underestimated due to the omission of this sector. It is **highly recommended** data collection be improved in this key area for 2016, and that process would need to begin quite quickly given we are already halfway through the year. The data required would ideally include 'bill of material' accounts for all refurbishment and construction on campus, including if possible supplier, item name and type, item amount, ISK cost, date and contractor/installer. If that data was considered unrealistic to collect, then at the very least item type, amount and ISK spend for general categories (e.g. wood, steel, etc.) would allow Input-Output emissions factors to be applied in future inventories (for example, see DEFRA, 2015).

The second point of note is that the second largest sector, Solid Waste & Water, uses EFs from the UK, as no appropriate EFs could be found for Iceland. The details of this EF choice are discussed in the solid waste and water section of this report. However, given Iceland's low carbon energy supply, it is likely that the UK EFs overestimate the GHG output from water supply and waste treatment, which would result in lower recorded emissions for the HI. It is recommended that these EFs be located, or developed by HI academics in consultation with local water authorities and environmental agencies.

Furthermore, no data was forthcoming from HI for Postage and Freight, Fugitive Emissions or Construction. These sectors were therefore **not included** in the final inventory and represent an underestimate, although the first two sectors are thought to be relatively small.

Only partial data was received from Félagsstofnun Stúdenta (FS) for the Accommodation, Restaurant and Cafes, and Products sectors of the 2015 inventory. The authors were told that this data existed, but for some reason the remaining data was not forthcoming in the 2 months available for collection. Therefore, these sectors also represent an **underestimate** of GHG emissions at HI in 2015.

Energy and Transport, traditionally the two largest sectors (not energy in this case) were well reported, although some minor improvements could be made with data collection in the future that would allow for more efficient mitigation strategies. Maintenance and Equipment was well reported, as was Solid Waste. Further specific reporting issues are discussed in each sector of the inventory.

Overall, it is **highly recommended** that itemised data be collected in addition to ISK data for all sectors. For example, bus trips would record the bus company, destination, number of students and date, or on campus cafes would record the quantity and type of food bought, date, ISK paid and supplier bought from. This detail of data will allow the University to make accurate predictions of GHG emissions into the future, and to design cost-effective mitigation strategies accordingly. Sectors and subsectors currently lacking that detail of reporting are;

- Construction and refurbishment of infrastructure (most critical)
- Postage and Freight
- Fugitive emissions
- Accommodation
- Cafes and Restaurants
- Products (primarily the bookshop)
- Wastewater
- Events
- Office consumable use
- Bus, Taxi and Rental Car, when the University paid
- Chemical waste
- Use of natural gas and similar by the university (e.g., science labs

Emissions Sectors

This section discusses each emissions sector reported on in the 2015 GHG inventory, detailing the data source, activity data received, EF used, EF source and total and percentage inventory contribution. Each sector also includes a discussion on any assumptions and limitations involved in the inventory calculations, recommendations for future reporting and a brief analysis of any trends that are relevant to future emissions reductions. In the cases where data was poorly reported, recommendations for what data is required are discussed, as well as potential strategies to accurately report in future.

All Subsector and Subsector Reference fields correspond to the fields in the Microsoft Excel Inventory and ERS file (henceforth, 'Excel') in the Resources folder. All data sources listed as 'HI' come from Sigurlaug Lövdahl from the division of operations and resources at HI, typically quoted directly via email or in a Excel file, which are also included in the Resources folder.

1. Transport

The largest emissions sector in 2015 was transport, accounting for 91% of the total GHG emissions at HI. The majority of this sector (85%) is dominated by emissions relating to commuting to and from HI campuses, with 13% coming from international flights and the small remaining percentage coming from a range of other transport activities. See Figure 2 for an emissions breakdown of the transport sector at HI.

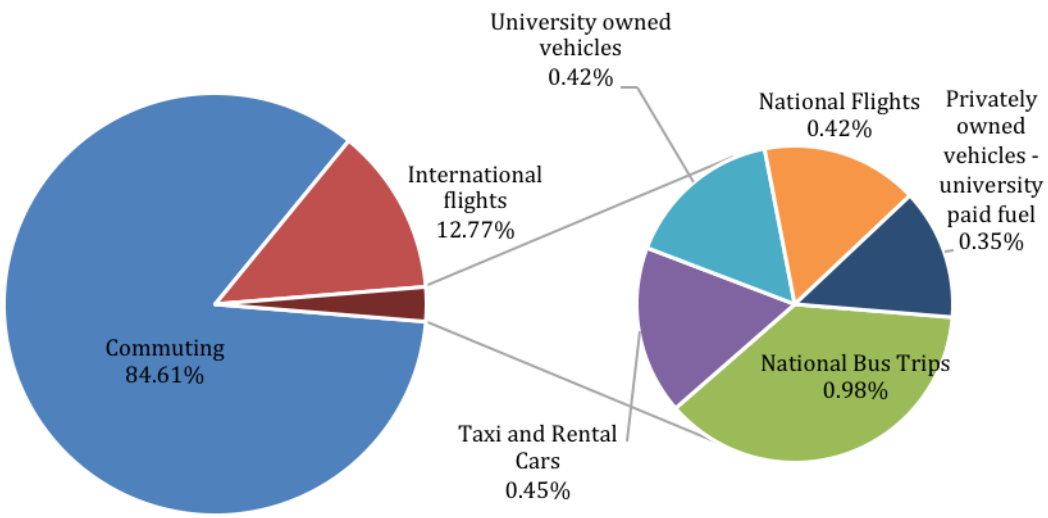

Figure 2: Emissions from Transport in 2015, broken down by subsector

1.1 International Flights

Data Source	HI
Activity Data	1,446 return flights, 18% Erasmus 1,223,871 km travelled, 20% Erasmus Data listed by destination country
Emissions Factor Source	ICAO Emissions Calculator (ICAO,2016)
Emissions Factors	Calculated on website based on a range of factors – see ICAO methodology section
Emissions (tonnes CO2eq)	780.7 (19% Erasmus)

The data for International Flights was well reported in 2015 and included all flights that HI paid for in 2015, as well as HI students partaking in the Erasmus program. Only the outward bound Erasmus students were included in the inventory for 2015, with incoming students deemed to be outside the control of HI, and thus outside the scope the GHG inventory.

Data was only reported by country, so assumptions were made as to the destination within each country – see the Excel file for specific country assumptions. In general, for smaller countries (including most European countries) the major airport was used. For large countries like the USA and Canada, a midpoint destination was assumed (e.g., halfway between the two extremes – like Winnipeg). All flights were assumed to be return journeys, except where information was given about multi-trip journeys and then that specific data was used.

Data for Erasmus flights is reported with the academic year, which spans over two calendar years. The Erasmus flight data included in the 2015 GHG inventory is for the 2014/2015 academic year. All international flights in the 2015 inventory were assumed to depart from Keflavik airport and transfers to and from the airport were not considered.

The International Civil Aviation Organisation (ICAO) operates an online GHG emissions calculator which was used to calculate emissions for this subsector. The calculator accounts for radiative forcing, indirect routes, airborne waiting time at landing, specific airline types, route specific data, passenger load factors, flying weights and a percentage of embodied emissions from airport infrastructure. See the online methodology paper (ICAO, 2016) for more information. When no direct flight was available in the calculator from Keflavik to the reported destination, the most direct flight path was found using Google Flights (www.google.com/flights) and these intermediate destinations were used as inputs for the calculator. This is listed as 'via X' in the Excel sheet in the Resources folder.

The most popular destinations for non-Erasmus flights were Denmark, Sweden and the USA (all about 10%), followed by the UK (6%), with all other countries less than 5% of all trips made. For Erasmus flights, the most popular were Denmark (15%), the UK (12%), Sweden (11%) and France (8%). Emissions from airline flights are traditionally very difficult to mitigate, as there is often little alternative and price no longer acts as a strong disincentive. However, the high number of very local flights (Denmark, Sweden, UK) suggest that there may be some mitigation potential in promoting and facilitation the use of the ferry/public transit alternative.

1.2 University Owned Vehicles

Data Source	HI
Activity Data	11 vehicles owned, 113,231 km travelled See Table 3 for vehicle specifics
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/km)	See Table 4
Emissions (tonnes CO2eq)	25.87

The data for University Owned Vehicles was well reported in 2015, with 11 vehicles registering a combined 113,231 km travelled, or just over 10,000 km/vehicle. However, the accuracy of the reporting could be questioned, with round numbers (see 'Facilities management' department in Table 3) usually a good indication that data has been estimated. Any vehicle where the 'vehicle type' was not reported was assumed to be 'average', and the appropriate EF was applied. Additionally, no individual data was available for the two vehicles servicing the research centres (only a combined 33,000 km travelled), so they were assumed to be 'average', 'gasoline' vehicles. The data accuracy should be **improved** by reporting the vehicle type for all vehicles in the fleet, and recording rather than estimating vehicle kilometres travelled.

Table 3: Activity data for university owned vehicles

Department	Vehicles	Fuel Type	Vehicle Type	Km
Buildings and facilities	Skoda	Gasoline	Average	4,156
	VW Caddy	Gasoline	Medium	6,728
	WV Caddy	Gasoline	Medium	5,155
	Renault	Diesel	Average	3,387
	Renault	Diesel	Average	10,805
Facilities management	Renault Kangoo	Gasoline	Medium	8,000
	Renault Kangoo	Gasoline	Medium	8,000
	Skoda Fabia	Diesel	Medium	25,000
	Renault Traffic	Diesel	Large	9,000
HI Institute of Research Centres	Unknown	Gasoline	Average	16,500
	Unknown	Gasoline	Average	16,500
Total				**113,231**

The vehicle fleet at HI had an average efficiency of 189g CO2eq/km in 2015, well above that of the European Commission's (2016) laws for new car sales at 130g CO2/km, and more than twice that of the 2021 new car target of 90g CO2/km. It should be noted that these limits only apply to CO2, not CO2eq, however for passenger vehicles this is typically 97%-99% of the CO2eq value (DEFRA, 2015). This also only accounts for direct emissions. If upstream emissions (Well-to-Tank) emissions are included the HI vehicle fleet has an average efficiency of 228g CO2eq/km.

The EF's used to calculate sector 1.2, as well as all other passenger vehicle travel in the GHG inventory except where noted, were taken from the UK Department of Environment, Food and Rural Affairs (DEFRA) database. This database is compiled using a combination of input-output and direct emissions studies and the methodology behind each EF is available in the online methodology paper (see Resources folder, also DEFRA, 2016). The DEFRA corporate conversion factors database is one of the databases recommended by the GHGProtocol for company and institution reporting. The DEFRA database is compiled using data from a range of sources, including current academic literature, data from the International Energy Agency (IEA) and the UK Department of Energy and Climate Change (DECC) and national and international statistical bodies.

The decision was made, in line with DEFRA reporting guidelines, to report not only direct emissions for passenger transport but also upstream emissions arising from hydrocarbon extraction, processing and transport. The EF for this type of upstream reporting are referred to as Well-to-Tank (WTT) and are shown in Table 4, along with the Direct emissions resulting from the combustion of hydrocarbon fuels during engine operation. The sum of the two EFs results in the final EF used in this report, shown under TOTAL in Table 4.

Table 4: Emissions Factors for passenger transport, including Direct, Well-to-Tank and the combined TOTAL, all expressed in kg CO2eq/km (DEFRA, 2016).

	Direct			**WTT**			**TOTAL**		
	Diesel	**Gasoline**	**Hybrid**	**Diesel**	**Gasoline**	**Hybrid**	**Diesel**	**Gasoline**	**Hybrid**
Small	0.144	0.159	0.108	0.031	0.031	0.021	0.175	0.190	0.129
Medium	0.176	0.199	0.118	0.038	0.039	0.023	0.214	0.238	0.141
Large	0.225	0.291	0.174	0.049	0.057	0.034	0.274	0.348	0.208
Average	0.182	0.191	0.129	0.039	0.037	0.025	0.222	0.229	0.154

The accuracy of these emissions factors to HI reporting is assumed to be quite good, given that the largest component of the EF is from direct fuel combustion, which is based on physical and chemical calculations and is the same all around the world. However, as the WTT EFs are calculated specifically for the UK, the WTT factors may differ to that of the Icelandic case. For example, gasoline suppliers in Iceland could source their fuel from a different supplier, which could come from a different production well in a different country. This is a limitation that is somewhat unavoidable without examining the Icelandic fuel cycle in detail. Here it is assumed that the difference in WTT emissions between Iceland and the UK is small. Furthermore it's assumed that vehicles are adequately represented by the Small, Medium and Large vehicle categories, and inherently misreport any non-standard vehicles (e.g., extremely efficient large vehicles).

1.3 Privately owned vehicle use – university paid fuel

Data Source	HI
Activity Data	Unknown vehicle numbers, 93,374 km travelled
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/km)	See Table 4 EV's assumed 0 emissions
Emissions (tonnes CO2eq)	21.36

The only data available for this sector was total km and total ISK reimbursed for travel in 2015, and it should be noted that HI only reimburses travel for longer distances than 5 km, which means that there is some **underestimation** in this category. No information about the number of vehicles or trips, destinations, vehicle types or fuel types was recorded. The model assumes that the vehicles were all 'average', 'gasoline' and apply the EF listed in Table 4.

It is **highly recommended** that in future this sector be more accurately reported, covering trip origin, destination, exact km travelled, vehicle type, fuel type, ISK spent and number of vehicle trips made. This data will allow for a more accurate understanding of travel behaviour, and as such effective mitigation policies can be designed.

1.4 Commuting

Data Source	Survey Data
Activity Data	Various vehicle types Cycle 2,634,212 km Walk 2,020,887 km Car 15,602,058 km Bus 5,955,424 km Car-pool 5,226,735 km
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/km)	Passenger vehicles, see Table 4 Bus 0.122 EV's assumed 0 emissions
Emissions (tonnes CO2eq)	5,173.6

An online survey was sent via email and UGLA to all HI staff and students, asking participants to voluntarily answer a questionnaire relating to commuting travel behaviour. The online survey had 1,211 respondents, of which data was complete for 1,058 samples. This represents around 7% of the HI population and is considered an excellent response rate, especially considering the survey did not require any specific funding to complete. The survey was created with Google forms and was available in both Icelandic and English. Both the surveys, and the responses received are included in the Resources folder.

The survey did however have some significant limitations. It is likely that it was affected to some degree by non-response bias, where the responding group are likely to have different responses to the group that did not respond. This is particularly likely as the first time the survey was sent around via email, as it was framed as a sustainability initiative. This was unknown to the authors at the time, and an attempt was made to correct this by posting the survey again via the UGLA platform, framed as a travel commuting survey. There is also the possibility that the survey was responded to twice, but every effort was made to inform participants that it was the same survey and that it need not be filled in again.

Individual survey results were also removed from consideration if the data was inconsistent. For example, a participant who filled in travel to University 10 days per week. There were not many of these responses (<10), which indicates the survey was largely understood by staff and students. In the situation where participants didn't respond to the postcode question, used to calculate average distance from campus, the participants' perceived distance from campus was used. If this was also not returned that result was considered invalid and removed.

It is **recommended** that in future the survey be made available to all students and staff at the same time, via a number of different platforms (UGLA, email, staff internal mail, student centre and around campus), however, the authors recommend it be framed in a neutral way so as not to create a bias towards those with an environmentally inclined attitude.

It is **also recommended** that the 'I don't know' response be removed from the survey, as this created confusion amongst some participants (or simply encouraged lazy answers) and as a result a large proportion of survey results were incomplete. Maintaining an option for 'I would prefer not to answer' would be a better alternative, and choosing this options for key questions would result in discontinuation of the survey.

Finally, it is **recommended** that the car-pooling question be re-structured, as the results indicate it was poorly understood. The question read "If you commute by Car or by Car Pooling, how many people are in the car?" Most regular car commuters stated 1 and car-poolers stated 2 or more, but many participants stated 1 *and* then provided data for the car-pooling question "In SPRING, SUMMER AND FALL, how many days per week, on average, do you commute by Car Pooling?". This implies that they may have misunderstood, and entered the 1 to mean themselves, plus 1 extra passenger. In the 2015 inventory, it's therefore assumed this information is correct. Still, the authors recommend this confusion could be avoided in future surveys through a careful rewording of these questions.

The survey resulted in a large amount of data, as a significant portion of the HI community responded. 67% of respondents were female and the average age of respondents was 35. The average commuter distance was 8km and the average perceived commuting time was 15 minutes. Car commuters cover 50% of the total Km travelled in 2015, followed by bus commuters (19%) and car-pooling (17%). Walking and cycling were popular commuter choices, together accounting for just over 40% of trips made to HI, similar to driving and car-pooling combined. The average days per week commuted was 4.5, and there was no noticeable difference in the summer and winter periods. 51% of HI students and staff commuted by active transport (walking or cycling) at least 1 day per week.

The survey shows that the average distance people commute to University is 8km, and the average perceived time taken to commute is 15 minutes. Results indicate that 25% of commuters live within 1km of University, in the 101 postcode. Distances were calculated using the maximum and minimum distance possible from each campus, for each postcode, and then the average of those two values was used. For example, the main HI campus is in postcode 101, so the minimum distance was 0km and the maximum possible distance for someone living in 101 to commute to the main HI campus was 2.2km. Hence the assumed distance for a commuter in postcode 101 was (2.2 – 0)/2 = 1.1km. These distances were estimated using Google maps, and all calculations are included in the Excel sheet.

The survey data shows that 77% of commuters live within 10km, which is a commute of less than 30 mins by bicycle using published average bicycle speeds, although these vary considerably based on the individual situation. The distance and cumulative percentage of HI attendees commuting that distance are shown in Table 5. Although walking speeds vary much more than cycling speeds for commuters, over half of all commuters (53%) live with 5km of University, which is a rough upper limit for acceptable walking commuter distance. This data shows high potential for active transport mode switching in order to reduce HI's GHG emissions in future years. To really understand the barriers to active transport, one needs to consider the effect of seasonality. Table 6 shows the summer-winter split by transport mode for commuters to HI in 2015. Numbers are for the sample of 1058 participants, and the authors generalise these results to HI population.

