



Technical Design Document

Version 1.0

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*One person can change the world*

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S1 2020

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# Introduction

This technical design document outlines and explains the components required to build the game: “The Model Citizen”. Here we describe each system and its purpose in the overall design, as well as explaining its processes. We outline our testing plan and results to ensure the game functions as designed, and list as well as reference all assets used in the games production.

# Game Architecture

## Game Engine

This game was produced using the Unity engine, both for its features and as it was a requirement for this unit.

Unity comes with a simple and easy-to-use editor, allowing game environments to be built easily. Extensive integration with external tools, such as 3D modelling software, and scripting editors make it a versatile tool. A key factor is its component for easy control mapping for multiple forms of input devices, and for its multiple platform deployment capability.

## Objective System

The objective system is designed to use scriptable objects pre-made inside the Unity editor. The system keeps track of all the objectives and GUI relevant to each objective. By using dynamic lists, the objective system sorts and populates each list for each objective state between tutorial, core, game end and side objectives. The objective manager keeps track of the current state of the objectives and ensures once the player completes a given list of objectives that different events are triggered based of the list completed. The objective system is discussed further in section [3](#_Objective_System).

## Interaction System

Player interaction with the game world is handled by the interaction system, designed to allow the player to pick up and move objects around the world. The interaction system uses raycasts to from the player to check and manage different states of the player and the objects they might be trying to interact with. By using the interaction system, the player can view object details, view displayed prompts about said object, pick up a given object and perform special actions based on the object the player is attempting to interact with. The interaction system is discussed further in section [4](#_Interaction_System).

## Inspection System

Inspecting different items in the game allow the player to have a closer look at specific given items in the game environment. The inspection system ties into the interaction system, allowing the player to use a custom action to inspect and display different GUI based on the item the player is interacting with. By designing the interaction system with custom actions in mind, it allows functions like object inspection to be easily used by the player. The scoring system is discussed further in section [5](#_Inspection_System).

## Scoring system

The player’s achieved score is broken up into two separate but interrelated outcomes, in the form of a total greenhouse gas emissions saving, and a titled ranking. These scores are based on the number of completed tasks and their correctness. The scoring system is discussed further in section [6](#_Scoring_System).

## Dialogue system

The dialogue system is a simple UI system that allows the game to give feedback to the player based on what they have done in the game world. By using queues, the system adds sentence strings into a queue and displays these on the dialogue UI to the player. Each dialogue is designed with a scriptable object allowing fast addition of more dialogue into the game and by using static systems, triggering a new dialogue can be done from anywhere in the game. The scoring system is discussed further in section [7](#_Dialogue_System).

# Objective System

An explanation of processes and purpose of the objective system

## Objective Lifecycle

All objectives use different lifecycles based on the type of objective. Main core objectives are initiated once the player enters that given objective list. As the player completes the objective, the objective will check itself if it meets the completion criteria. Once the objective is complete it updates its UI element and tells the objective system to check if the given list has been completed. Once the list is complete, objectives are cleared from the list making way for the next list of objectives.

## Primary Objectives

The player is given primary required objectives to complete in the game world. Some objectives are washing clothes, buying food and planting trees. Each objective has their own requirement factor and the objective system uses this to determine if the given objective is a primary or optional objective.

## Optional Objectives

Optional objectives are in the game world to give the player more depth in what they could do to improve their final score. Some optional objectives include unplugging devices, changing the light bulbs and throwing away said light bulbs.

# Interaction System

An explanation of processes and purpose of the interaction system

## Pick up/Drop

The player is able to pick up and drop items in the game world by using raycasts and object tag checking to pick up and drop objects. This system uses the physics system to move the object to a set location in front of the player and drops the objective from said point by enabling gravity and making the object not track the holding point to fall back to the ground.

## Move

Moving objects is done by picking up and moving objects around the game world.

## Place Into

Objects can be placed into bins and other areas into the world. By dropping items, the player can drop these items into bins or other objects and using the physics system and collisions, the game can check and perform different actions based on what the player has done.

# Inspection System

An explanation of processes and purpose of the inspection system

## Interaction

The inspection system is tied into the interaction system and allows the player to perform a custom action to inspect different items in the game world.

## GUI

Each item the player can inspect has a different UI based on the contact the player is meant to be able to see. In the case of the rubbish magnet on the fridge, the player can get a zoomed in inspection of the magnet and its details. In the case of the CCS documents, the UI allows the player to flip though different pages of the documents and open a new webpage with more information about the document.