Table 5: Cumulative percentage of commuters living a certain distance from campus

Distance from campus (km)	Cumulative percentage of commuters
1	25%
2	34%
5	53%
7	63%
10	77%

The 'winter' period in the survey is October-February, 14 weeks long after the two-week Christmas break is removed. The 'summer' period is the remaining portion of the year, less a four-week holiday, totalling a maximum of 34 weeks. The average student attended University 24 weeks per year and the average staff member 33 weeks per year, although 30 and 42 were the norm (respectively) with the results being skewed by casual and part-time attendees. Most attendees attended throughout the 14 winter weeks, with a variable amount of 'summer' period attendance. As such, some of the results in Table 6 must be interpreted with caution. All trips in the summer period increase, as the period is longer.

Table 6: Commuter transport modes in Winter and Summer

	Winter				**Summer**			
	Users	Trips	Modal Share (users)	Modal Share (trips)	Users	Trips	Modal Share (users)	Modal Share (trips)
Cycling	106	9,499	7%	7%	280	38,875	18%	20%
Walking	339	36,165	23%	28%	361	51,117	23%	27%
Bus	252	21,756	17%	17%	222	23,366	14%	12%
Car	548	46,178	37%	35%	505	57,933	32%	30%

Car Pooling	256	17,226	17%	13%	223	20,964	14%	11%
TOTAL	**1,501**	**130,824**	**100%**	**100%**	**1,591**	**192,255**	**100%**	**100%**

*Users can use more than 1 mode of transport, hence totals will not add to sample size

The useful insights in Table 6 are in the change in modal shares. Modal shares measured on a user basis count anyone who uses a certain mode at least once in the week, as many commuters are mixed mode over the week. A trip based modal share shows the percentage of the total trips made, capturing the *frequency* of modal use. A user basis is useful for designing infrastructure and provisions for commuters at the university, as someone who rides a bicycle to university one day per week still needs adequate parking on that one day, whereas trip based data is more useful for predicting GHG offsets, as it correlates linearly to kilometres travelled and hence fossils fuels burned for certain modes.

Regarding active travel modes, the number of users cycling at least one day per week increases 2.6 times in the summer period. Walking modal shares remain about the same in summer, whilst Bus, Car and Car Pooling all decrease. This shows that there are additional barriers that need to be overcome for active travel in the winter months, which is useful when designing mitigation strategies.

There were roughly 15,500 students and staff that attended HI in 2015, calculated by extrapolating the 2011 to 2014 population numbers to 2015, as those figures were not yet published (HI, 2015). It is assumed that the survey results are a representative sample of the greater HI population and multiply total population (15,500) by percentage modal shares in order to calculate total emissions from the commuting subsector. Thus, HI students and staff made around 4.7 million trips (to university and back is two trips) in 2015, spilt across five modes as shown in Figure 3. Cars and Car Pooling make up 44%, with active transport modes comprising about the same share at 42% and Bus commuters making up the remaining share.

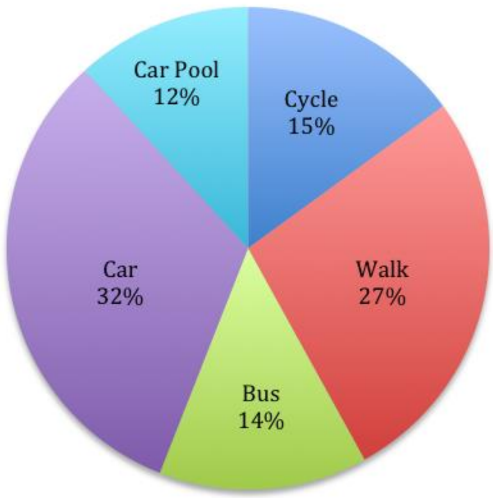

Figure 3; Modal share for University commuters in 2015, average of both winter and summer seasons

Commuter emissions at HI in 2015 were 5,173.6 tonnes of CO2eq, which makes up 85% of transport emissions and 77% of the total GHG inventory in 2015. 70% of the commuting emissions come from private vehicles, 14% from public bus travel and 16% from car-pooling, with an average of 1.7 people per car (see previous discussion on car-pooling data for explanation).

The results presented are promising. There is already a very high modal share for active transport modes, and over half of all commuters used active transport at least one day per week in 2015. Obviously, active transport modes don't produce any direct GHG emissions, so are an essential part of any university mitigation strategy. The close proximity of the university population should also make this transition feasible, as will policies that increase the convenience of active transport modes in contrast to car, car-pooling and bus commuting.

In addition to the quantitative responses received in the survey, two open questions were asked, seeking qualitative feedback and mitigation ideas for the HI community.. Staff and students were asked 'What changes would enable you to commute less by car, and more by cycling, walking or public transport?', as well as 'Is there anything else you want to add in relation to this survey?'.

The response from the HI community was excellent, with most survey participants offering their advice, insight and feedback on the current systems. The recurring themes are presented here, and all responses are available in the Resources folder under 'Commuting Survey English/Icelandic Responses'. Table 7 summarises the main themes of feedbacks received from the open questions in the survey.

The most frequently reported feedback was the inadequacy of the bus system. 186 people responded that the bus system would need to be improved, that the bus takes too long, is too infrequent or that routes are inconvenient. The second most common response was that the bus is too expensive. A single trip costs 420 ISK, independent of where in the capital area you are, so a return trip to HI campuses for the majority of commuters amounts to 840 ISK. It can therefore be perceived to be cheaper to drive in many cases than to take the bus, with free parking available all over campus. The only student discount offered is for 12-month bus passes, which does not suit all types of commuters. It costs 46,700 ISK, which for the average commuter (according to the survey results) who attends 26 weeks per year, this is around 1800 ISK/week, or about 400 ISK/day. For these commuters the bus pass is economically attractive, but for single semester attendees, or for commuters who attend less often each week, this is an unattractive economic position in comparison with driving or other modes.

For cyclists, the most common responses were that covered bike parking is needed at the University, better bike paths are needed around the city, access to free showers at campus for people who cycle and better snow clearing. Other less common responses were that a bike rental schemes would be needed at university and a bike repair station.

A high number respondents also commented that better weather, living closer to University, or not having kids at day-care would be factors but those were not included in the table because they cannot be influenced by the university.

Some people also had very specific and interesting ideas about what can be done to change people's travel mode. One respondent suggested a car sharing app for carpooling, where people who give others rides could collect points which could be used for printing quota, credit at Bóksala or at Háma. The app would also have an option to review drivers so they would have an incentive to do a good job. The development of this app could possibly be a very interesting student project. Another person had an idea about having an electric car for students and staff which would drive around different campuses (Main building, Læknagarður, Stakkahlíð) for when people have classes or meeting in different places.

Table 7: Recurring qualitative response topics received in the commuting survey

#People	**What changes would enable you to use bus, bike or walking more?**
186	Better bus system; takes too long, too infrequent and routes are inconvenient
96	Bus needs to be cheaper; it is often cheaper to drive than take bus
29	Covered bike parking at University, and better infrastructure for bikes
21	Better bike paths around the city
17	Better subsidies for people who don't use car
16	Free showers at University
16	Better snow clearing on paths, possibly heated paths
11	Free bus
10	Flexible hours or a shorter work day
9	Charge for parking on campus
8	Light train system
7	Bus would need to stop closer to campus and student housing

6	Bike rental scheme at HI
5	Electric car charge on campus
5	Transportation provided between different campuses
4	Bike repair station
4	Organized carpool system, such as an app

Finally, a small number of people were unhappy about this survey and said it made them feel guilty about needing to use a car to come to university.

General comments concerning the survey itself were;

- Missing campuses, such as Læknagarður and Keilir
- Survey does not consider distance learning students
- Survey does not account for people living outside the capital area
- Survey is too confusing and complicated

It is recommended that these comments be incorporated in commuting surveys in future years, as well as to inform GHG mitigation policies.

1.5 Taxi and Rental Cars

Data Source	HI
Activity Data	Taxi 2,342,846 ISK only, estimate 81,531km Rental Car 13,548,485 ISK only, estimate 65,939km
Emissions Factor Source	Rental Car – AVIS Taxi – DEFRA, passenger vehicle, average, gasoline
Emissions Factors (kg CO2eq/km)	Rental Car – 135gCO2eq/km Taxi – See passenger vehicles, see Table 4
Emissions (tonnes CO2eq)	10.8

This subsector was not well reported in 2015. Only total ISK data was reported for both Taxi hire and Rental Car hire by HI, with no breakdown at all available. It is **highly recommended** that HI report on this data in 2016. The data required would be the company hired from, origin and destination, km travelled per hire, number and dates of hire purchases, vehicle type, fuel type and ISK cost per hire. This probably an improbable amount of data to collect at each point of hire or rental service, therefore it is recommended that HI establish a corporate account with one or two hire companies, so they can be responsible for tracking this data. This is discussed further in the Section IV of this report.

It is assumed that all rental cars were hired from Avis and take data from their website (https://en.avis.is/). The quoted figure of 135g/km is assumed to be correct. Assumed rates are based on a three day hire in July, which totals to 43,149 ISK. It is further assumed that the car is used to and from airport, and then to get around town, to and from HI and to a hotel. Thus, 70km per day and 210km per hire are assumed. This results in roughly 66,000 km travelled and 8.8 tonnes CO2eq emissions form rental hire in 2015.

The taxi hire is assumed to be used exclusively for airport trips, based solely on the need to simplify reporting. The authors repeatedly contacted taxi companies in Reykjavik when data was not forthcoming from HI to try to more accurately estimate emissions, but no response was received. Thus, it is assumed the 52.2km trip to Keflavik international airport (distance from Google maps) costs 15,000 ISK, based on published fares on one local taxi company's website (www.hreyfill.is/verdskra). Using these values it is calculated that under these assumptions taxi travel costs 287.4 ISK/km, resulting in roughly 8,200km travelled by taxi in 2015. The journey is more typical of open road passenger vehicle driving, rather than the typical stop-start taxi environment, and thus an emissions factor for an average gasoline vehicle is applied, as presented in Table 4. The result is 1.87 tonnes CO2eq emissions in 2015.

1.6 Bus Trips

Data Source	HI
Activity Data	19,581 km, estimated based on 12,315,653 ISK
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/km)	0.122
Emissions (tonnes CO2eq)	59.7

This sector was poorly reported in 2015. Only total cost for all trips was available. It is recommended that HI report the date, company, bus type, fuel type, cost, destination and origin of each bus hired in future inventories. Further recommendations for reporting this sector accurately are included in Section IV, together with the mitigation strategies available.

As no detailed information was available for this sector, a sample of bus trips taken from the Environment and Natural Resources (ENR) department was provided by Bjargey Anna Guðbrandsdóttir. This sample was used to estimate the km travelled/ISK relationship, which was then assumed to be correct for all HI bus travel and was used to calculate the total km travelled by hired bus in 2015. For details on the ENR sample set provided, see the Excel sheet.

1.7 Domestic Flights

Data Source	HI
Activity Data	9,954 km
Emissions Factor Source	ICAO Emissions Calculator
Emissions Factors (kg CO2eq/km)	Calculated on website based on a range of factors – see ICAO methodology section
Emissions (tonnes CO2eq)	25.72

This sector was well reported in 2015. Domestic flights include all flights within Iceland, as well as flights to the Faroe Islands and Greenland as these were reported together. The flights leave from the small domestic airport in Reykjavik. No flight data was available in the ICAO calculator for Eagle Air flights (small, national carrier) to Höfn, Húsavík or Vestmannaeyjar. For these flights the distances were estimated using the Google maps 'measure' tool, and then CO2eq emissions were assumed based on the CO2eq/km efficiency of flights with the same airline. See the Excel sheet for further details.

2. Maintenance and Equipment

This section includes the combustion and use of fuels associated with grounds keeping, campus maintenance and general repairs.

2.1 Maintenance and Equipment

Data Source	HI, N1 Service station, BYKO hardware store
Activity Data	Diesel 48,881 ISK, 198.7 ISK/litre Lubricant Oil 48,778 ISK, 1350 ISK/litre Gasoline 37,437 ISK, 184.3 ISK/litre 1 car battery
Emissions Factor Source	DEFRA – average fuel blends Car battery – LCA study (Premrudee et al, 2013) Density of Lubricant Oil SAE-10W-40 (Viscopedia, n.d) - 0.8629g/cm^3
Emissions Factors	Lubricant Oil – 3182 kg CO2eq/tonne, Gasoline 2.1944 kg CO2eq/litre Diesel 2.5839 kg CO2eq/lire
Emissions (tonnes CO2eq)	1.28

The data in this subsector was moderately well reported in 2015. Data was reported in total ISK, and fuel prices from the local N1 service station and BYKO hardware store were used to calculate total litres used for each fuel. In future it is **recommended** that fuel use in this subsector be reported in both litres and ISK, as prices can fluctuate dramatically between time of purchase and time of reporting. However, the volumes used are small and as such this sector is considered to be accurately reported in 2015.

The ISK/litre values sourced from N1 (gasoline and diesel) and BYKO (lubricant oil) were collected in person by the authors after requests to the grounds and operations staff at HI returned no results. These values allow for the total amount of fuel use to be calculated, and then standard fuel mix EFs were applied from the DEFRA database.

The CO2eq emissions resulting from the production the car battery purchased were estimated using a life cycle analysis (LCA) study available in the academic literature (Premrudee et al, 2013). This study is not in any way specific to the actual battery purchased, and accuracy could be improved here, but the impact of this single purchase on GHG emissions is minimal.

3. Energy

This sector details all of the electricity and heat used by HI, as well as any stationary fuels combusted on campus for energy production. In typical GHG inventories this is the largest sector of the entire inventory, but in the case of Iceland, this sector is one of the smallest. Iceland's electricity is generated using hydropower and geothermal energy, both of which produce very small amounts of CO2eq emissions per unit of energy. Iceland's residential and commercial heat demands are also met by low carbon sources, utilising the low heat geothermal sources abundantly available in Iceland's natural landscape.

3.1 Purchased Electricity

Data Source	HI				
Activity Data	8,050,063 kWh				
Emissions Factor Source	DEFRA – *Overseas Electricity*				
Emissions Factors (kg CO2eq/kWh)	**Energy Use**		**WTT**		**Total**
	Generation	T & D	Generation	T & D	
	1.7E-04	1.0E-05	3.0E-05	0	0.00021
Emissions (tonnes CO2eq)	1.69				

This subsector was well reported in 2015. The EF from DEFRA incorporates electricity losses in transmission and distribution (T & D), as well as upstream emissions (WTT). It should be clear that the unique Icelandic energy supply situation holds lots of potential for GHG mitigation, in that many other GHG sources (e.g., cars, grounds equipment) can be switched to an electric energy supply to reap large GHG reduction benefits.

3.2 Gas Generation on Campus

Data Source	None
Activity Data	None
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/kWh)	None
Emissions (tonnes CO2eq)	None

This subsector was not reported in 2015, despite known use of gas burners in chemistry and other scientific laboratories on campus. The authors asked various university departments but no data was forthcoming. It **is highly recommended** that for completeness, and to comply with GHG reporting protocols and guidelines, these emissions be reported in future.

3.3 Emissions from Hot Water Production

Data Source	HI
Activity Data	400.437 m^3
Emissions Factor Source	(Daviðsdóttir, 2016)
Emissions Factors (kg CO2eq/kWh)	0 CO2eq/m^3
Emissions (tonnes CO2eq)	None

This subsector was well reported in 2015. In Iceland, hot water for residential and commercial use is supplied from the low heat geothermal sources nearby to Reykjavik. As such, Daviðsdóttir (2016) confirmed that these sources of heat and hot water have an emissions intensity of 0 kgCO2eq/MJ, as it is considered that these sources would otherwise flow into the environment.

4. Solid Waste

This section includes all waste collected on HI campuses, with the exception of specific waste collection for the cafes and restaurants, and accommodation on university grounds. These waste streams are include in the café and restaurant and accommodation categories later in this section. This sector includes emissions from waste sent to landfill, waste composted and recycled plastic, paper, metal and industrial waste and finally chemical and hazardous waste related emissions. The activity data was reported and calculated together, so here the sector is presented together.

Data Source	HI
Activity Data	See Table 6
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/tonne waste)	Recycled waste 21 Landfilled waste 459 Industrial waste – landfilled 93 Composted organic waste 6 Chemical waste 93 (estimated)
Emissions (tonnes CO2eq)	4.1 Waste landfilled 73.6 4.2 Recycled plastic, paper and metals 1.86 4.3 Organic waste composting 0.2 4.4 Chemical Waste 1.4 Total Solid Waste emissions 77.1

This sector was well reported in 2015, with the exception of the chemical waste subsector. No information was available about the type of chemical waste, the type of disposal pathway, or even the company that handled the waste. It is **recommended** that this be accurately reported in 2016, and that a specific EF be discussed with the chemical waste company responsible for the handling of HI's chemical waste. An EF for chemical waste was not available in the DEFRA database, and without additional information on the type of chemical waste no other EFs could be located. Finally, the chemical waste EF was assumed to be the same as the industrial waste EF in the DEFRA database. It is recommended this estimated EF be corrected in the 2016 inventory.

The accuracy of the DEFRA emissions factors is not thought to be good with respect to recycled waste. All recycled waste streams have the same emissions intensity (21 kg CO2eq/tonne), arousing suspicion that there may be data gaps in their database. This may be amended in 2016, but if it is not, it is recommended that new EFs be found if available.

There are well established EFs for waste emissions published by the IPCC for national GHG reporting that could be used. However, the main problem here is one of scope. The IPCC emissions factors calculate only direct emissions, typically from methane and nitrous oxide emissions from anaerobic digestion of waste. Input-Output (IO) models, which form the basis of most of the DEFRA emissions factor database EFs, calculate the emissions by sector, accounting for most additional energy inputs involved in processes such as transport, waste collection, aggregation and processing, and final distribution of waste by-products. Most energy inputs typically have a GHG emissions output, and IO models attempt to capture that.

As such, it is **recommended** that EFs that are based on IO analysis should be sought for the waste sector in the 2016 inventory.

The total amount of solid waste reported in 2015 is shown in Table 8, divided into categories by sorted waste stream. HI estimates that 50% of the industrial waste generated is recycled, and was assumed to be correct. The waste sector was the only sector in the 2015 inventory where historical data was available, and as such it is included here. The data shows that overall waste volumes are increasing at around 2.63% each year and that recycling rates have stagnated at around 28% for the past 3 years.