## Descriptions

The fridge magnet is a design from the City of Melville and indicates to the player what different items can go in what bin. CCS documents are documents in the game world used to display information to the player about other effects society have on the climate.

## Articles

Articles are included in the game to present the player with information on climate change that is required to be included but cannot be explored using in-game tasks. Physical articles are places within the game world that display a GUI with the article contents to the player. A ‘Read More’ button can be selected to open the referenced article in full in the system’s default web-browser.

# Scoring System

In-depth explanation of processes and purpose of the scoring/feedback system

## Tracked features

Below is a list of actions that are tracked to determine the player’s final score and ranking, as well as determining what learning objectives they have accomplished.

* Tree planting
* Laundry collection
* Washing clothes
* Rubbish disposal
* Changing light bulbs
* Light bulb disposal
* Drying clothes
* Phantom power devices
* Buying food
* Mode of transport
* Read Solar Activity article
* Read Earth’s Rotation Article

## Scoring Calculations and Weighting

The final score at completion of the game is comprised of two separate but interrelated outcomes. The first is an approximate total of greenhouse gas emissions potentially saved by the players actions and choices. The second is a titled ranking based on the number of completed tasks and the choices made for each.

### Greenhouse Gas Emission Savings

The baseline total emissions saved for the game starts at 0 metric tonnes. This total will not change if the player selects all of the most incorrect options during primary tasks, and fails to attempt any optional tasks, with the exception if the ‘Plating trees’ primary objective. The total is based on the impact of a single household following the choices the player made over a period of one calendar year.

More correct choices made during the completion of primary objectives and attempting and/or completing some or all of the optional objectives will improve the total saved GHG emissions based on table 1 below.

Table 1. GHG emissions saved by objective

|  |  |
| --- | --- |
|   | CO2 saved per annum per tree (kg) |
| Trees | 21.7724 |
|  |  |
| Devices | **CO2 saved per annum (kg)** |
| Microwave | 1106.2128 |
| TV (LCD) | 1060.1206 |
| PC | 13827.66 |
| Washing machine | 1843.688 |
| Clothes dryer | 1198.3972 |
| Large Lamp | 0 |
| Desk Lamp | 0 |
|  |  |
|   | **CO2 saved per annum (kg)** |
| Bicycle over car | 3560.94 |
|  |  |
| Cold Wash vs Hot Wash | **CO2 saved per annum (kg)** |
| Hot | 0 |
| Medium | 185.64 |
| Cold | 458.64 |
|  |  |
|   | **CO2 saved per annum (kg)** |
| Clothes Dryer | 518.7 |
|  |  |
|   | **GHG saved per bulb per annum (kg)** |
| Lighting | 8.687 |
|  |  |
| FOGO Waste | **CO2 saved per annum (kg)** |
| Old Apple | 618.3216 |
| Greasy Pizza Box | 618.3216 |
| Pop Stick | 1368.9 |
|  |  |
| Recycled Waste | **CO2 saved per annum (kg)** |
| TP Roll | 2421.9 |
| Cola Can | 1235.52 |
| Rusty Razor | 4766.58 |
| Chip Packet | 4766.58 |
| Single Lightbulb | 38.61 |
|  |  |
| General Waste | **CO2 saved per annum (kg)** |
| Toothpaste Tube | 0 |
| Coffee Cup | 0 |
|  |  |
| Food | **CO2 saved per annum (kg)** |
| Beef | 0 |
| Fish | 10037.5 |
| Veggie | 10767.5 |

All figures are based on extensive research and readily available statistics. References are outlined in appendix A.

### Overall Ranking

The overall ranking is a title given to the player based on the number of tasks completed and the correctness of the choices made for each. There is a total of five titles that can be awarded based on a scale from 0 to 100 as outlined in table 2. The weightings towards this scale for each task and choice are provided in table 3.