Table 8: Solid waste volumes at HI from 2009 to 2015 (kg's)

Waste Stream	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mixed Waste	210,831	210,567	171,894	170,875	143,445	147,433	159,191
Industrial Waste (50% recycled)	31,050	28,260	24,400	28,919	13,810	9,170	11,570
Metals	1,010	1,640	1,140	1,200	830	1,540	1,900
Glass	1,020	640	1,350	950	1,190	1,510	1,830
Soft Plastics and Corrugated Paper	8,575	12,241	13,950	12,090	13,935	16,186	17,350
Paper, Plastic	570	340	20,112	26,282	41,345	45,693	50,548
Quality Paper	7,405	10,690	12,657	9,246	10,549	9,065	11,280
Organic waste - compost	141	18,992	25,681	29,689	32,664	33,853	33,156
Chemicals	0	0	8,647	12,066	12,456	13,908	15,020
Total	**260,602**	**283,370**	**279,831**	**291,317**	**270,224**	**278,358**	**301,845**
Recycle rate	13%	14%	22%	22%	28%	28%	29%
Compost rate	0%	7%	9%	10%	12%	12%	11%
Chemical waste rate	0%	0%	3%	4%	5%	5%	5%

5. Wastewater and Water Use

The liquid and slurry waste streams are accounted for in this category, as well as emissions arising from cold water usage on campus.

5.1 Cold Water Use

Data Source	HI
Activity Data	150,039 m^3
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/m^3)	0.344
Emissions (tonnes CO2eq)	51.6

This subsector was well reported in the 2015 inventory. The EFs used to calculate emissions from both cold water supply and wastewater processing were taken from the DEFRA database, and are based on an IO style sustainability report published by UK Water. It is highly recommended that HI and future inventory compilers work with the local water authority in Reykjavik to compile a similar brief report which allows for Icelandic EFs to be specified. As many of the energy inputs to water treatment processes may be electric, it could be that the current EFs used in the 2015 report overestimates HI's emissions from wastewater and water use, because of Iceland's low carbon electricity supply.

5.2 Wastewater

Data Source	None
Activity Data	Estimated 300,078 m^3
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/m³)	0.708
Emissions (tonnes CO2eq)	212.5

This data was poorly reported in 2015, with only ISK data available from HI. No ISK/volume data was available from the local water authority. It is assumed that total wastewater volume was twice that of cold water use, to account for hot water usage and biological solids. This is an estimate only and the accuracy of this estimate is completely unknown. Therefore it is **highly recommended** that this data be reported on accurately in 2016, and combined with an appropriate EF as discussed in subsector 5.1. It is especially important for this subsector in particular, as it wastewater emissions are the second largest sector after transport in the 2015 inventory.

6. Accommodation

This sector includes all the on campus accommodation available to staff and students, as well as the day care centre on the main campus. These facilities are run by the organisation Félagsstofnun Stúdenta (FS) and they were responsible for reporting the requested data.

6.1 Purchased Electricity

Data Source	FS
Activity Data	1,900,000 kWh
Emissions Factor Source	DEFRA – *Overseas Electricity*
Emissions Factors (kg CO2eq/kWh)	see table below
Emissions (tonnes CO2eq)	0.4

Energy Use		WTT		Total
Generation	T & D	Generation	T & D	
1.7E-04	1.0E-05	3.0E-05	0	0.00021

This subsector was poorly reported in 2015. It is clear from the whole number reported that this is an estimated amount of electricity usage. When the authors first approached FS they were reluctant to provide any data, and follow up with them has been slow and painstaking. FS finally revised their data, the result of which is shown here. As for subsector 3.1, the EF from DEFRA incorporates electricity losses in transmission and distribution (T & D), as well as upstream emissions (WTT).

A similar data accuracy, incompleteness and inconsistency issue exists with all the FS data sources in this inventory, specifically the Accommodation, Cafes and Restaurants, Products and Fugitive Emissions sectors. It is **highly recommended** that future GHG inventory compilers take this into account, and engage FS very early on in the process with the full support of HI. It is **further recommended** that contract riders be developed with FS and all businesses operating on HI campuses, to hold them accountable to sustainability commitments made by HI. This is discussed further in Section IV.

6.2 Heat and Hot Water purchased

Data Source	FS
Activity Data	203.726 m^3
Emissions Factor Source	(Daviðsdóttir, 2016)
Emissions Factors (kg CO2eq/m3)	0 CO2eq/m^3
Emissions (tonnes CO2eq)	None

This subsector was well reported in 2015.

6.3 Waste collected in accommodation

Data Source	FS
Activity Data	None
Emissions Factor Source	DEFRA
Emissions Factors	None
Emissions (tonnes CO2eq)	0

This data was not reported in the 2015 inventory, despite many requests of FS to provide it. It is **highly recommended** that this data be reported in 2016. For further recommendations see subsector 6.1.

6.4 Vehicle Use by Housing Staff

Data Source	FS
Activity Data	2 vehicles, 37,300 km (gasoline) 30,000 km (95% methane, 5% gasoline vehicle)
Emissions Factor Source	DEFRA – 'average, gasoline' passenger vehicle Methane considered 0 emissions, 5% gasoline
Emissions Factors (kg CO2eq/km)	See Table 4
Emissions (tonnes CO2eq)	8.88

This data was poorly reported in 2015. Again, it is clear from the whole number that this data has been estimated. It is recommended that this be accurately reported in 2016. The methane component of vehicle emissions are assumed to be 0 in this case. Methane in assumed to be captured by SORPA at the landfill site close to Reykjavik, and as such these emissions have already been accounted for in the landfilled waste section.

6.5 Electricity Use by Day Care

Data Source	FS				
Activity Data	85,000 kWh				
Emissions Factor Source	DEFRA – *Overseas Electricity*				
Emissions Factors (kg CO2eq/kWh)	**Energy Use**		**WTT**		**Total**
	Generation	T & D	Generation	T & D	
	1.7E-04	1.0E-05	3.0E-05	0	0.00021
Emissions (tonnes CO2eq)	0.018				

This data was poorly reported in 2015. Again, it is clear from the whole number that this data has been estimated. It is recommended that this be accurately reported in 2016.

6.6 Heat and Hot Water purchased

Data Source	FS
Activity Data	None
Emissions Factor Source	(Daviðsdóttir, 2016)
Emissions Factors (kg CO2eq/m3)	0 CO2eq/m^3
Emissions (tonnes CO2eq)	None

This data was poorly reported in 2015. Again, it is clear from the whole number that this data has been estimated. It is recommended that this be accurately reported in 2016, although in this case the activity data is considered emissions free so it would be of the lowest priority.

7. Fugitive Emissions

This sector captures the GHG emissions arising from leakage of the various types of coolant fluids used to operate chillers, fridges, air conditioners, laboratory equipment with cooling cycles and many other forms of equipment. It is typically estimated by the amount of replacement fluid required to be added each time a unit is serviced.

Data Source	HI, FS
Activity Data	None
Emissions Factor Source	IPCC (2007)
Emissions Factors	Various, depends on the type of coolant
Emissions (tonnes CO2eq)	None

This sector was not reported in 2015, despite numerous attempts by the authors to request data from the various laboratories around campus, central department offices and FS. It is **recommended** that this data be reported in the 2016 inventory.

8. Construction

This sector includes all new infrastructure, refurbishments and furniture purchased by HI, as all products inherently have some embodied GHG emissions.

Data Source	HI
Activity Data	225,000,000 ISK
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/tonne)	Asphalt 39.2 Bricks 244.8 Concrete 134.8 Insulation 1864.8 Metals 4768.9 Plaster 120.1 Wood 435 Glass 894.6
Emissions (tonnes CO2eq)	None

This sector was not reported in 2015, as the total ISK data provided was insufficient to estimate with any degree of accuracy the emissions profile of the sector. Based on an even split of ISK amongst the available materials with EFs available in DEFRA, and quoted ISK/kg or ISK/m3 values obtained from local hardware stores (BYKO), it was possible to produce a very, very rough estimate of the sectorial emissions. The sector amounted to roughly 3,600 tonnes CO2eq, or around 60% of the total 2015 GHG inventory. It is therefore **highly recommended** that this sector be accurately reported on in 2016, as it may be a major sector in the inventory. The data required would include 'bill of material' receipts for all materials purchased by HI or contractors working for HI, as well as itemised lists of dates, costs, contractors, supplier and detail product information. It is recommended that HI require this level of data reporting from their contractors in future, as compiling this detail of data afterwards would be extremely difficult.

9. Events

This sector includes all emissions related to event activities co-ordinated by HI, and is made up of catering, transportation, accommodation and equipment and venue hire.

Data Source	HI
Activity Data (ISK)	Catering 1,976,480 Transportation 2,733,452 Accommodation 4,254,020 Artists 1,532,736 Other cost 19,575,190
Emissions Factor Source	Catering and Other costs (ECU, 2015) Transportation – see subsector 1.5
Emissions Factors	Catering 0.006915307 kg CO2eq/ISK Transportation 0.001 kg CO2eq/ISK Accommodation 0 Artists 0 Other costs 0.003923854 kg CO2eq/ISK

Emissions (tonnes CO2eq)	Catering 13.7 Transportation 2.18 Accommodation 0 Artists 0 Other costs 76.8 Total 92.7

This sector was moderately well reported in 2015. Costs were available across 5 broad categories for the major events in 2015. See the Excel sheet for further details. The authors were also told that numerous other small events occur on campus that are not accounted for, but no data for these events was forthcoming. It is **recommended** that these events be reported on in the future.

No other information was available for this section, other than total costs (not even company names), so this sector is largely based on assumptions and estimates. Firstly, it's assumed that all waste is already included in the waste volumes received. It's assumed the 'Accommodation' category, given the low carbon energy supply in Iceland, contributes negligible emissions and is estimated as zero. A similar assumption is made for the 'Artist' category, as this is assumed to be simply labour, which is emissions free.

All flights and national trips are assumed to be accounted for in sector 1.1, 1.6 and 1.7, and that the remaining transport related emissions are trips to and from the airport. Thus the authors assume the taxi CO2eq/ISK figure developed in subsector 1.5 applies and use it to calculate emissions from event related transport.

Finally, for catering services an estimate a value of 0.6230 kg CO2eq/AUD taken from Edith Cowan University's GHG Inventory Report (ECU, 2015), based on an IO analysis report developed in Australia called The Balancing Act. For other services it is assumed that a value of 0.3535 kg CO2eq/AUD taken from the same report. These values was then converted, using the exchange rate at the time and ignoring any price change through time (1 AUD = 90.09 ISK at time of writing) to arrive at the final 'EFs', expressed in terms of GHG/ISK.

This sector was heavily estimated and the assumptions underlying these reported emissions are thought to be very uncertain. With only ISK per category, and no IO emissions factors available in the Icelandic or European context in terms of GHG/currency, there was little other option but to estimate this sector. It is **highly recommended** that this sector be reported in higher detail in 2014, and if possible appropriate studies found of commissioned so that EF can be utilised with accuracy.

10. Postage and Freight

Data Source	HI
Activity Data	None
Emissions Factor Source	DEFRA
Emissions Factors	Various
Emissions (tonnes CO2eq)	None

This sector was not reported in 2015, despite numerous attempts by the authors to request data from HI. It is **recommended** that this data be reported in the 2016 inventory.

11. Products

This sector includes all embodied emissions in products sold on HI campuses. Products are typically only sold from the university bookshop.

Data Source	FS
Activity Data (tonnes)	Books Sold 60 Stationary and Gifts Sold 10
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/tonne)	Books 939 Average plastics 3353
Emissions (tonnes CO2eq)	89.9

This sector was poorly reported in 2015, as it is again clear from the round numbers that the sales volumes are estimated. It is **recommended** that this data be reported accurately in the 2016 inventory. The non-book products sold in the HI bookshop seem to be mostly made from plastic, so an EF for 'average plastic' from the DEFRA database has been utilised. This EF should be updated when more accurate data becomes available.

12. Restaurants and Cafes

This sector includes all emissions arising from the operation of the on campus food outlets, including embodied emissions in the food sold, packaging and disposable cutlery and cups, operating energy use, waste produced (that isn't already accounted for in sector 4) and commercial transport fuel use.

Data Source	FS
Activity Data	Disposable dishes 3 tonnes
Emissions Factor Source	DEFRA
Emissions Factors (kg CO2eq/tonne)	Polystyrene 3,948
Emissions (tonnes CO2eq)	11.8

This sector was poorly reported in 2015, as it is again clear from the round numbers that the volumes are estimated. No data was reported for energy use, waste collected, gas cookers used (if any), food composted, food sold or packaging re-used. FS estimated that 30% of their food is locally sourced. It is **highly recommended** that this data be reported accurately in the 2016 inventory. Disposable dished were assumed to be made of polystyrene, which seems to be the most common plastic for disposable dishes, cutlery and cups.

13. Office Supplies

This sector includes all emissions arising from the purchase of office consumables, primarily stationary and similar items, office paper and toilet paper.

Data Source	HI
Activity Data	Paper 28.536 tonnes Consumables 8,645,097 ISK
Emissions Factor Source	Paper – DEFRA Consumables – estimated, unit prices at BYKO
Emissions Factors	Paper 939 kg CO2eq/tonne Consumables 5.11 x 10-4 kg CO2eq/ISK
Emissions (tonnes CO2eq)	31.2 (26.8 office paper)

This sector was moderately well reported in 2015, with accurate office paper data allowing for effective mitigation strategies to be designed. Only cost data was received for other office consumables and it is **recommended** this be improved in the 2016 inventory to include where possible all items purchased, their cost and details about the item. Care must be taken not to report items bought from the bookshop by HI staff again in this category.

In calculating a GHG/ISK EF for non-paper consumables, it was assumed that these consumables were 70% plastic items, 20% books and 10% small electrical items (e.g., calculator, mouse). The average cost and weight of one of these items was then estimated for each category. A plastic pen (50 ISK, 0.01 kg), a small guidebook or textbook (3000 ISK, 0.5 kg) and a mouse (5000 ISK, 0.3 kg) were used to estimate the cost/kg of each category. Finally a weighted average was taken using the 70-20-10% split, resulting in an emissions factor for office consumables of 5.11×10^{-4} kg CO2eq/ISK.

Finally, it is **recommended** that HI also collect data on toilet paper use across the university in 2016, in order to further mitigate the emissions from the office consumables category.

14. GHG Credits

There were no applicable GHG credits or purchased offsets in 2015.

15. LULUCF

This sector was not reported on in 2015. It is **recommended** that this sector be incorporated into future reporting, but it should be considered a low priority initially, as reporting LULUCF emissions is complex and somewhat unnecessary based on the sites that HI operates (mostly urban and suburban).

Section II: Business As Usual Emissions Forecast

The Business as Usual forecast (BAU) estimates how HI's GHG emissions are predicted to change in the period from 2015 to 2030. Given that this is the first inventory to be completed at HI, the data available for forecasting is limited. The university student and staff population has remained relatively constant throughout the past 6 years at around 15,500. This population is a large predictor in the GHG emissions for future years and in this forecast is assumed to remain constant at 15,500 people. Secondly, HI's published income since 2011 has remained relatively constant, increasing steadily at around 1%. This increase was considered small enough to not have a large impact on GHG emissions and thus income was considered exogenous to the forecast model.

Given that the two major macro-economic drivers of GHG emissions were relatively stable in this case, a bottom up analysis would best suit the GHG forecast model. However, given that this is the first year that data was collected for GHG forecasting purposes, it is understandable that historical data was not available for most sectors, nor was there much detailed breakdown of data with which to make justified assumptions.

The waste sector was the only data with historical trends, and these were used to project emissions from solid waste to 2030. The trends show an annual 2.63% increase in the volumes of waste generated, and that the amount of waste recycled has peaked at 28-29% for the past 3 years. The BAU forecast assumes this trend continues.

The energy sector is assumed to be directly correlated in this forecast to the HI population, so it is forecast to remain unchanged. Some may argue that energy efficiency increases will reduce overall energy consumption in the future, but there is still much debate as to whether rebound effects cancel out small gains in efficiency (See Greening et al., 2000 or Sorrell et al., 2009 for review). As such the forecasted emissions related to energy use are expected to remain unchanged. Emissions in the transport category are assumed to remain unchanged with the same justification. The wastewater and water use sector emissions are also assumed to be related to the HI population and no technology changes are modelled in the BAU forecast, so this sector also is predicted in remain the same.

As discussed in Section I, the accommodation, events, office consumables, cafes & restaurants and products sectors were modelled with only economic data, and as such increase or decrease in GHG emissions related to these sectors would simply be a guess. Thus, until additional materials flow data becomes available for these sectors they are forecast to remain unchanged from 2015 levels. Finally, the maintenance & equipment sector was forecast to remain unchanged in the BAU as no additional grounds keeping or landscaping tasks were predicted in following years.

In the BAU scenario GHG emissions at HI are predicted to increase very slightly, from 6,677 to 6,713 tonnes CO2eq by 2030 as shown in Figure 4. The increase is roughly 0.5% over 14 years. All GHG mitigation reduction strategies discussed in the following sections will be measured against the 6,677 tonnes 2015 'base year' value, but reference will also be made to reductions from the BAU value in 2030 of 6,713 t CO2eq.