Table 2. Ranking titles

|  |  |
| --- | --- |
| Title | Rank % |
| Climate Conscious | 20% |
| Greenthumb | 40% |
| Carbon Cutter | 60% |
| Eco Champion | 80% |
| The Model Citizen | 100% |

Table 3. Task and choice weightings for ranking scale

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Objective ID | Objective | Requirement | Weight |  |
| 99 | **Tree Planting** | **Yes** | **10%** |  |
|  |  |  |  |  |
| 98 | **Laundry Collection** | **Yes** | **10%** |  |
|  |  |  |  |  |
| 97 | **Washing Clothes** | **Yes** | **10%** |  |
|  | Hot |  | 0% | Choice 1 |
|  | Warm |  | 50% | Choice 2 |
|  | Cold |  | 100% | Choice 3 |
|  |  |  |  |  |
| 96 | **Rubbish Collection** | **Yes** | **15%** |  |
|  | Old Apple |  | 10% |  |
|  | Greasy Pizza Box |  | 10% |  |
|  | Pop Stick |  | 10% |  |
|  | TP Roll |  | 10% |  |
|  | Cola Can |  | 10% |  |
|  | Rusty Razor |  | 10% |  |
|  | Chip Packet |  | 10% |  |
|  | Toothpaste Tube |  | 10% |  |
|  | Coffee Cup |  | 10% |  |
|  | For collecting all |  | 10% |  |
|  |  |  |  |  |
| 95 | **Light bulb changing** | **Optional** | **5%** |  |
|  | Single bulb |  | 15% | x6 |
|  | For collecting all |  | 10% |  |
|  |  |  |  |  |
| 94 | **Trashing light bulbs** | **Optional** | **5%** |  |
|  | Single bulb |  | 15% | x6 |
|  | For collecting all |  | 10% |  |
|  |  |  |  |  |
| 93 | **Drying clothes** | **Optional** | **5%** |  |
|  | Machine |  | 0% | Choice 1 |
|  | Leave |  | 20% | Choice 2 |
|  | Clothesline |  | 100% | Choice 3 |
|  |  |  |  |  |
| 92 | **Phantom power/unplugging items** | **Optional** | **15%** |  |
|  | Microwave |  | 15% |  |
|  | TV (LCD) |  | 15% |  |
|  | PC |  | 20% |  |
|  | Washing machine |  | 15% |  |
|  | Clothes dryer |  | 15% |  |
|  | Desk Lamp |  | 10% |  |
|  | Large Lamp |  | 10% |  |
|  |  |  |  |  |
| 91 | **Buying Food** | **Optional** | **10%** |  |
|  | Beef |  | 0% | Choice 1 |
|  | Fish |  | 80% | Choice 2 |
|  | Veggie |  | 100% | Choice 3 |
|  |  |  |  |  |
| 1 | **Car or Bike transport** | **Yes** | **15%** |  |
|  | Car |  | 0% | Choice 1 |
|  | Bike |  | 100% | Choice 2 |
|  |  |  |  |  |
|  | **Solar Activity Article** | **Optional** | **5%** |  |
|  |  |  |  |  |
|  | **Earth's Rotation Article** | **Optional** | **5%** |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  | **Total** |  | **100%** |  |

# Dialogue System

An explanation of processes and purpose of the dialogue system

## Implementation

The dialogue system is implemented in a static sense allowing any other script in the game world to interact and start dialogues.

## Scripts

All dialogue in the game is based off scriptable objects and are triggered from their related managers or scripts. Depending on what the player has done a dialogue could be initialized from the puzzle system for completing a puzzle or a set trigger that checks if the player is in a set area to trigger the dialogue.

# Resources

Note: As the assignment was altered to not require a specific percentage of in-game assets, we have not mentioned the percentage split between created and imported assets. We have instead indicated each asset in-game, and whether it was created by the team or sourced externally.

## 3D Assets

### Created by Team

* House
* Nightstand
* Fridge
* Doors
* Electric Box
* Patio
* Seed Packet
* Seed
* Road
* Windows
* Fridge Magnet
* Pizza Box
* Popstick
* Power cable
* Clothesline – created poles and used externally sourced wire with peg

### Externally Sourced

* Lampshade - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/1235284>
* Wall Outlet - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/247838>
* Potato Chip Bag - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/320983>
* (mentioning of Sabritas brand was removed to avoid copyright issues)
* Razor - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/147999>
* (mentioning of Gillette brand was removed to avoid copyright issues)
* Clothesline - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/830022>
* Toilet Paper Holder - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/1356611>
* Coffee Cup - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/1277348>
* Basketball - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/1460117>
* Clothes Basket- <https://www.turbosquid.com/FullPreview/Index.cfm/ID/270038>
* Folded shirts - <https://open3dmodel.com/3d-models/shirt-folded_377973.html>
* Bicycle - <https://free3d.com/3d-model/mountain-bike-pacific-invert-560146.html>
* Toothpaste - <https://free3d.com/3d-model/tube-of-toothpaste-v2--919684.html>
* Washing Machine, Dryer - <https://resources.blogscopia.com/2015/04/12/clothes-washing-machine/>
* Clipboard - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/1118885>
* Light Switch - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/1138494>
* Pants - <https://free3d.com/3d-model/polopants-v2--696649.html>
* Underwear - <https://www.turbosquid.com/FullPreview/Index.cfm/ID/154860>