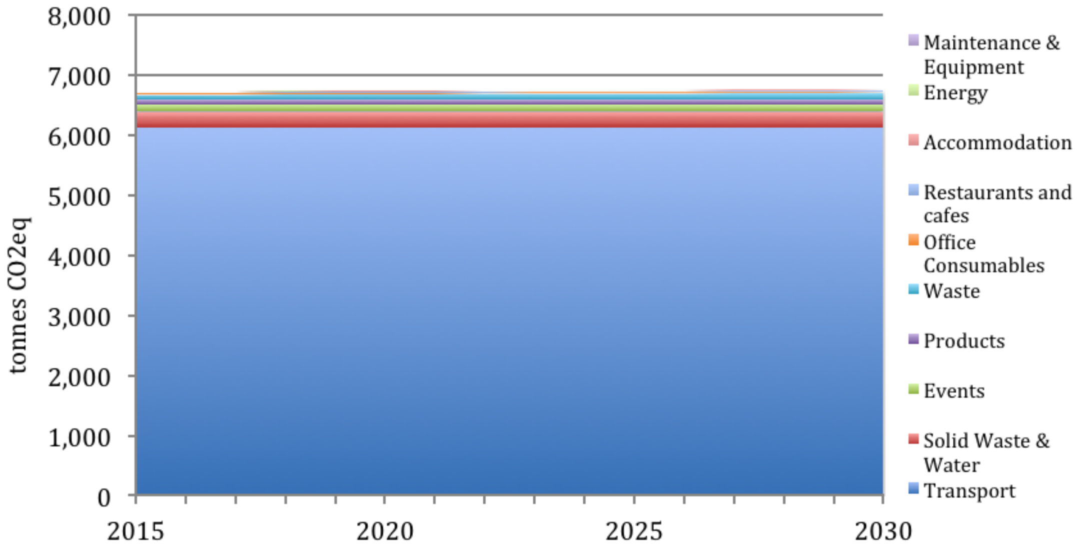

Figure 4; The BAU GHG emissions forecast

Section III: Emissions Reduction Strategies

This section presents the Emissions Reduction Strategies (ERS's) available to HI, which are discussed and compared based on the reduction in annual GHG emissions in 2030. See Table 9 for a direct comparison of annual GHG reductions by 2030 and see Figure 5 for the GHG emissions profiles for each scenario over the period 2016 to 2030.

The Low adoption scenario presents only the simple, low cost or free and easy to implement policies available to HI, with low to moderate adoption rates modelled for policies that involve behavioural change (e.g., commuting modes, waste separation). The Moderate and High scenarios represent increasing policy investment, focus and an overall deployment of more policy measures and progressively larger increase in adoption rates. Finally, the Best Case scenario involves the deployment of all policies, with high adoption rates for all sectors. This Best Case scenario may be unlikely to be achieved, but it sets somewhat of a practical upper limit for the years 2016 to 2030, in order to guide policy-making decisions. There are minimal policy options presented for the very poorly reported sectors, and no policies presented for the unreported sectors in 2015, namely construction, fugitive emissions and postage and freight.

Table 9: GHG reduction percentages in 2030, measured against the BAU scenario

Scenario	Overall Reduction
Low	8%
Moderate	33%
High	46%
Best Case	96%

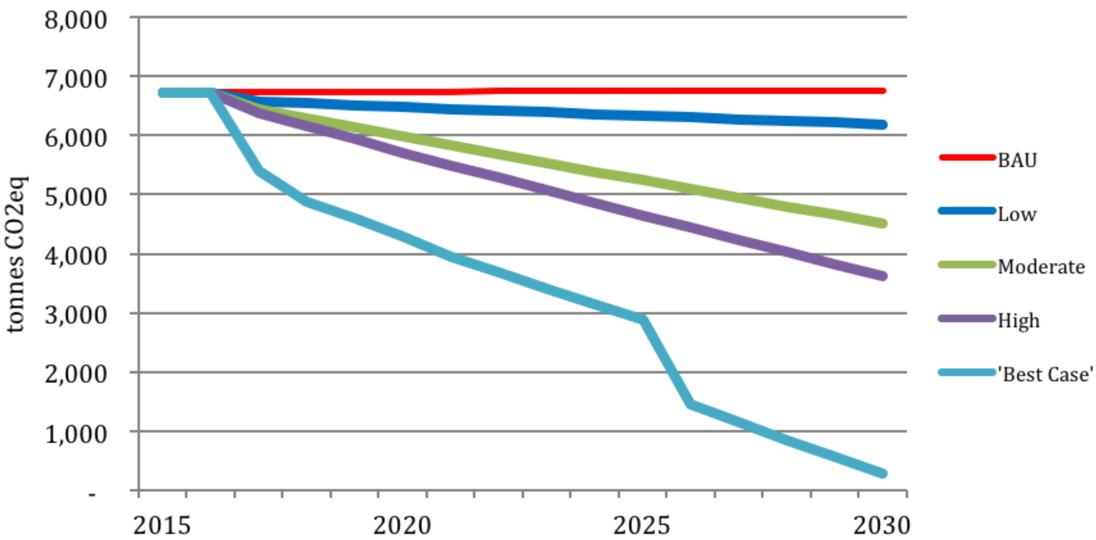

Figure 5: Comparison of the ERS and BAU scenario

The discussed ERS are forecasts of the GHG reductions that are predicted to occur in response to the policy options recommended. Like all forecasts, these reductions are based entirely on a series of assumptions. These assumptions are detailed in Table 10 and are discussed in detail within each ERS. To be clear, reduction rates shown in Table 10 are GHG reduction percentages measure against the BAU 2030 inventory emissions, whereas the assumed percentage reductions for each sector listed in Table 10 are reductions against the inventory base year (2015). Given the very low growth BAU forecast, these figures are almost the same (0.5% increase) but in future this distinction will become increasingly important.

Table 10: List of assumed reduction rates for ERS modelling, in the year 2030, compared to the base year

Modal Shares in 2030 - Commuting	BAU	Low	Mod	High	Best Case
Cycle	15%	17%	23%	26%	30%
Walk	27%	28%	30%	32%	34%
Bus	14%	14%	20%	25%	31%
Carpool	12%	12%	15%	4%	0%
EV	0.6%	1%	2%	4%	5%
Drive	31%	28%	10%	9%	0%
Waste volume and separation rates in 2030, against 2015 levels					
Total solid waste generated	148%	100%	90%	70%	70%
Recycling rate	29%	35%	50%	60%	65%
Compost rate	11%	13%	15%	18%	20%
Landfill rate	55%	45%	28%	15%	8%
Chemical waste	5%	7%	7%	7%	7%
GHG reductions in 2030 against 2015 inventory levels					
Domestic flights	100%	100%	98%	95%	0%
International flights	100%	100%	98%	95%	0%
Bus hire	100%	97%	90%	60%	10%
Taxis and rental cars	100%	90%	75%	50%	30%
University owned vehicles	100%	90%	55%	0%	0%
Private vehicles - HI paid fuel	100%	100%	70%	3%	3%
Events	100%	100%	90%	80%	20%
Waste water	100%	80%	80%	50%	50%
Energy	100%	100%	102%	105%	108%
Products	100%	100%	98%	98%	98%
Office consumables - office paper	100%	67%	60%	0%	0%
Office consumables - non-paper	100%	100%	90%	70%	50%
Local food share	30%	30%	40%	50%	75%
GHG from local food sourcing	100%	100%	85%	65%	0%
Accommodation - Operations	100%	100%	100%	100%	100%
Accommodation - Vehicle use	100%	100%	100%	0%	0%
Maintenance and equipment	100%	100%	0%	0%	0%

Low Emissions Reduction Scenario

This scenario represents the minimum effort and investment in ERS that HI can implement to decrease emissions below the BAU forecast of 6,713 t CO2eq in 2030. These policy options are simple to implement and are typically low cost or free, but have only minimal impact on overall GHG emissions. However, some policies here are the 'low hanging fruit' options, which offer emissions reductions for both minimal effort and minimal investment. These policies should of course be enacted immediately where possible.

The major policies simulated here are the installation of some basic cycling infrastructure and adoption of cycle awareness programs, installation of waste separation bins across all campuses and locations, switching to recycled office paper, centralising the taxi, rental car and bus hire system with a 'green' supplier and priority parking on campus for electric vehicles (EV's).

In this low case scenario, an overall emissions reduction of 8% on 2015 levels is achieved with this strategy. These gains are made mostly through the partial adoption of strategies that support cycling and the reduction of waste sent to the landfill. The authors would **recommend** that the policies included here in the Low Adoption Scenario be viewed as the minimum level of action required to make progress towards reducing GHG emissions at HI.

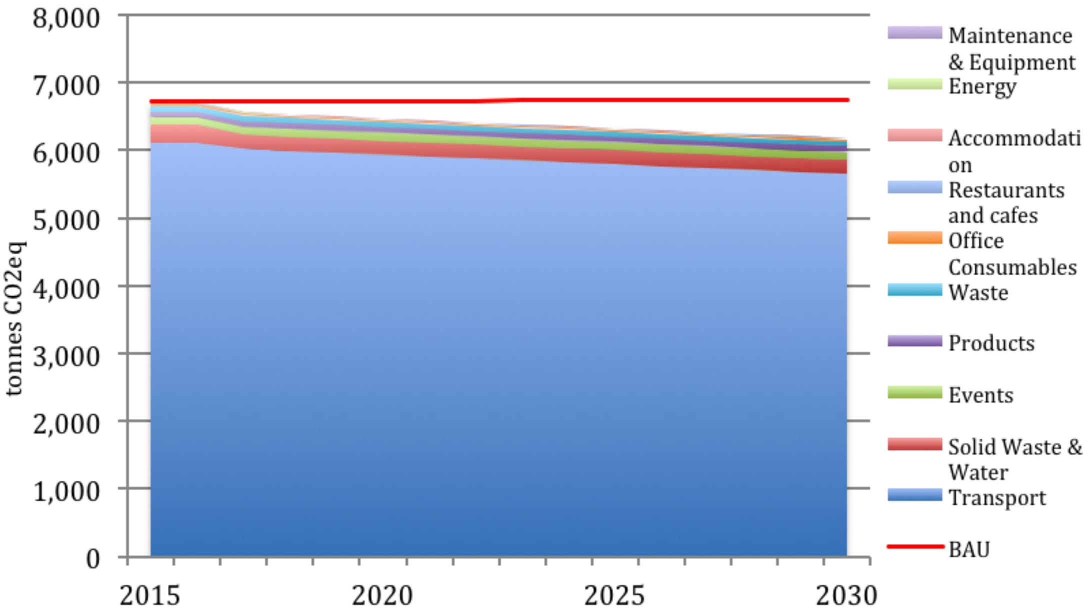

Figure 6: Low Reduction Strategy GHG emission forecast to 2030

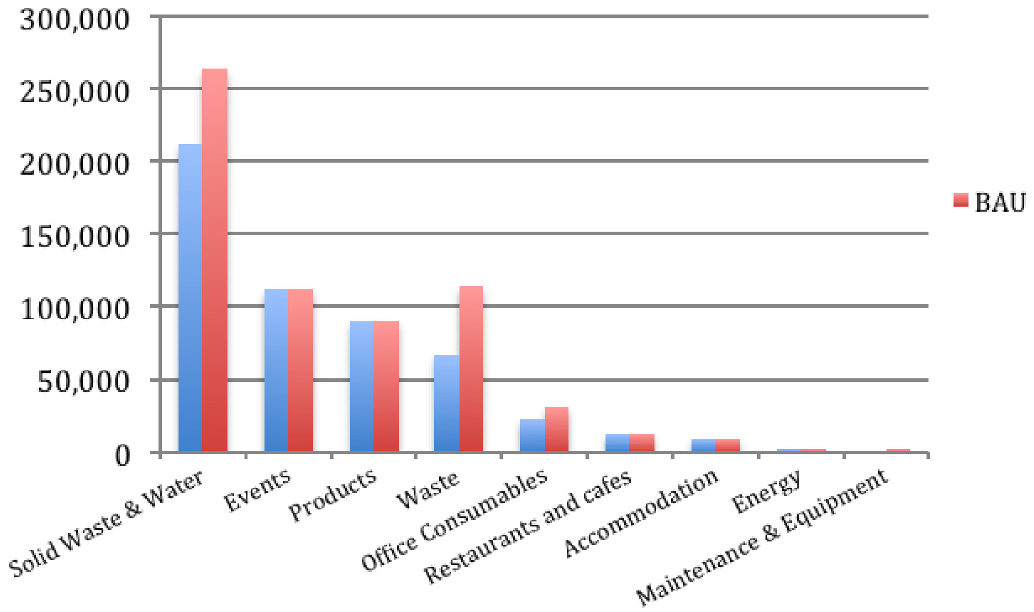

Figure 7: Change in the smaller sectors relative to BAU in the Low ERS

Table 11: Sector and overall GHG reductions in the Low ERS, measured against the BAU scenario

	BAU	Low ERS	Sector 'Reduction	Overall Reduction
Transport	6,097,797	5,634,671	8%	7%
Solid Waste & Water	264,069	211,255	20%	1%
Events	92,654	92,654	0%	0.0%
Products	89,870	89,870	0%	0.00%
Waste	113,755	66,792	41%	1%
Office Consumables	31,215	22,373	28%	0.1%
Restaurants and cafes	11,844	11,844	0%	0.0%
Accommodation	9,292	9,236	1%	0.0%
Energy	1,691	1,691	0%	0.000%
Maintenance & Equipment	1,283	1,283	0%	0.00%
TOTAL	**6,676,779**	**6,141,667**		**8%**

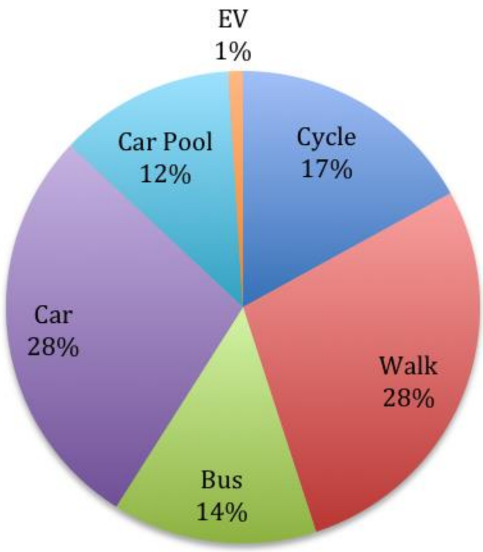

Figure 8: Modal share of all commuter trips in 2030 in the Low ERS

Summary of Policies: Low ERS

Transport		
Sector	**Policy / Action**	**Reduction**
International and national flights	None	None
University owned vehicles	By 2030 1 vehicle is replaced with an EV, others are lower emissions in line with EU regulations	10% subsector reduction, slight overall reduction
Privately owned vehicles - university paid fuel	None	None
Commuting	Shower access and a small amount of secure cycling parking infrastructure installed	28% of commuters walk, up 1% from the BAU, including 75% of people within 2km 17% of commuters cycle, up 2% from the BAU due to City of Reykjavik's infrastructure focus. Poor end of trip facilities and information at HI still prevent large cycle adoption 14% of commuters use the bus, no change from the base year High overall reduction
	Snow clearing on campus is effective and efficient.	
	EV use increases to 1% from 0.6% in the base year.	
	Basic walking and cycling education and promotion programs are implemented.	
	Priority parking spaces are provided for EVs.	
National Bus, Taxi, Rental Car use	Rental, Taxi and Bus hire are centralised, well reported and low carbon options are preferred	GHG reductions: 3% bus, 10% taxi and rental. Moderate overall reduction
Maintenance & Equipment		
All sub-sectors	None	None
Energy		
All sub-sectors	None	None

<table>
<tr><th colspan="3">Waste</th></tr>
<tr><td>Waste landfilled</td><td rowspan="3">Provide waste sorting bins across all areas of campus</td><td>Waste landfilled falls to from55% to 45%</td></tr>
<tr><td>Waste recycled plastic, paper and metals</td><td>Recycling rate increases from29% to 35%</td></tr>
<tr><td>Waste composted</td><td>Composting rate increases 11% to 13%</td></tr>
<tr><td>Chemical Waste</td><td>None</td><td>None</td></tr>
<tr><td>Industrial Waste</td><td>None</td><td>None</td></tr>
<tr><th colspan="3">Restaurants & cafes</th></tr>
<tr><td>All sub-sectors</td><td>None</td><td>None</td></tr>
<tr><th colspan="3">Solid Waste & Water</th></tr>
<tr><td>All sub-sectors</td><td>Correct EFs for Icelandic specific case</td><td>20% reduction on base year estimated</td></tr>
<tr><th colspan="3">Accommodation</th></tr>
<tr><td>All sub-sectors</td><td>None</td><td>None</td></tr>
<tr><th colspan="3">Events</th></tr>
<tr><td>Food</td><td>None</td><td>None</td></tr>
<tr><td>Energy use</td><td>None</td><td>None</td></tr>
<tr><td rowspan="2">Product Use and Waste</td><td>Electronic dissemination of data at events
Limit physical handouts</td><td rowspan="2">Slight reduction (2% of subsector)</td></tr>
<tr><td>Limits are placed on the use of disposable catering materials</td></tr>
<tr><th colspan="3">Products</th></tr>
<tr><td>All sub-sectors</td><td>None</td><td>None</td></tr>
<tr><th colspan="3">Office Consumables</th></tr>
<tr><td>Products purchased</td><td>None</td><td>None</td></tr>
<tr><td>Paper use</td><td>Switch to 100% recycled, certified office paper across all campuses in 2017</td><td>Slight overall reduction, 33% subsector reduction</td></tr>
</table>

Moderate Emissions Reduction Scenario

This scenario represents adoption of all 'low hanging fruit' policy options included in the low adoption scenario, plus increased investment and focus on GHG mitigation. More policies are deployed and adoption rates for active transport and waste segregation increase substantially.

The key policies in this scenario are the introduction of paid vehicle parking on campus from 2017, a large increase in cycling facilities on campus, installation of a small number of EV charging stations, and widespread awareness and information campaigns for active transport modes. Solid waste (bins) information is improved and the overall volume of waste is reduced through bans on disposable packaging, a focus on local, packaging free foods and a paperless office approach. Tele-conferencing and online learning helps to reduce the demand for flights and total commuting travel very slightly, and stricter limits are imposed for low carbon travel in the bus, rental car, taxi, and reimbursed private travel subsectors.

The Moderate ERS reduces emissions by 33% against BAU.

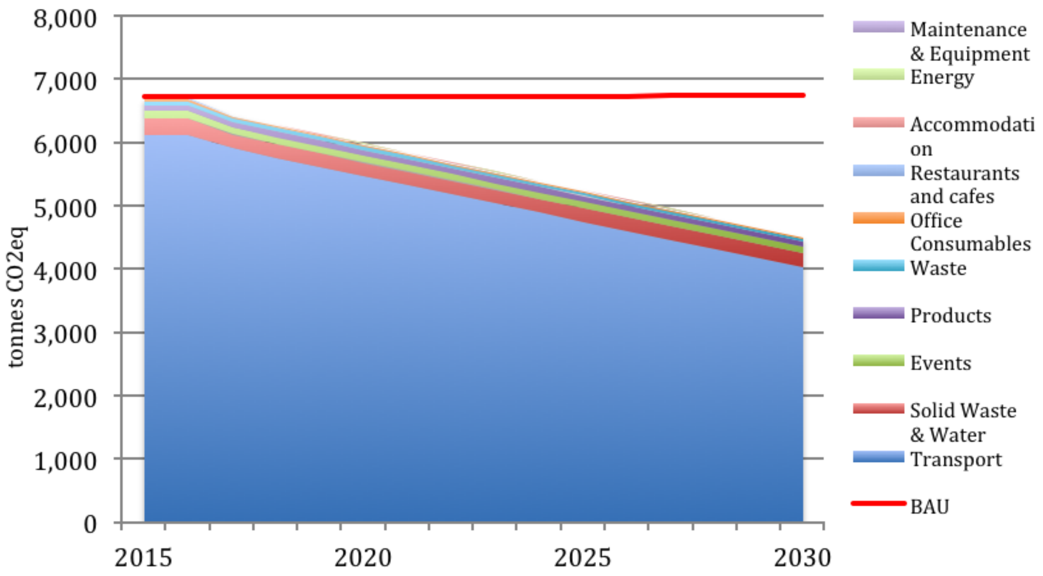

Figure 9: Moderate ERS GHG emission forecast to 2030

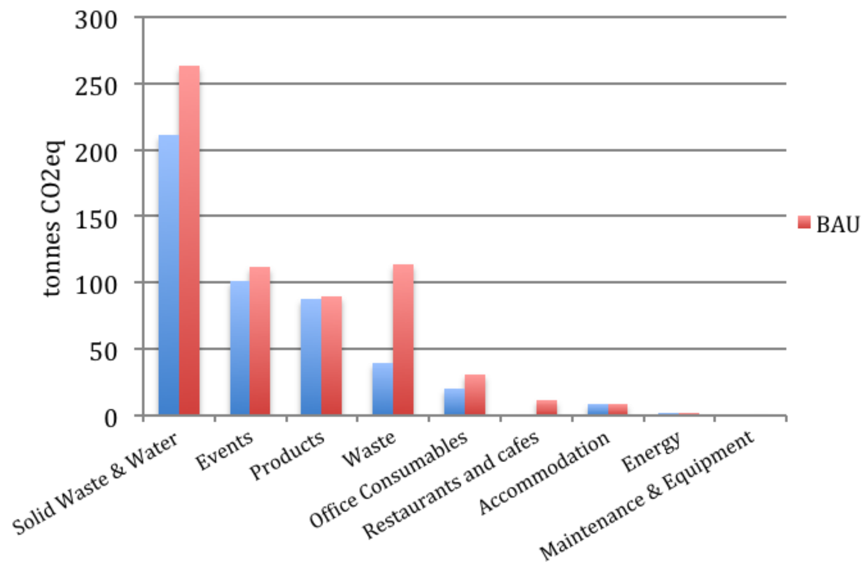

Figure 10: Change in the smaller sectors relative to BAU in the Moderate ERS

Table 12: Sector and overall GHG reductions in the Moderate ERS, measured against the BAU scenario

	BAU	Moderate ERS	Sector Reduction	Overall Reduction
Transport	6,097,797	4,021,370	34%	31%
Solid Waste & Water	264,069	211,255	20%	1%
Events	92,654	83,389	10%	0.2%
Products	89,870	88,073	2%	0.03%
Waste	113,755	39,253	65%	1%
Office Consumables	31,215	20,055	36%	0.2%
Restaurants and cafes	11,844	0	100%	0.2%
Accommodation	9,292	9,236	1%	0.0%
Energy	1,691	1,724	-2%	-0.001%
Maintenance & Equipment	1,283	0	100%	0.02%
TOTAL	**6,676,779**	**4,474,356**		**33%**

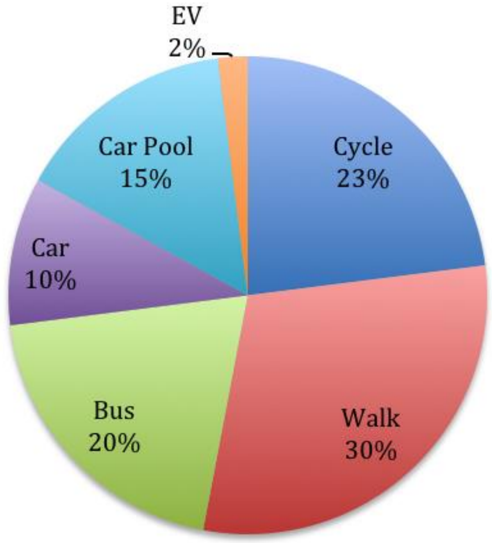

Figure 11: Modal share of all commuter trips in 2030 in the Moderate ERS

Summary of Policies: Moderate ERS

Transport		
Sector	**Policy / Action**	**Reduction**
International and national flights	Domestic and International flight demand decreases, with the uptake of tele-conferencing and alternative travel modes	2% GHG subsector reduction, high overall reduction
University owned vehicles	HI replaces 5of the fleet vehicles with EV's.	45% subsector reduction, moderate overall reduction
Privately owned vehicles - HI paid fuel	Reimburse fuel use on private vehicles only for low emission (defined by European Commission).	30% subsector, high reduction
Commuting	Shower access, small bike rental scheme, improved bike parking facilities, signage, and bike repair stations	30% of commuters walk, up 3% from the BAU, including 75% of people within 2km 23% of commuters cycle, up 8% from the BAU due to HI and the City of Reykjavik's infrastructure focus. Cycling increases 6% above the Low ERS from increased focus on cycling policies. 20% of commuters use the bus, up 6% from the BAU EV use increases to 2% from 0.6% in the BAU. Transport emissions related to events are reduced to 0 by 2020, using the low carbon transport modes High overall reductions
	Snow clearing on campus is effective and efficient.	
	Walking and cycling education and promotion programs are well implemented and widespread	
	Small number of electric vehicle charging stations installed	
	Priority parking spaces are provided for EVs.	
	Parking fees for non-EV vehicles. Other very low emissions vehicles can apply for free parking permit.	
	Improved connectivity with Reykjavik city bike and walking path networks. Priority for pedestrians and cyclists on and around campus	
	Increased use of video-conferencing and online course material decreases demand for HI travel	Total trips decrease 2% by 2030. High overall reductions
National Bus, Taxi, Rental Car use	Rental, Taxi and Bus hire centralised, well reported and stricter low carbon options are used, compared with the low ERS	Moderate overall reduction
Note: Increased EV use raises in emissions related to charging stations. It is assumed that the electricity usage goes up each year with adoption of EV supportive policies on campus. This scenario models a 2% increase in GHG from the energy sector, which has a very small impact overall.		
Maintenance & Equipment		
Grounds equipment	Replace maintenance equipment with electric powered items by 2020	100% reduction in sector by 2020, slight overall reduction
Energy		
All sub-sectors	None	None
Waste		
Waste landfilled	Waste sorting and deposit stations everywhere on campus Improve signage and education targeting better waste management through sorting and reduction	Waste landfilled falls to 28%
Waste recycled plastic, paper and metals		Recycling rate increases to 50%

Waste composted	of landfill waste Slight reductions in waste produced helps with recycling, composting and overall emissions reductions	Composting rate increases to 15% Moderate overall reductions
Chemical Waste	None	None
Industrial Waste	None	None
Restaurants & cafes		
Waste landfilled, composted and recycled	Elimination of disposables in cafes and catering, reduction in waste generated on campus, primarily through minimising packaged food goods sold on campus and a ban on carry bags with product sales	None, not reported so not modelled
Gas/fuel cooking	None	None
Disposable dishes and products	Disposable cutlery and cups are replaced in 2018 by conventional kitchenware and reused Elimination of disposables of carry bags	100% reduction in sector, slight overall reduction
Food Sold	Prioritise local food sources, resulting in reduction in packaging waste created	None, not reported so not modelled
Solid Waste & Water		
All sub-sectors	Correct EFs for Icelandic specific case	20% reduction on base year estimated
Accommodation		
All sub-sectors	All sub-sectors	None
Events		
Food	Event related emissions decrease as preference is given to local food, zero disposable plastic is used, and low carbon transport modes where possible.	Slight reduction
Energy use & Transport	Foreign participants at events are incentivised to join via video-conference, and for those that come to Iceland accommodation is arranged walking distance from Campus.	Slight reduction
Product Use and Waste	Electronic dissemination of data at events Limit physical handouts Zero disposable plastic is used	Slight reduction, combined effect of all sector policies modelled as 10% reduction in sector GHG emissions
Products		
Bookstore product sales	End use of disposable carry bags and wrapping in bookshop to minimise waste and embodied CO2	2% sector reduction, slight overall reduction
Office Consumables		
Products purchased	Slow adoption of paperless office policies	10% subsector reduction, slight overall reduction
Paper use	Switch to carbon neutral office paper across all campuses in 2017	33% sub-sector reduction, slight overall reduction

High Emissions Reduction Scenario

This scenario represents adoption of all policies in the moderate adoption scenario, with increased investment and focus resulting in higher adoption rates. There are also a small number of new policies added in this scenario. The major new policies include subsidised semester and year-long bus passes, strong adoption of the cross-cutting tele-conferencing, online learning and paperless office policies, completion of an attractive network of active transport facilities on campus with no weak links, increased bus use from discussions with Strætó regarding route, fare and infrastructure feedback, carbon neutral office paper and a comprehensive shift to EV on campus, including the HI fleet, hired services and priority parking and access.

Moderate cross-cutting emissions reductions are made in this scenario via the development contract riders for all businesses on campus (including FS) by 2020, in order to hold them accountable to sustainability policies of HI. This will affect the products, cafés and accommodation, solid waste, wastewater and water use, fugitive emissions and transport sectors, having far reaching GHG mitigation reductions. It will also provide a method in which to guarantee effective reporting from third-party organisations operating on university campuses.

The High ERS reduces emissions by 46% in 2030, measured against the BAU scenario.

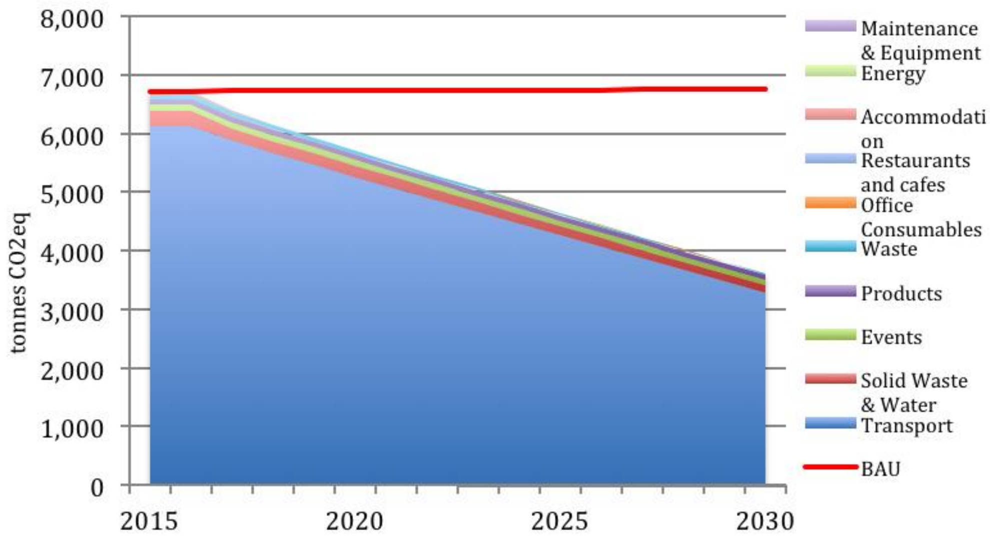

Figure 12: High ERS GHG emission forecast to 2030

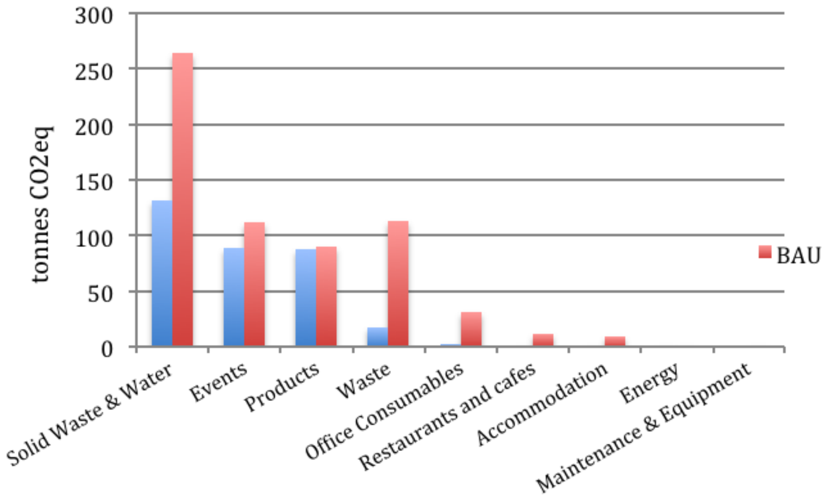

Figure 13: Change in the smaller sectors relative to BAU in the High ERS

Table 13: Sector and overall GHG reductions in the High ERS, measured against the BAU scenario

	BAU	High ERS	Sector Reduction	Overall Reduction
Transport	6,097,797	3,270,958	46%	42%
Solid Waste & Water	264,069	132,034	50%	2%
Events	92,654	74,123	20%	0.3%
Products	89,870	88,073	2%	0.03%
Waste	113,755	17,288	85%	1%
Office Consumables	31,215	3,094	90%	0.4%
Restaurants and cafes	11,844	0	100%	0.2%
Accommodation	9,292	704	92%	0.1%
Energy	1,691	1,775	-5%	-0.001%
Maintenance & Equipment	1,283	0	100%	0.02%
TOTAL	**6,676,779**	**3,588,049**		**46%**

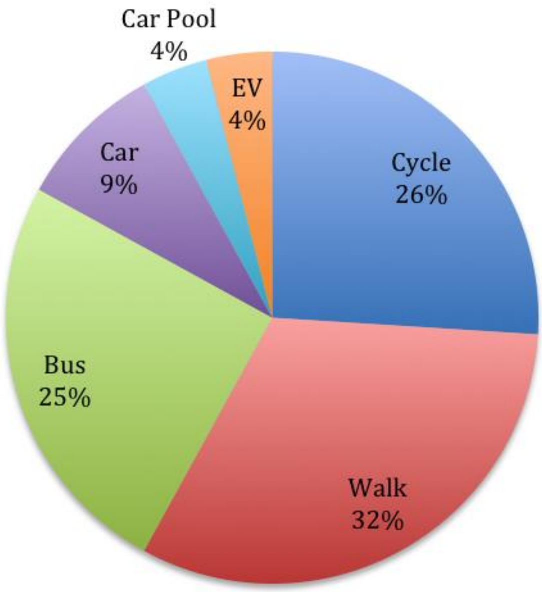

Figure 14: Modal share of all commuter trips in 2030 in the High ERS

Summary of Policies: High ERS

Transport		
Sector	**Policy / Action**	**Reduction**
International and national flights	International and domestic flight demand is reduced by 5%	High reduction
University owned vehicles	The university vehicle fleet are replaced by 2030	High reduction
Privately owned vehicles where University paid fuel	In 2025 HI stops paying for fuel on non-EV private vehicles (or similar, e.g., methane from waste, range extended EV). The period 2020 to 2025 is voluntary transition period and switching is encouraged.	97% subsector reduction, high overall reduction
Commuting	Shower access, bike rentals, improved bike parking facilities, signage, and bike repair stations Snow clearing on campus is effective and efficient. Walking and cycling education and promotion programs are implemented. Large cycle rental scheme, both short and long term, potentially in partnership with the City or Reykjavik Priority parking spaces are provided for EVs. Reduction in number of non-EV parking spaces Parking fees for non-EV / low-carbon vehicles. Many electric vehicle charging stations installed	32% of commuters walk, up 5% from the BAU, including 87% of people within 2km 26% of commuters cycle, up 11% from the base year, and up 3% from the Moderate ERS, primarily from network connectivity, crossing point upgrades and signage 25% of commuters use the bus, up 11% from the base year and 3% from the Moderate ERS, due to the

	Improved connectivity with Reykjavik city bike and walking path networks. Full signage coverage with distance and time by active transport modes. All intersections and crossing points on campus or at fringes prioritise active transport, creating inconvenience for vehicles a sense of belonging for cyclists and walkers	introduction of ticket subsidies EV use increases to 4% from 0.6% in the BAU. Transport emissions related to events are reduced to 0 by 2020, using the low carbon transport modes Combined impact of commuting policies is a very high reduction
	FS vehicle used for accommodation maintenance is replaced by EV in 2020	
	Promote tele-conferencing and online learning	Total trips decrease by 10%, very high overall reduction
National Bus, Taxi, Rental Car use	Rental, taxi and bus hire centralised, well reported and low carbon options are utilised on corporate plan. Hybrids are used initially, with more EV's being used from 2020. 75% of trips are using EV's in 2030. Buses take the longest to change, with EV's making up more trips from 2020 to 2030	Bus: 40% sector reduction Taxi and rental: 50% sector reduction High overall reduction
Note: Increased EV use raises in emissions related to charging stations. It is assumed that the electricity usage goes up each year with adoption of EV supportive policies on campus. This scenario models a 5% increase in GHG from the energy sector, which has a very small impact overall.		
Maintenance & Equipment		
Grounds equipment	Replace maintenance equipment with electric powered items by 2020	100% reduction in sector by 2020, slight overall reduction
Energy		
All sub-sectors	None	None
Waste		
Waste landfilled	Full coverage across campus of waste sorting stations Improve signage and education targeting better waste management through sorting and reduction of landfill waste This is also made possible by increase in local vegetable produce sold, reducing the amount of packaged food sold on campus, as well as a campus wide education program and office based recycling competition. Leftover food is made available to students and an arrangement is made with a local pig farm for any surplus. Finally vegetable off-cuts are composted. This creates a cascading use of food resources HI, similar to the way Iceland uses heat.	Waste landfilled falls to 15%, down from 55% in the base year
Waste recycled plastic, paper and metals		Recycling rate increases to 60%
Waste composted		Composting rate increases to 18%, up 3% from the Moderate ERS Edible food waste goes to 0 by 2020
Chemical Waste	None	None
Industrial Waste	None	None
Restaurants & cafes		