**Unity Asset Store Assets**

* Cola Can - <https://assetstore.unity.com/packages/3d/cola-can-96659>
* Apple piece - <https://assetstore.unity.com/packages/3d/props/food/fruit-pack-80254>
* Low Poly Car - <https://assetstore.unity.com/packages/3d/vehicles/low-poly-car-149312>
* Soccer ball - <https://assetstore.unity.com/packages/3d/low-polygon-soccer-ball-84382>
* Pot plants, pots, pens, pen lid, Laptops, Tablet, Briefcase, Phone, Desk, Cabinet, Chair
* <https://assetstore.unity.com/packages/3d/environments/low-poly-office-props-lite-131438>
* Steel Ladder - <https://assetstore.unity.com/packages/3d/props/exterior/free-steel-ladder-pack-24892>
* Rocks and fencing - <https://assetstore.unity.com/packages/3d/vegetation/trees/free-low-poly-nature-project-pack-1-meadows-123574>
* Lightbulbs (both models) - <https://assetstore.unity.com/packages/3d/props/interior/low-poly-office-props-spike-119407>
* Pencil, eraser, legal pad, tape dispenser, stapler, hole punch, calculator
* <https://assetstore.unity.com/packages/3d/props/office-supplies-low-poly-105519>
* Trash bins - <https://assetstore.unity.com/packages/3d/props/exterior/plastic-trash-bins-160771>
* GOV Bot - <https://assetstore.unity.com/packages/3d/characters/robots/robot-sphere-136226>
* Sink, Bathtub, Bed, Big Drawer, Shelf, Lamp, Microwave, Mirror, Kitchen Sink, Garage Table, Sofa, Dinner Table, Lamp, Toilet, TV, TV table - <https://assetstore.unity.com/packages/3d/simple-home-stuff-69129>
* Crystal - <https://assetstore.unity.com/packages/3d/props/stylized-crystal-77275>
* Toilet Paper and Rolls – <https://assetstore.unity.com/packages/3d/props/toilet-paper-roll-proto-series-165615>
* Toolbox with tools – <https://assetstore.unity.com/packages/3d/props/tools/tools-pack-asset-84733>
* Terrain, Trees, Grass, Bushes etc (Basically everything environmental)- <https://assetstore.unity.com/packages/tools/terrain/gaia-pro-terrain-scene-generator-155852>

## Images

### Created by Team

UI Elements (These Assets can be found in the UI Folder)

* basicBackground
* DetailTransparent
* MenuButton
* MenuUI
* ObjectiveList
* ObjectiveListNoMargin
* TerraBG
* TerraBiteTrans
* TMCW1TB
* TMCW1TW
* TMCWhiteTrans
* UIBG
* UIBUT1
* Controls
* UIBUT2
* UIMENU
* dialogue\_UI
* cross
* controllerImage
* handGrab
* handOpen
* pixelButton

### Externally Sourced

UI Elements (These Assets can be found in the UI Folder)

* creditButton – uses pine voc logo found at: <https://pinevoc.bandcamp.com/album/green-ideas>
* Earth wobble - <https://climate.nasa.gov/faq/30/if-all-of-earths-ice-melts-and-flows-into-the-ocean-what-would-happen-to-the-planets-rotation/>
* Solar Graph - <https://climate.nasa.gov/faq/14/is-the-sun-causing-global-warming/>
* Star (Full and Empty) - <https://publicdomainvectors.org/en/free-clipart/Cartoon-gold-star/49750.html>
* Beef - <https://pixabay.com/vectors/steak-isolated-icon-meat-beef-1750291/>
* BinImages - <https://www.melvillecity.com.au/waste-and-environment/waste-recycling-fogo/3-bin-fogo-system/faq-s>
* Fish - <https://www.clipartmax.com/middle/m2i8G6G6m2Z5H7K9_meat-clipart-fried-fish-fried-fish-clip-art/>
* Fruit­\_Veg - <https://freesvg.org/fruits>

## Sound/Music

All audio resources used (soundtracks, sound effects)

### Music

#### Created by Team

No music was created by the TerraBite team.