Waste landfilled, composted and recycled	Elimination of disposables in cafes and catering, reduction in waste generated on campus, primarily through minimising packaged food goods sold on campus and a ban on carry bags with product sales Develop contract riders for all businesses on campus (including FS) by 2020, in order to hold them accountable to sustainability policies of HI.	None, not reported so not modelled
Gas/fuel cooking	None	None
Disposable dishes and products	Disposable cutlery and cups are replaced in 2018 by conventional kitchenware and reused Elimination of disposables of carry bags	100% reduction in sector, slight overall reduction
Food Sold	Prioritise local food sources, resulting in reduction in packaging waste created	None, not reported so not modelled
Solid Waste & Water		
Cold water purchased	Low flush toilets Recycled water use (cascading use, e.g. Drinking and basin water used in toilet flushing and garden watering) Discussions with municipality and water authority to ascertain the best strategies for decreasing use and mitigating CO2 emissions from waste processing Install timed faucets and no flow urinals	50% reduction in sector emissions, high overall reduction
Waste water produced	Once waste water is accurately reported in 2016, the University investigates the above options for mitigating water waste production, by limiting water use overall and developing better handling strategies	
Accommodation		
Vehicle Use	FS controlled private vehicle replaced with EV in 2020	100% reduction in sector, slight overall reduction
All other sub-sectors	None	None
Events		
Food	Catering emissions are reduced by engaging a green catering service	Moderate sector reduction
Energy use & Transport	Prioritise low carbon transport modes Foreign participants at events are incentivised to join via video-conference, and for those that come to Iceland accommodation is arranged walking distance from Campus. Consider offering a small EV shuttle service for off campus event attendees.	High sector reduction
Product Use and Waste	Electronic dissemination of data at events Limit physical handouts	Slight reduction Overall, 20% reduction of sector emissions from all policies
	Zero disposable plastic is used	
Products		
Bookstore product sales	End use of disposable carry bags and wrapping in bookshop to minimise waste and embodied CO2	2% sector reduction, slight overall reduction

Office Consumables		
Products purchased	Adopt paperless office policies. GHG emissions from office consumables reduced by 30%, primarily by consuming less unnecessary equipment and by paperless office approach (less pens, staplers, highlighters, etc.)	Slight overall reduction
Paper use	Switch to carbon neutral office paper across all campuses in 2017 Move towards a paperless campus, with 70% reduction in paper use by 2030.	100% sub-sector reduction, slight overall reduction

Best Case Emissions Reduction Scenario

This scenario represents adoption of all reasonable policy options available and the maximum reductions thought to be physically possible in all sectors. It also demonstrates a pathway to carbon neutrality for the University of Iceland. It is very unlikely that this scenario would occur, rather it is included to show the level of mitigation that is possible over a long time frame – perhaps out to 2050 or 2060, with commitment, planning and funding from all sectors of HI. It is included to promote 'blue sky' thinking and to not limit policy makers who wish to be aggressive in combating climate change.

An overall emissions reduction of 96% on 2015 levels is achieved with this strategy, including a 100% reduction in the major emissions sector of transportation. Energy emissions are projected to increase as electricity use increases with the adoption of electric vehicles, but the impact of the increase on GHG emission is very small. The scenario assumes the City of Reykjavík replaces the Strætó bus fleet with electric buses in 2025. Without the City modifying the bus system, the maximum emissions reduction possible is 75% by 2030, including a 69% reduction in transport emissions, with all other policy measures unchanged.

The other key policies, on top of the High ERS, are higher adoption rates on most policies including a 10% reduction in commuter and airline travel demand, very strong adoption of active transport from a flawlessly walking and cycling campus environment, increased commuter bus use and a reduction in car parking space on campus – with the space being replaced with on-site food production facilities and eateries.

The remaining 263 tons CO2eq emissions could be offset for roughly 500,000 ISK with Kolviður (retail prices), making the University of Iceland a carbon neutral university by 2030 in this scenario.

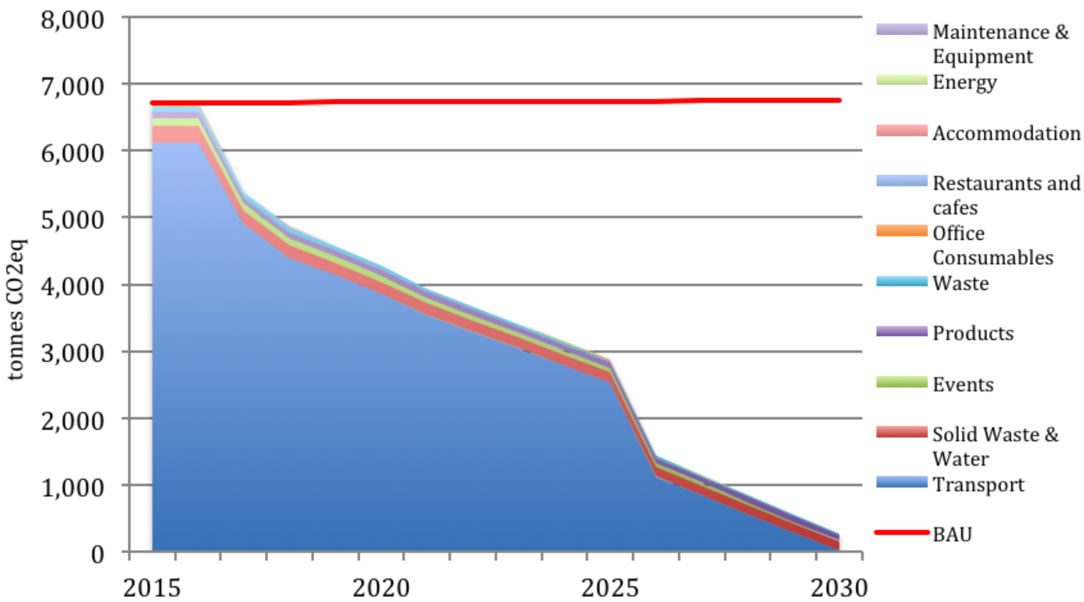

Figure 15: Best Case ERS GHG emission forecast to 2030

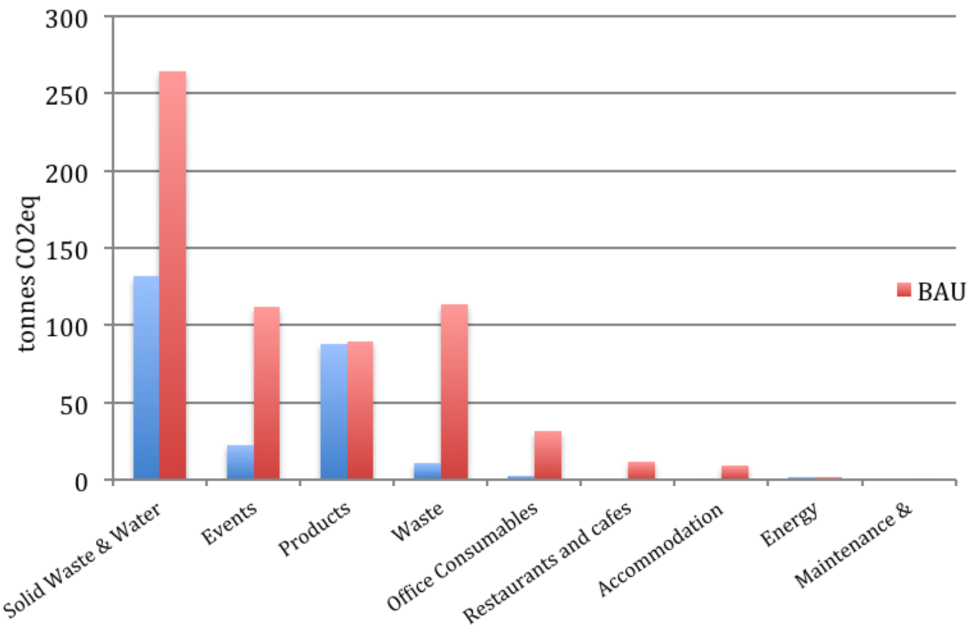

Figure 16: Change in the smaller sectors relative to BAU in the Best Case ERS

Table 14: Sector and overall GHG reductions in the Best Case ERS, measured against the BAU scenario

	BAU	Best Case	Sector Reduction	Overall Reduction
Transport	6,097,797	8,830	100%	90%
Solid Waste & Water	264,069	132,034	50%	2%
Events	92,654	18,531	80%	1.3%
Products	89,870	88,073	2%	0.03%
Waste	113,755	10,641	91%	2%
Office Consumables	31,215	2,210	93%	0.4%
Restaurants and cafes	11,844	0	100%	0.2%
Accommodation	9,292	704	92%	0.1%
Energy	1,691	1,826	-8%	-0.002%
Maintenance & Equipment	1,283	0	100%	0.02%
TOTAL	**6,676,779**	**262,848**		**96%**

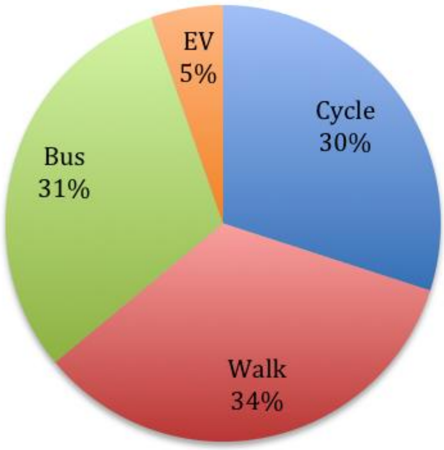

Figure 17: Modal share of all commuter trips in 2030 in the Best Case ERS

Summary of Policies: Best Case ERS

Transport		
Sector	**Policy / Action**	**Reduction**
International and national flights	International flights are offset from 2017 Domestic flights are reduced by 20%, and the remainder are offset from 2020	Very high overall reduction, 100% subsector reduction
University owned vehicles	All vehicles replaced with EV's	High reduction
Privately owned vehicles where University paid fuel	In 2025 HI stops paying for fuel on non-EV private vehicles (or similar, e.g., methane from waste, range extended EV). The period 2020 to 2025 is voluntary transition period and switching is encouraged.	97% subsector reduction, high overall reduction
Commuting	All active transport policies adopted Shower access, bike rentals, improved bike parking facilities, signage, and bike repair stations, bike rental	100% of people with 2km walk 90% of people within 7km cycle, unless they live within 2km and walk 10% of people in 7 to 10km distance bracket cycle EV use increases to 5% from 0.6% in the base year Hydrocarbon fueled vehicle use for commuting is reduced to 0 100% sub-sector reduction,
	Snow clearing on campus is effective and efficient.	
	Walking and cycling education and promotion programs are implemented.	
	Electric vehicle charging stations installed	
	Priority parking spaces are provided for EVs. Limited parking for non-EV vehicles driven by visitors, and only short term availability	

	On campus parking fees introduced in 2018. Very, very steep fees for non-EV	Very, very high overall reduction
	Flawless connectivity with Reykjavik city bike and walking path networks.	
	Widespread adoption of tele-conferencing and online learning	Total trips decrease by 10%
National Bus, Taxi, Rental Car use	Rental, taxi and bus hire centralised, well reported and low carbon options are utilised on corporate plan. Hybrids are used initially, moving to EV's towards 2030. Most trips are by EV by 2025.	Bus: 90% sector reduction Taxi and rental: 30% sector reduction High overall reduction
Note: Increased EV use raises in emissions related to charging stations. It is assumed that the electricity usage goes up each year with adoption of EV supportive policies on campus. This scenario models a 5% increase in GHG from the energy sector, which has a very small impact overall. The City of Reykjavik replaces the Strætó bus fleet with electric buses in 2025, reducing tailpipe emissions to zero.		
Maintenance & Equipment		
Grounds equipment	Replace maintenance equipment with electric powered items by 2020	100% reduction in sector by 2020, slight overall reduction
Energy		
All sub-sectors	None	None
Waste		
Waste landfilled	No additional policies to High ERS, but slightly higher adoption rates. Full coverage across campus of waste sorting stations Improve signage and education targeting better waste management through sorting and reduction of landfill waste This is also made possible by increase in local vegetable produce sold, reducing the amount of packaged food sold on campus, as well as a campus wide education program and office based recycling competition. Leftover food is made available to students and an arrangement is made with a local pig farm for any surplus. Finally vegetable off-cuts are composted. This creates a cascading use of food resources HI, similar to the way Iceland uses heat.	Overall waste volume unchanged from High ERS, with 30% reduction on base year Waste landfilled falls to 8%, down from 15% in the High ERS
Waste recycled plastic, paper and metals		Recycling rate increases to 65%, up from High ERS by 5%
Waste composted		Composting rate increases to 20%, up 2% from the Moderate ERS Edible food waste goes to 0 by 2020
Chemical Waste	None	None
Industrial Waste	None	None
Restaurants & cafes		

Waste landfilled, composted and recycled	Elimination of disposables in cafes and catering, reduction in waste generated on campus, primarily through minimising packaged food goods sold on campus and a ban on carry bags with product sales Develop contract riders for all businesses on campus (including FS) by 2020, in order to hold them accountable to sustainability policies of HI.	None, not reported so not modelled
Gas/fuel cooking	None	None
Disposable dishes and products	Disposable cutlery and cups are replaced in 2018 by conventional kitchenware and reused Elimination of disposables of carry bags	100% reduction in sector, slight overall reduction
Food Sold	Prioritise local food sources, resulting in reduction in packaging waste created	None, not reported so not modelled
Solid Waste & Water		
Cold water purchased	Same as High ERS Low flush toilets Recycled water use (cascading use, e.g. Drinking and basin water used in toilet flushing and garden watering) Discussions with municipality and water authority to ascertain the best strategies for decreasing use and mitigating CO2 emissions from waste processing Install timed faucets and no flow urinals	50% reduction in sector emissions, high overall reduction
Waste water produced	Once waste water is accurately reported in 2016, the University investigates the above options for mitigating water waste production, by limiting water use overall and developing better handling strategies	
Accommodation		
All sub-sectors	None	None
Events		
Food	Catering emissions are reduced to 0 by 2020 through the hire of carbon neutral food catering services	100% sub-sector reduction, slight overall reduction
Energy use & Transport	Prioritise EV's, with stricter focus than in High ERS Foreign participants at events are incentivised to join via video-conference, and for those that come to Iceland accommodation is arranged walking distance from Campus. Flights are offset. Consider offering a small EV shuttle service for off campus event attendees.	High sub-sector reduction, slight overall reduction

Product Use and Waste	Electronic dissemination of data at events Limit physical handouts	High subsector reduction, slight overall reduction Combined policies modelled as an 80% sector reduction against base year
	Zero disposable plastic is used	
Products		
Bookstore product sales	No change from High ERS End use of disposable carry bags and wrapping in bookshop to minimise waste and embodied CO2	2% sector reduction, slight overall reduction
Office Consumables		
Products purchased	Adopt paperless office policies. GHG emissions from office consumables reduced by 50%, primarily by consuming less unnecessary equipment and by paperless office approach (less pens, staplers, highlighters, etc.)	Slight overall reduction
Paper use	Switch to carbon neutral office paper across all campuses in 2017 Move towards a paperless campus, with 70% reduction in paper use by 2030.	100% sub-sector reduction, slight overall reduction

Section IV: Policy Options

This section details all the available emissions reduction policies identified as effective and appropriate to HI. Policies are presented by sector, and estimated implementation costs and their reduction potentials, relative to overall emissions, are given. It should be made clear that the cost estimates are very rough estimates, often for the general European situation only, and appropriate local contractors will be required for accurate implementation costs.

Transport

The transport sector is the largest component HI's GHG emissions inventory and as such presents the biggest opportunity for emissions reductions. In order to reduce emissions the following transport related goals are defined.

1. Increase the number of commuters cycling to University
2. Increase the number of commuters walking to University
3. Increase the use of Bus transport for University commuters who currently drive or carpool and for whom active modes of travel aren't an option
4. Reduce the frequency of flights taken where possible, and where flights are the only option consider carbon offsetting
5. Increase the number of car and car pool drivers that commute using electric vehicles
6. Accurately report on hired Bus, Taxi and Rental Car trips, and increase the proportion of electric and low emissions vehicles used in this category

The recommended policy options are discussed in detail here, including brief cost estimates. See Section III for which policies are included in each ERS. It should be noted that this sector produces almost all of the GHG emissions in the 2015 inventory, and as such the successful uptake of these policies is critical to achieving emissions reductions at HI. Many cities, universities and businesses around the world have tried and failed to attract large active transport transitions for a number reasons, but arguably the largest is the sheer convenience of the motor car. In order to provide an environment where HI commuters find it more convenient to commute by active transport modes or by bus, a range of policies need to be enacted simultaneously, as individually these policies will almost certainly not achieve the adoption rates desired. Some strategies will increase the convenience of active transport or bus commuting, some decrease the convenience (or the cost) of car commuting, and some do a little of both. The authors of this report would be happy to advise on a low carbon transport strategy in the future if required.