#### Externally Sourced

The three songs in-game are from the album “Green Ideas’ by pine voc.

Tracks used:

* sustainability
* 100% natural
* please recycle

The artist pine voc was contacted and asked for permission for the album to be used in The Model Citizen and was excited to be included. Credit has been given in-game as per the Creative Commons license agreement, and a link to the album can be found below:

<https://pinevoc.bandcamp.com/album/green-ideas>

### Sounds

#### Created by Team

* WashingCompleteClip <https://kronbits.itch.io/retrosfx>
* ObjectiveComplete <https://kronbits.itch.io/retrosfx>
* IndisposableBinItemClip <https://kronbits.itch.io/retrosfx>
* IndisposableBinItemClip2 <https://kronbits.itch.io/retrosfx>
* IncorrectBinItem <https://kronbits.itch.io/retrosfx>
* Egg <https://kronbits.itch.io/retrosfx>
* CorrectBinItem <https://kronbits.itch.io/retrosfx>
* ActionClickClip <https://kronbits.itch.io/retrosfx>

## Articles

### Source articles – link to internal articles and GOV BOT facts

Solar Activity CCS Doc - <https://climate.nasa.gov/faq/14/is-the-sun-causing-global-warming/>

Earth Rotation CCS Doc - <https://climate.nasa.gov/faq/30/if-all-of-earths-ice-melts-and-flows-into-the-ocean-what-would-happen-to-the-planets-rotation/>

Lightbulb facts - <https://homeguides.sfgate.com/changing-light-bulbs-environment-70834.html>

Food facts - <https://www.greenpeace.org/usa/sustainable-agriculture/eco-farming/eat-more-plants/>

Wash/Dry – facts <https://www.theguardian.com/environment/green-living-blog/2010/nov/25/carbon-footprint-load-laundry>

<https://www.abc.net.au/life/how-washing-your-clothes-differently-can-help-the-environment/12003770>

# Testing

Below is a set of requirements that were tested to ensure the complete functioning of the game:

Table 4. Testing plan and results

|  |  |
| --- | --- |
| Test | Result |
| Objectives track correctly | All objectives show in the tracker once started and are crossed out when completed |
| Game can complete without optional objectives | Game can only be completed once core tasks are finished, and regardless of optional objective progress |
| Door opens after tutorial | Once the “Collect Clothing” objective is completed the door opens |
| Objects can be picked up | All interactable objects can be picked up and moved |
| Objects can be released and placed | All interactable objects can be released and fall to the surface below once picked up |
| Objects can be placed in appropriate receptacles | All appropriate objects are removed from the game world when placed in the correct receptacle |
| Only appropriate objects can be placed receptacles | Inappropriate objects are not removed from the game world when placed in a receptacle |
| Objects can be inspected for correct information | When an inspectable object is inspected, the correct details are shownOnly inspectable objects display information when prompted |
| Articles can be read | Both articles show the correct GUI and article contentFull article is opened in default web-browser when prompted |
| Appropriate GOV-BOT prompts trigger | GOV-BOT correctly responds to the player’s choices and the proceeding state of the game. |
| Game can be completed | Game can be completed when all primary objectives are completed |
| Accurate final scores | Final scores match result calculations |
| Collision checks | All movable objects perform appropriate collisionsPlayer model performs appropriate collisions |
| Trees grow | Trees grow quickly once seed is planted |
| GUI buttons function correctly | All buttons function as expected in GUI |
| Sounds play when triggered | Sound effects trigger when objectives are complete |
| Music is audible | Game music plays and volume can be changed in options |

# Delivery Platform and Requirements

## Delivery Platform(s)

### Windows PC

The Windows PC version of The Model Citizen is our primary release platform and should be considered the proper TMC experience.

### WebGL

The WebGL version of The Model Citizen was created to fulfill the requirements of the client for an easily accessible version of the game. It doesn’t perform as well as the main Windows platform release and we recommend you play that version instead of the WebGL version if you want the best looking and performing experience.