Goal #1: Increase the number of commuters cycling to HI

The University has strong potential for cycle commuting. 77% of the University population live within cycling distance and up to 20% of trips are already made by bicycle. Key to increasing the number of cycle commuters is understanding the mobility options of the University population. The current choices are to commute by car, car-pooling, bus, bike or walking. For the majority of residents cycling is an option. Bannister (2013) outlines convenience as the key factor when encouraging switching to active transport modes, meaning that the option to cycle must be made more convenient than the option to drive before commuters will make the change. With convenience in mind, and related work on promoting mode switching from cars to cycle commuting (See for example - Bonham & Johnson, 2015; Buehler, 2012; de Sousa, Sanches, & Ferreira, 2014; Fernández-Heredia, Monzón, & Jara-Díaz, 2014; Scheepers et al., 2014) the authors recommend the following policy recommendations:

1. Instigate a ‘Cycle Commuter’ program, where students who register with HI can access the gym shower facilities free of charge. Enable locker hire for a nominal fee. The University gym shower facilities are easily large and under-utilised enough to accommodate an increase in patronage. No option for showering on campus was identified as the barrier that stopped people from cycling by feedback responses on the transport survey. This is confirmed by current literature on cycle transport, particularly for commuters.
   Cost to implement: 0, with increased revenues generated from bicycle locker hire
   Emission reduction potential: High

2. Install a bicycle repair station on campuses, to allow commuters to make their own repairs on site. Local bicycle advocacy groups or bicycle shops can advise on the exact design, or standard products are available like the one shown in Figure 18. It is also recommended to explore options for listing local bike shops, for both the option of partial funding and so cycle commuters know where to go in the situation where major bicycle repairs are required. Listing links to information, maps, and apps for cyclists (Such as Hjolaferni á Islandi, 2014; RideTheCity, 2013; Visit Fjardabyggd, 2013) would also be useful to encourage an adoption of cycling culture, and to increase the rate of adoption on campus (current non-cyclists can read the information also).
   Cost to implement: estimated 150,000 ISK
   Emission reduction potential: Medium

Figure 18: A bicycle repair station at McMaster University, Ontario. The right image shows the selection of tools source: Left: ‘Joe’ on Flickr, image has been modified, Right: Wikipedia commons

3. Install secure cycle parking infrastructure on campus. Offering a range of bicycle parking options, ranging from secured, paid storage to short-term bike parking the University already has some of on the main campus. The secure, covered bicycle parking should be located in close proximity to the gymnasium. These facilities can be rented for a small yearly cost, typically between 3000 to 10000 ISK/year. This caters to riders with expensive bicycles, who often cycle larger distances to campus and require shower and change facilities, and are willing to pay to have covered, secure bicycle parking. They must be located within 150m of the gymnasium to be effective, and be accessible without stairs from the road.

   The bulk of cycle parking on campus should cater to medium term stay cyclists (up to 8 hours) and be of any form that allows for a lock to be attached to the frame of the bike

and to the bike parking infrastructure. Ideally, these parking spaces will be undercover, but it is unnecessary to locate them in secure storage. They need to be within 50m of building entry points and well signed if not on normal through ways.
The remaining cycle parking on campus can be simple, front tyre secured racks like those already in use at the HI main campus. These are for short term stays and should always be located in high traffic areas, as they are the most at risk to theft. Feedback from the commuter survey was that this form of bicycle parking alone was not safe enough and deterred commuters from cycling to campus. These short term parking solutions need to be located within 10 meters of entry ways, be accessible within 10 seconds of leaving the cyclable path and have plenty of space surrounding them for quick unlocking. This maximises convenience and increases the chance of cycle commuting being adopted as a mobility choice. Finally, these short term cycling storage options should only make up a small percentage of bicycle storage at the University, in the range of 20-30%.

For medium term cycle parking, an estimate of 20000 ISK per space is reasonable (See Danish Cyclists Federation, 2008), and estimate a required 10 spaces around 5 locations on main HI campus, plus 50 spaces near the University gymnasium. The existing short term parking can remain (no cost) and secure bike parking could be included in one of the disused garage spaces near the gymnasium for minimal cost.

Comprehensive guidance on the appropriate size, type, price, installation procedure, spacing and a range of other urban design principles relating to cycling infrastructure can be found in (Danish Cyclists Federation, 2008; See also - Bonham & Johnson, 2015; SFMTA, 2015).

Cost to implement: estimate 2 million ISK in first year, and then 200,000 ISK every 1-2 years as cycling population grows. Smaller investments would also be worthwhile, focused around the gymnasium and Háskolatorg building. Secure bike parking would provide additional revenue.
Emission reduction potential: High

4. Address the barrier of bicycle access by instituting a semester or yearlong bicycle rental scheme designed to give exchange students, new and rural students, and low income students and staff access to bicycles for commuting. These could be second-hand bicycles, new bicycles or a mix of the two. The university could partner with local bicycle shops for maintenance of the bikes between semesters, or like many Universities have done, look to student cycling clubs to look after maintenance in exchange for access to tools, workshops and clubroom space. The rental scheme could probably charge 5000 ISK per semester for long term rental, with a large refundable deposit payable on registration. This scheme could be actively promoted through orientation week to encourage new cyclists.

   Cost to implement: Depends on the bikes and/or maintenance schedule. Estimate 500,000 ISK to start with 10 bicycles.
   Emission reduction potential: Medium

5. Introduce car parking fees on campus. Fees could be moderate in comparison to central Reykjavik, in the range of 400 to 1200 ISK per day. Given that the current bus ticket price is 800 ISK return, this figure would provide a reasonable starting point. Students and staff living more than 5km from University without bus access can apply for a free parking permit each year, as can students with disabilities, or anyone with just grounds. Bus access could be defined as living more than 1km from a bus stop.

   This fee will do a number of things. It will decrease the convenience of driving a car to University, both in the cost and in the extra work required to pay for a ticket each day. To keep admin costs low, commuters could be required to buy a ticket online through UGLA each day in the same way as students buy printing credit, using their kennitala and vehicle registration number. The database could then be searched in real time on a tablet by a parking inspector, minimising the need for physical parking meter infrastructure (ticket machines, etc.). Visitor parking could be facilitated by credit card through a parallel portal.

This fee would also raise revenues, in order to finance different ERS or other University programs. At 800 ISK per day, with 300 vehicle parking spaces this would raise 240,000 ISK per day. This strategy also encourages car-pooling, where commuters can split the cost of parking. Walking, cycling and bus trips all become much more economically valuable and more convenient with the introduction of parking fees. Leading research from Washington DC (Buehler, 2012) shows that free car parking is associated with 70% smaller odds for bike commuting.

This strategy would require some co-ordination with the city of Reykjavik, such that equally close parking to the University campuses were also no longer free. This shouldn't be a problem, given the City's recent announcement that 25% of all trips in 2017 will be made by bicycle (http://reykjavik.is/frettir/hjolreidaaaetlun-reykjavikur-samthykkt).

Electric vehicles, or vehicles running on methane from landfill would also be eligible for a free parking permit, in order to encourage the uptake of these vehicles.
Cost to implement: None, increased revenues in the range of 6 to 60 million ISK per annum.
Emission reduction potential: Very high

6. Facilitate high efficiency snow clearing on campus, particularly the areas with high pedestrian and cyclist traffic. This was mentioned repeatedly in the transport survey results as a barrier to cycling and walking, as well as a frustration to bus travellers. Consider installing heated water pipes under the main and secondary bus stops on campus. This is another policy that relies somewhat on co-operation with the City of Reykjavik.
   Cost to implement: unknown
   Emission reduction potential: High

7. Install signage for cycling and walking commuters, as well as all University patrons, giving walking and cycling directions to downtown, waterfront and other nearby points of interest. This signage would include destinations distance, as well as time by walking and by bicycle, averaged at 5km and 20km per hour. On the main campus, show directions to nearby bike paths, especially the Hringbraut path that serves the South Eastern suburbs. This serves to direct active commuters, but much more importantly it acts as a signal that cycling to campus is a socially 'normal' practice, actively promotes cycling in the eyes of the whole campus population and also advertises the travel times for cycling and walking – which in the case of the main campus are competitive compared to most other transport modes within Reykjavik.
   Cost to implement: estimate 300,000 ISK
   Emission reduction potential: Low

8. Initiate more online video and audio lectures by University staff, which students can download from UGLA as part of their course package. This is common place amongst Universities around the world and has far reaching consequences, some of which are relevant to transport. Students will commute less to University if material is available online, attending only practical and tutorial classes. This is particularly relevant for post-graduate and later year undergraduate classes, as these students traditionally have less contact hours, and would be more likely to only have 1 class in a day – which would then allow students to work from home once per week. The effect of adopting this policy university wide has been modelled as a 10% reduction in total trips made, meaning a

student would attend 2 day less per month (20 days). This is an estimate only, and further analysis would be required of student course structures to accurately predict this reduction into the future.

Cost to implement: None, organisational only

Emission reduction potential: Very High, 10% reduction in trips would result in 425,000 avoided emissions, or 7% of the total HI inventory for 2015

9. Facilitate easier movement about campus by bicycle. Cyclists and pedestrians should be given priority at every crossing point on HI grounds, not just major intersections. This helps encourage a cycling culture, as well as build social proof for cycling as a viable commuting strategy for everyone on campus. It also slows down vehicular traffic, making the campus more walkable, quieter, and acts as a small convenience dis-incentive to commuting by car (eg, it takes a long time to get out of the car park because you have to wait for pedestrians and cyclists).

   Cost to implement: estimate 300,000 ISK

   Emission reduction potential: Low

10. Facilitate connections to cycle paths and quiet access roads in every direction from University campuses, in consultation with the city of Reykjavik. Particular attention must be paid at intersections, where cyclists and pedestrians are most at risk. Care should also be taken to make routes continuous, with no stairs, curbs or transition areas where cyclists need to stop or turn suddenly. Line of sight is important, just as it is on a road. Extensive literature exists to help campus designers decide how to connect a campus for cycle access to the neighbouring streets and paths (Bonham & Johnson, 2015; City of Copenhagen, 2013).

    Particular care should be taken at the following points of the main campus, which are cycling blackspots identified by the authors of this brief, although they are also echoed in by some responses to the commuter survey. The changes would be facilitated by a combination of modifying curbs, reducing traffic speeds on campus border and inner roads and installing crossings with pedestrian and cyclist priority. It is worth considering covered bicycle and walking access for the winter months, which would not require snow clearing and would promote an actively accessible campus in winter. The City of Reykjavik has plans to install some covered cycle-ways throughout the city, connecting to covered cycle parking around schools in the City. Consider learning from their example and producing similar infrastructure around HI.

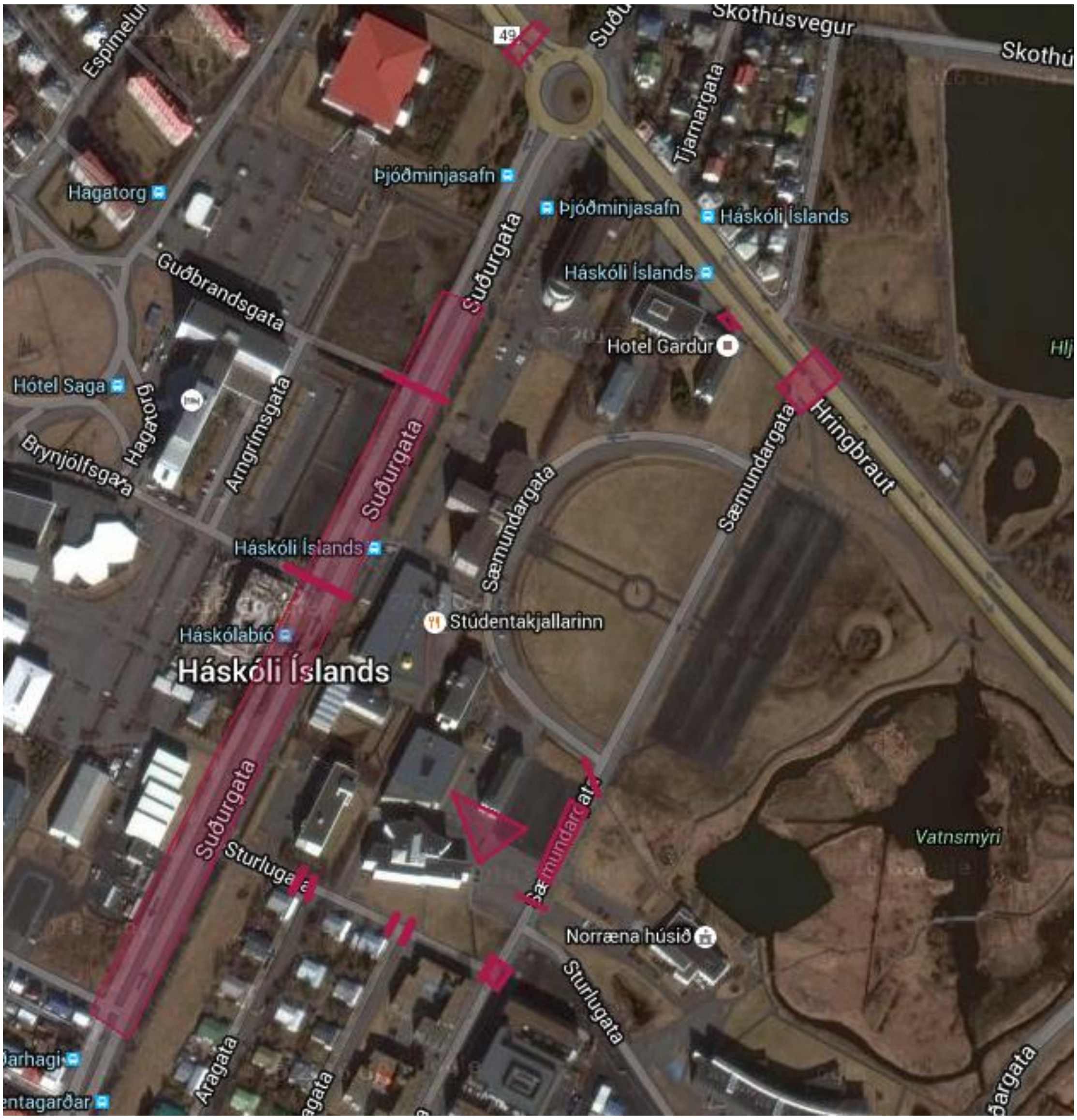

Figure 19: Cycling blackspots identified by the authors and HI transport survey respondents

Cost to implement: estimate depends on whether these upgrades are paid for by the City or the University. Range 0 ISK to 5 million ISK
Emission reduction potential: High

11. Begin an active transport promotional campaign around campus, including the environmental, economic and health benefits of walking and cycling to University rather than taking the car. Include interviews with current active commuters for social proof, information for active commuters including maps and guides, walking/cycling groups and clubs, active travel opportunities within Iceland and links to local business. A promotional campaign targeted at recruiting new cycling and walking commuters could be run monthly in the summer months, similar to the Ride to Work initiatives run by cities around the world. These days can be incentivised by free breakfasts for active commuters, prizes or can cultivate competition between teams within an office an environment. Promotional activities could be in to form of informative posters across campus, email and web-based marketing through HI channels and even organisation of engaging events on campus.

Research has shown that these programs can have high success rates at breaking mobility habits associated with car commuting (Bonham & Johnson, 2015; Chen, 2013; Ministry of Transporation Denmark, 2000; Schwanen, Banister, & Anable, 2012), and that the process of forming new mobility habits is very much based in social interaction, public acceptance and normative behaviour, rather than the product of simply individual preference. Hence, without information, marketing and cycling 'trial' events, it is unlikely infrastructure alone will create widespread adoption of active transport commuting.

Goal #2: Increase the number of commuters walking to HI

Many of the policies discussed for cycle commuting provide co-benefits to walking commuters (particularly cycle policies 6 - 10), although walkers tend to be more forgiving with snow clearing and transitional infrastructure. Adoption of cycling policies therefore includes the benefits of increases in walking commuting, at no additional cost.

Commuting by foot may initially be seen by many commuters as an inferior mobility option, given the often slightly longer time taken on the commute. This is viewed as time 'wasted', using the traditional neo-classical economics valuation of time point of view, where 'time-is-money'. Modern research into the behavioural aspects of urban transport are starting to find that the opposite may be true (for summary, see Givoni & Banister, 2013), in that active commuters may gain more value from the physical activity and relaxation time afforded to them by an active commute. Of course, this varies from person to person as well.

Promotional material and education campaigns should stress the health, environmental and economic benefits of commuting by walking, and the ways in which the extra 'commuting time' can be seen as an advantage rather than a disadvantage. Of particular interest to walking commuters may be ways to 'use' commuting time, such as podcasts, audiobooks, news radio, recorded audio lectures for students and even audio learning courses such as languages (See for example Oxford University - https://podcasts.ox.ac.uk/). HI need not create all this material themselves, but simply collect and make available the resources on an 'active commuting' portal on the University website.

Cost to implement: no further investment in addition to cycling policies
Emission reduction potential: Very High

Goal #3: Increase the use of bus transport for HI commuters who currently drive or carpool and for whom active modes of travel aren't an option

The commuter transport survey provided a lot of insight into the perceptions, limitations and possible improvements to the City of Reykjavik's bus system, Strætó. Based on the qualitative survey responses, the current bus fare is considered by many commuters to be too expensive for the distance travelled, and not good value for money overall. The bus service is also perceived to be unreliable, infrequent and the routes and transfers inconvenient for commuters to the University. There is minimal evidence of real-time waiting times or feedback mechanisms for delayed service and poor connectivity with other transport modes. Other recommended improvements from the survey were improved snow clearing for safe access to bus loading and unloading points, later services in the evenings and at night, shorter travel times via the use of dedicated bus lanes in peak times and improved shelter from bad weather at bus stops. Almost all of these proposed improvements are out of the control of the University, however it is recommended that HI discuss this valuable feedback with the City of Reykjavik in order to develop an improved service for commuters. Further information on the Strætó bus system and its strengths and limitations, including a proposed pathway for its complete electrification is available (Ortiz, 2013).

Cost to implement: None, City of Reykjavik's costs
Emission reduction potential: High

The obvious policy option regarding the bus commuting is subsidising student and staff bus fares. This was suggested repeatedly in the commuter transport survey and it has been a policy used in the past to encourage public transport use. This option is recommended, especially if used in conjunction with the policy option of institution parking fees on campus. A 4 month (Erasmus students), 6 month and 12 month option for students and staff would be recommended, with the price set to be well below the daily parking fee at HI and cheaper than the 840 ISK cost of a full bus fare. If the survey data is extrapolated to the full university population, roughly 2,150 users used the bus service in 2015 to commute to University. This figure could help policy makers decide whether a bus subsidy is a cost effective measure for GHG mitigation. One option may be to have subsidised bus tickets on an application basis only, ensuring that those commuters who need financial help receive adequate support. However, the administrative cost of this option would be relatively high.

Cost to implement: unknown, but thought to be High
Emission reduction potential: Medium

Goal #4: Reduce the frequency of flights taken where possible, and where flights are the only option consider carbon offsetting

Emissions from flying are inherently out of the control of the University to some extent, but there are some options that can be made available to the University for GHG mitigation. The only way to reduce the emissions from international and domestic airfares is to reduce the number of flights taken each year. This can be done by promotion of digital commuting, as well as video and audio recording of international presentations. For domestic airfares, bus transport should be considered as an alternative, although this may not be feasible in many cases.

Cost to implement: None
Emission reduction potential: High

The subsector of International flights comprises 15% of the transport sectors emissions. 20% of emissions from international flights are from Erasmus students travelling abroad from HI, primarily to locations within Europe. The Erasmus program typically covers the cost of flights abroad, so the GHG emissions responsibility lies with the University. Including in the Erasmus program the option of travelling by ferry, bus and train (via the Faroe Islands) to European destinations may be an attractive proposition for many enthusiastic Erasmus adventurers, and it is estimated that this option could save up to between 60 to 90% of emissions from Erasmus travel in Europe. For example, a trip to Copenhagen in Denmark by land and ferry is comparative in price to an Icelandair flight, and produces 67% less emissions than flying. Whilst it is unlikely staff or business flights will ever take up this option, Erasmus students may as they are by definition seeking new travel experiences abroad.

Cost to implement: None
Emission reduction potential: High

The remaining mitigation opportunity is carbon offsetting. This could be done through companies like Kolviður in Iceland, who for a nominal fee will plant trees to sequester the required amount of carbon dioxide purchased in the offset. Based on the 2015 emissions from International flights of 630,554 kg's CO2eq, an offset for this amount at their published retail rates (http://kolvidur.is/) would cost roughly 1.5 million ISK per year. Partnership packages are available with discounted rates. Offsetting of domestic flights is also an option.

Cost to implement: High, estimated as 1.5 million ISK annually for international only
Emission reduction potential: Very High

Goal #5: Increase the number of car and car pool drivers that commute using electric or low carbon vehicles

A range of policy options are available to support the uptake of low carbon passenger vehicle technology. Electric vehicles are an excellent low carbon passenger vehicle option in Iceland, given the unique electricity supply situation. Research confirms the suitability and cost effectiveness of electric vehicles (EV's) to the Icelandic market (Davíðsdóttir & Agnarsson, 2010; Shafiei et al., 2012; Shafiei, Davidsdottir, Leaver, Stefansson, & Asgeirsson, 2014, 2015).

1. The first is simply to offer free car parking permits of car to electric and methane-powered vehicles. This is a simple policy option to implement and has been implemented successfully in many universities and cities across Europe.
   Cost to implement: None
   Emission reduction: Low

2. Prioritise electric and methane vehicles by allocating the closest car parking spaces to campus to only these vehicle types, in the situations where this wouldn't displace parking for disabled access parking spaces. Care should be taken not to only take up this policy option in isolation, as it can be a regressive policy in a sense – i.e., it will only benefit those who can afford to purchase electric vehicles, with no benefit (and in contrast sometimes a perceived loss) to those who cannot afford to purchase a personal vehicle.
   Cost to implement: None
   Emission reduction: Low

3. Install a number of electric vehicle charge-points adjacent to conveniently located car parking spaces for free charging at the University. This option is costly, but makes a strong public statement that demonstrates the University's commitment to sustainability. Guidance on what type of charge-point to install should come from the City or Reykjavik, who have installed a number of superchargers throughout the City. Background information for the EU market is available (McKinsey, 2014) and technical guidance should come from the responsible electricity body (OR, Landsvirkjun, etc.).
   Cost to implement: estimate 300,000 per charge-point
   Emission reduction potential: Initial charge-points, Very High – rest of charging network, Medium

4. Consider investing in 1-2 small electric vehicles, in order to offset the small amount of emissions generated from on-site vehicles such as the postal service, grounds maintenance vehicles and local staff transportation. There was not enough information provided to the authors to ascertain whether this would be a valuable asset to the University, based on usage patterns, so the decision will need to be made by policy makers within the University. The authors simply recommend it for consideration.
   Cost to implement: estimate 6 million per vehicle, including all costs
   Emission reduction potential: Low to Medium

5. Consider replacing the University vehicle fleet with electric vehicles when each vehicle is due for natural replacement. Again, the effectiveness will depend on the vehicles usage patterns and this data was not made available. It is recommended this be considered as a policy option. In the High and 'Best Case' scenarios it is assumed all HI owned vehicles are replaced by 2020 with EV's.
   Cost to implement: estimate 6 million per vehicle, including all costs
   Emission reduction potential: Low to Medium

Goal #6: Accurately report on hired bus, taxi and rental car trips, and increase the proportion of electric and low emissions vehicles used in this category

There was a critical data gap in 2015 for rental cars, taxis and buses hired by HI for staff and student trips. The only data available was the total ISK in 2015 for the sector, with no breakdown by company, vehicle type, distance, date, University department or even individual fares. It is recommended that this data collection process be improved so effective mitigation strategies can be implemented.

Cost to implement: None
Emission reduction potential: High

It is recommended that the University move towards hiring exclusively from 1 company in Iceland, to enable effective accounting to be completed. If this isn't possible, a minimum number of companies is recommended with a co-ordinated data collection system in place at HI. Hiring from 1 company may also attract corporate discount rates. It is recommended that the partner company be able to offer electric and fuel-based range extended EV's in order to reduce emissions from this sector. If these aren't available, other hybrid models or similar low emissions vehicle are recommended until these vehicles become available in the rental and taxi market. There is also the possibility to offset emissions directly through corporate rental and taxi packages, usually through a company like Kolviður (See www.Avis.is for example).

Cost to implement: unknown given data quality
Emission reduction potential: High

Wastewater and Water Use

Strategies to reduce cold water use and waste water produced include replacing existing infrastructure with low water use and more efficient technology (e.g., low flow toilets), education programs to target behavioural change and downstream solutions, such as alternative water treatment on site. Given that EFs were unavailable for water supply and treatment in Iceland in 2015, and an EF for the UK was used for both, it is likely that correctly quantifying this EF will result in a large reduction in *reported* emissions. This is the recommended first step in 'reductions' in this sector. As part of that process, which will probably need to involve the local water treatment and supply authority, it is recommended that HI seek guidance from them regarding the most cost effective ways to reduce emissions in this sector.

Cost to implement: Low to High
Emission reduction potential: Low to High

Events

Data reporting for this sector needs to be improved before detailed emissions reduction strategies can be designed. It is recommended that the data reporting processes for this sector be made the first priority.

Event related emissions are thought to occur prom the production and disposal of food, packaging and material products, as well energy use from equipment hire and transport. Energy use related to events in buildings in Iceland is thought to be minimal, as is energy use for equipment hired for events (lights, sound systems, etc.) so the focus in the events sector should be on food, goods and transport.

The GHG emissions arising from food and catering services can be reduced substantially, by working with catering organisations with a focus on sustainability. This would typically focus on an increased share of local produce, zero packaging where available and no use of disposable materials such as cutlery, cups or plates. Iceland has some existing expertise in the area of local produce, particularly through the local farmers co-operative SFG (www.islenskt.is/), who spoke at the 2016 Green Days Sustainability Summit at the HI.

Events and catering companies with a focus on sustainability may exist in the Icelandic market, but the authors were unaware of one at the time of writing. An example of such a company would be the Melbourne based catering company Fred and Ginger's, who have removed all disposable packaging from their events, source local foods where available, reuse packaging effectively and sort waste accordingly (Fred and Ginger's Catering, 2016). The remaining emissions are offset, as discussed below.

After local food and food related materials waste is reduced or removed, the remainder of emissions can be accounted for by offsetting, which is becoming more common amongst event companies. In Iceland, the Secret Solstice music event in 2016 will be carbon neutral (Secret Solstice, 2016) through offsetting and local bottled water company Icelandic Glacial has also achieved carbon neutrality. Offsets will be organised by the catering company as part of the package price, and will typically include all food sourcing, preparation, clean-up and disposal.

The remaining emissions from events are related to transport. International and national flights are thought to be included in the data supplied for the transport sector, so the remaining transport related events emissions are thought to be the result of land transfers to and from airports, and movements between the event location, HI and the participants accommodation where required.

In the ERS's, the GHG emissions reductions are 2%, 10%, 20% and 80% for the Low, Medium, High and Best Case scenarios. These are estimates only, given the lack of detailed data available for this sector.

In the case of larger events, it is recommended that HI enlist the services of a taxi, rental car or bus company that can offer EV transfers to event staff, or alternatively promote cycling walking and public transport as the commuting option of choice. In reality, a combination of both approaches will be effective, to accommodate for a range of travel destinations, clientele and budgets. It is also recommended that HI could look to provide the use of its EV fleet, discussed further in the transport policy section, for patrons at smaller events.

Cost to Implement: Moderate
Emission reduction potential: High

Products

Data from this sector needs to be improved before detailed emissions reduction strategies can be designed. However, a 2% reduction in 2015 reported emissions was modelled in 3 ERS due to a ban on carry bags or wrapping for products by the HI bookshop. This policy relies, like some others, on the co-operation between on campus businesses and HI. It is recommended that contract riders be established to hold these businesses accountable to the sustainability goals of HI.

Cost to Implement: 0
Emission reduction potential: Low

Waste

It is recommended that the colour-coded waste bins that exist across some parts of campus be installed everywhere, in order to increase the percentage of waste recycled rather than landfilled, which has stagnated at 29% (45% when chemical and compost is included in 'recycled') in the past 3 years. These bins should also be in campus accommodation, at events and

Education programs, especially at point of decision, will also assist with this waste management policy. The High and Best Case ERS's modelled included a more comprehensive focus on recycling and waste sorting, including the information programs which are used to inform staff and students. There is existing knowledge within Iceland, particularly within SORPA, with regards to demand side waste management and education projects.

Cost to implement: unknown, but relatively low

Emission reduction potential: low to moderate

The best way to reduce emissions from waste is to produce and sell less packaged goods on campus. Reduction policies for food and product sales are covered the relevant sectors below, but the emissions reductions will also be evident in this sector. Reduction will have a larger effect on waste emissions than recycling measures.

Office Consumables

There are a number of specific reduction policies for this sector. The first is to improve data collection for all non-paper office consumables used on campus, as this was only reported in total ISK in 2015.

The second is to switch all paper use (both toilet and office paper) on HI campuses to paper certified by the Forest Stewardship Council (FSC). The current European average for recycled paper consumption is 71% (ERPC, 2014), which sets the minimum benchmark for HI. Further guidance on which paper to select is given by WWF (2010, 2016) and Professor Brynhildur Davíðsdóttir in the ENR program, who is an expert in the US paper and pulp industry, can provide specific advice in this area. Modelling shows that switching office paper use to 100% recycled, FSC certified paper would reduce emissions by 7,305 kg CO2eq, or 23% of emissions from this sector in 2015.

Toilet paper data was not captured in 2015 directly and it is recommended this be included in 2016. Similar mitigation policies exist for toilet paper, with FSC certified products, including carbon neutral products, available in European markets.

Many paper suppliers sell a 'carbon neutral' product, which includes in the price offsets for carbon emissions related to embodied energy in production. Purchasing 100% FSC certified carbon neutral paper would reduce emissions from office paper to 0, saving 26,795 kg CO2eq based on the 2015 usage volumes. This is 85% of the emissions from this sector, and 0.5% of emissions from the whole HI inventory.

Cost to implement: unknown, but Low

Emission reduction potential: Low to Medium

Low carbon switching in product use also has the added benefit of being very visible to the HI population, acting to some degree as CSR advertising for HI, as well as encouraging positive social norms amongst students and staff around moderated consumption and environmental stewardship.

Finally, HI could slowly transition to a paperless office approach. This would result in not only a reduction in office paper, eventually to zero, but a decrease in printed handouts and brochures, as well as secondary paper products like pens, staplers, highlighters and other stationary products. This is made possible by advances in app and online sharing technology, excellent access to Wi-Fi across all campuses and the replacement of physical information points with digital LCD displays. The result is a widespread reduction in materials use and packaging across campus, reduced waste levels and an increasingly connected or 'smart' campus information package. Guidelines and eventually rules would need to be implemented to promote this transition, including making student work submissions digital only, making all internal and eventually and most external communications digital, as well as considering financial disincentives such as increased printing quotas and paper charges for staff.

Cafes & Restaurants

Data from this sector needs to be improved before detailed emissions reduction strategies can be designed. It is recommended that the data reporting processes for this sector be the first priority in ERS selection.

Refrigerant may account for up to 90% of emissions for some food service businesses (Climate Smart, 2014). This is an area where food service can make a significant difference, though they may need to be incentivized upgrade older refrigeration units given that the decreasing efficiency of the older units will not provide a strong enough economic impact in the Icelandic context.

Once properly measured, waste will likely be the largest source of emissions from this sector. Generally the majority of the waste is organic and food services businesses may realise substantial emissions reductions by merely diverting organics from the landfill through composting.

The use of single use plastics is also expected to be a large contributing factor within this sector. Eliminating the use of these products, ought to be an attainable first step in achieve HI's reductions targets.

Cost to implement: Unknown
Emission reduction potential: Unknown

As discussed briefly in the waste sector, the addition of contract riders for all businesses operating on HI campuses is recommended. This involves some simple additions to contracts held between private businesses on campus, such as FS, and HI, allowing the university to hold businesses accountable to sustainability programs on campus. There is no direct cost to implement this policy, but it is thought that significant negotiations and staff time might be required over a number of years to develop effective and equitable contract riders for both parties.

Accommodation

Data from this sector needs to be improved before detailed emissions reduction strategies can be designed. However, even with this significant data gap in mind there are still some easily identifiable factors that could be targeted through HI initiatives before while the data collection process is being improved. For example, the mandatory sorting of waste in the on campus accommodation could lead to as significant reduction emissions. According to FS, though some residents have requested more recycling options many do not sort waste at all. Mandatory sorting in multi-family buildings has been implemented many locations. In most cases, tenants are made aware that they will have to share the cost of landfilling extra waste and rents may be reduced if the cost of landfilling drops below a certain threshold.

Cost to implement: Unknown
Emission reduction potential: High

For the emissions that were reported in 2015, the majority come from the operation of a standard gasoline vehicle. This vehicle was modelled in the High and Best Case scenarios as being replaced by an EV in 2020. Whilst this could be recommended, without significant leverage (in the form of contract riders) or financial incentives, it is somewhat unlikely that this policy will be enacted by FS. There is also the uncertainty of how the electric vehicle market will develop over the next 4 years in Iceland, as well as the supporting infrastructure. Installing EV change points near university accommodation (where the vehicle is used) would help to incentivise this decision.

Cost to Implement: None to Low
Emission reduction potential: Low

Energy

The Energy sector of the inventory only accounted for 1,691 kg CO2eq in 2015, or around 0.03% of the total emissions. Given the low carbon intensity of the electricity and heating supplies, it is unlikely that further reductions in this sector would be cost effective. Thus, it is recommended that no mitigation strategies be taken in this sector, other than quantifying the use of natural gas on campus as discussed in the inventory section of this brief.

If desired, HI could offset this small amount of GHG emissions in the same way as described in the air transport policy section of this report. It is also likely that the EF used for Iceland's electricity supply will change, as significant progress is being made on reducing the GHG emissions intensity of electricity produced from geothermal power plants throughout Iceland. These changes have not been modelled, as they are still very uncertain, and the impact of the changes to EF would result in almost negligible reductions in the overall GHG inventory.

Maintenance & Equipment

The emissions from this sector are from the burning of fossil fuels in grounds equipment. It is recommended that when the equipment reaches end of life and is to be replaced, that it is replaced with electric powered alternatives. Electric-battery grounds equipment typically comes at a higher capital cost, but produces very low emissions, given Iceland's unique electricity supply, and has minimal fuel costs over the system lifespan. In the forecast, the model assumes the electric grounds-keeping equipment as being purchased in 2020, and producing no GHG emissions from use. The savings in GHG emissions from 2020 onwards are 1,283 kg CO2eq per year.

Cost to implement: Unknown, but Low
Emission reduction potential: Low

Postage & Freight, Fugitive emissions and Construction

As discussed in the inventory section of this brief, these sectors were not included in the 2015 inventory. The best way to reduce emissions from these sectors is to first quantify these sectors in 2016, with a particular focus on the Construction sector.

Further Recommendations

Summary of recommendations from reporting, policies, feedback in future for tracking progress, repeat next year then every 2 years, then this discussion (edited if need be, it's from the initial brief)

The policies outlined and ERS's developed should provide a roadmap of the mitigation options available to HI until 2030. The authors would recommend that HI administration make a public commitment to a reduction level, based on the inventory year of 2015. If significant changes are made in 2016 with improved data capture, GHGProtocol gives guidelines on how to adapt emissions reductions commitments accordingly.

It is recommended that this inventory be completed again in 2016, with the goal of completeness in mind, in line with GHGProtocol guidelines. After the inventory is considered complete, accurate and consistent, inventories could be carried out every 2 years.

Greenhouse gas emissions are only part of the environmental, social and economic impact that HI has on the wider community. In order to show further leadership in accountability, HI should begin to make progress towards the STARS Sustainability Reporting framework (AASHE, 2014). Developed by the Association for the Advancement of Sustainability in Higher Education (AASHE) specifically for universities, this sustainability assessment framework provides easy to follow guidance to track progress towards multidimensional sustainability in higher education institutions.

The assessment framework rates universities from around the globe across 5 major dimensions; Academics, Engagement, Operations, Planning & Administration and Innovation. The GHG inventory and EMS report represents a large proportion of the operations component of this assessment tool. When coupled with Iceland's unique renewable energy situation HI would already score reasonable highly in this certification, within the operations component. The tool is free until certification is required, allowing the university to build up to its first submission over a number of years.

The SWG recommends this STARS certification primarily because it could be organised so that the university would have to contribute minimal resources to completion of the submission each year. The 5 major dimensions tie in perfectly with UAU101F Sustainable Development, Environmental Policy and Resource Management and UAU201F Environmental Governance. Both these subjects are coordinated by Professor Brynhildur Davíðsdóttir and have large assignments that could be the completion of the various sections of the sustainability assessment over both fall and spring semester. This would provide practical learning opportunities for students, enhancing educational outcomes, as well as allow HI to complete the STARS assessment in a cost effective manner.

The authors would also be available to help create course materials and provide student support for the development of the first report, in consultation with Professor Brynhildur Davíðsdóttir.

Finally, the authors would recommend opening discussions between HI and its service partners, such as the City of Reykjavik, FS, SORPA and/or Gámaþjónustan, the local water authority, rental vehicle companies, construction and building contractors and Kolviður. Working in partnership with these organisations will be a critical factor in developing maintaining effective GHG mitigation programs at HI in the future.

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