## Hardware Requirements

Given that we don’t have access to a multitude of test hardware, we can’t too easily give a recommended or minimum hardware requirements suggestion. Both releases of the game were tested on a multitude of machines containing NVIDIA GTX and RTX series graphics cards and ran with no real issues whatsoever. The WebGL version does suffer with some stuttering upon initially loading the game, however, considering you can play the full experience in the web browser we see this as well and truly satisfying the clients requirement for a WebGL version. The Windows build however runs effortlessly on the aforementioned hardware. I managed to test the game on a NVIDIA MX250 card (a low-end laptop GPU) and only had the occasional frame drop.

We recommend that to play the game you have at minimum a low range modern GPU, while we recommend a mid to high end GPU to ensure that the game runs smoothly at all times.

## Software Requirements

### Windows PC

The Windows PC version of The Model Citizen can be played so long as you have The Model Citizen release file that contains the games executable file, among other files that allow the game to run.

### WebGL

The WebGL version of The Model Citizen can be played on any computer web browser with WebGL support.

# Game Development cycle

## Pre-production

In the second and third weeks, our team was brought together and we began discussing and brainstorming ideas for our serious climate change game.

## High concept

Having determined to create an educational game modelling the ideal eco-friendly lifestyle, we decided to create a simulation of the real world detailing potential daily actions that would benefit the climate. To appeal to a younger and wide range of players, we have chosen to use a low-poly art direction.

## Design document

We created a level map that mapped the house out and listed everything that would be inside of it. We also determined what the game would look/play and sound like.

## Prototype / demo

Our team developed a demo which we presented to the class as our first assignment submission, establishing the technology requirements, intended platform and showcasing our future goals through incomplete features.

## production

Our team then continued to produce more content for the game, introducing new puzzles and features, fleshing out the levels and scene with purchased unity assets and creating new UI elements conforming to our low-poly direction.

## alpha

We completed our alpha phase three days before submission, having produced a completed game with sufficient puzzles and a clear ending that uses reinforcement learning to educate the players. Many issues still remain in terms of bugs and small adjustments, but they are to be addressed in the beta phase.

## beta

In the beta phase, we addressed bugs and issues that were appearing in preparation for the final candidate, making sure that the game would run smoothly and as intended within the editor.

## Final candidate

For the final candidate, we had to ensure through testing that the game would function in the built release on Windows and WebGL. There were large discrepancies between the game in the unity editor and the built release such that game-breaking bugs had emerged. We spent the final candidate phase correcting those major bugs to arrive at our final candidate version 0.5.7.

## Gold master

Finally, after submission our team plans to take a good rest and play some games!

# Appendices

## Appendix A: GHG Emmission Research

|  |  |  |  |
| --- | --- | --- | --- |
| Food | CO2 generated per annum (kg) | Daily CO2 averaging at 500g portion | References |
| Beef | 10950 | 30 | https://ourworldindata.org/food-choice-vs-eating-local |
| Fish | 912.5 | 2.5 |  |
| Veggie | 182.5 | 0.5 | (Average of plant-based products) |

|  |  |  |  |
| --- | --- | --- | --- |
|  | CO2 saved per year per tree (kg) | Details | References |
| Trees | 21.7724 | assumes fully matured tree | https://onetreeplanted.org/blogs/stories/planting-trees-reduce-carbon-footprint |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Devices | CO2 generated per year per household (kg) | avg. hourly idle useage (W) | annual kWh consumption | References |
| Microwave | 1106.2128 | 2.4 | 1580.304 | https://www.canstarblue.com.au/electricity/cost-leaving-appliances-standby/ |
| TC (LCD) | 1060.1206 | 2.3 | 1514.458 |  |
| Game console | 2488.9788 | 5.4 | 3555.684 |  |
| PC | 13827.66 | 30 | 19753.8 |  |
| Monitor | 460.922 | 1 | 658.46 |  |
| DVD Player | 691.383 | 1.5 | 987.69 |  |
| Washing machine | 1843.688 | 4 | 2633.84 |  |
| Clothes dryer | 1198.3972 | 2.6 | 1711.996 |  |
| Dishwasher | 1382.766 | 3 | 1975.38 |  |
| Air conditioner | 921.844 | 2 | 1316.92 |  |
| Wireless modem | 3917.837 | 8.5 | 5596.91 |  |
| Total | **28899.8094** | **62.7** | **41285.442** |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Annual saved CO2 (kg) | CO2 per km | Average daily commute | References |
| Bicycle over car | 3560.94 | 0.271 | 36 | https://www.ourstreetsmpls.org/does\_bike\_commuting\_affect\_your\_carbon\_footprint\_and\_how\_much |
|  |  |  |  | https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0.55.001~2016~Main%20Features~Commuting%20Distance%20for%20Australia~1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cold Wash vs Hot Wash | CO2 generated per year per household (kg) | Wash/Rinse Setting | Electrical Use kWh/load | References |
| Hot/Warm | 491.4 | 4.5 | 702 | https://coldwatersaves.org/ |
| Warm/Warm | 382.2 | 3.5 | 546 |  |
| Hot/Cold | 305.76 | 2.8 | 436.8 |  |
| Warm/Cold | 207.48 | 1.9 | 296.4 |  |
| Cold/Cold | 32.76 | 0.3 | 46.8 |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | CO2 generated per year per household (kg) | annual kWh consumption | Details | References |
| Clothes Dryer | 518.7 | 741 | 3.5 star | https://www.energyrating.gov.au/calculator |
|  |  |  | 7kg rated |  |
|  |  |  | 3 uses per week |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Lighting | CO2 generated per year per bulb (kg) | Watts per bulb | annual kWh consumption | Details | References |
| Incandescent | 10.22 | 40 | 14.6 | 5 hrs/day | https://www.energyrating.gov.au/document/factsheet-light-bulb-buyers-guide |
| LED | 1.533 | 6 | 2.19 |  |  |
| GHG saved per bulb | **8.687** |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Improper recycling | kg C02 per hh per anum | Waste per HH/yr (tonnes) | CO2 per tonne of MSW |  |  |  |
| Average | 3320.46 | 7.02 | 473 |  |  |  |
|  | 332.046 |  |  |  |  |  |
| Waste Type | **kg C02 saved per hh per anum (per item)** | **Coefficient** | **Portion of total waste** | 7.02 |  | **Bin** |
| Food/Organics | 618.3216 | 0.8808 | 0.1 | old apple | greasy pizza box | FOGO |
| OCC | 2421.9 | 3.45 | 0.1 | TP roll |  | Recycling |
| Mixed Paper | 0 | 3.78 | 0 |  |  |  |
| Plastic Film | 0 | 1.76 | 0 |  |  |  |
| Glass (Non Beverage) | 231.66 | 0.33 | 0.1 | light bulbs |  | Recycling |
| Mixed Paper/Cardboard | 0 | 3.61 | 0 |  |  |  |
| Beverage Containers | 1235.52 | 1.76 | 0.1 | cola can |  | Recycling |
| Mixed Rigid Plastic | 0 | 1.43 | 0 |  |  |  |
| Wood Waste | 1368.9 | 1.95 | 0.1 | pop stick |  | FOGO |
| Metals | 4766.58 | 6.79 | 0.1 | rusty razor (in container) | Chip packet | Recycling |
| Total | **10642.8816** | **25.7408** | **0.6** |  |  |  |
|  | 38.61 |  |  |  |  |  |
| Comingled Recycling | 24219 | 3.45 | 1 |  |  |  |
|  |  |  |  |  |  |  |
|  | toothpaste | general waste - recycle only through terracycle |  |  |  |
|  | coffee cup | general waste |  |  |  |  |
|  |  |  |  |  |  |  |
| FOGO Total saved | **Recycling Total saved** |  |  |  |  |  |
| 1987.2216 | 8655.66 |  |  |  |  |  |
| Lost if contaminated | Lost if contaminated |  |  |  |  |  |
| 2016-17 | References |
| 1.9kg of CO2 per kg of food waste | https://watchmywaste.com.au/food-waste-greenhouse-gas-calculator/ |
| 2.6 capita per household | https://quickstats.censusdata.abs.gov.au/census\_services/getproduct/census/2016/quickstat/036?opendocument |
| 2.7 tonnes per capita | https://www.environment.gov.au/system/files/resources/7381c1de-31d0-429b-912c-91a6dbc83af7/files/national-waste-report-2018.pdf |
| 13338 | kg of C02 from waste per HH anually |
|  | https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html |
| 7.02 | tonnes per HH per anum |
| 3320.46 | kg C02 per hh per anum |
|   | http://www.stopwaste.co/calculator/ |
| 473 kg CO2 per tonne of MSW | http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.976.9906&rep=rep1&type=pdf |
| IPCC 2007 |