**Final Project Report – Erick Jones**

I compiled the land use of Austin by zoning and land use data. Furthermore, number of parking spaces and the square footage of those parking spaces by land use (single family homes, apartments and commercial buildings). Furthermore, I compared that square footage with the square footage actually in the buildings and the land area of the city of Austin. And then I used the building data I compiled to determine how much rooftop space Austin has and how much solar that could hold. I then compared those results to similar studies. I also wanted to find income correlations and land changing results as well, but finding property tax information hard to compile. As for how things might change land use, turns out Austin has pretty strict zoning and the only thing that would change that is to redo the codes.

**Files Downloaded**

Downloaded Land Use detailed from open data Austin. It provides shape files based on the corresponding land use. The text file in the folder describes the land use codes.

Also downloaded zoning from Austin which breaks the city into its zoning subdivisions. A pdf file provided by the City of Austin details the zoning codes

Downloaded 3 CSV files from ECAD which breaks down all the audited buildings for commercial, residential, and multifamily units. Not all residential units are audited. Most of the multifamily and commercial units are audited.

**Organizing Land Use Data**

Broke the land use data by single family housing, multifamily housing, business, undeveloped, parks, and water.

Printed plots of the geospatial to get an idea of the land use in Austin and provide a nice visualization.

**Cleaning ECAD Data**

Took ECAD data for commercial, residential, and multifamily units.

Checked for missing data and looked up the appropriate information online.

If the square footage was missing looked up the property online

For apartments with number of apartments missing looked at the apartment website or realtor website to determine the average size of apartments and divided the total apartment size by that.

Also checked for discrepancies with large square footage values for houses and apartments.

Corrected any mistakes using the same method.

**https://austinenergy.com/ae/energy-efficiency/ecad-ordinance/for-commercial-buildings**

**ECAD Data Insights**

The average apartment square footage is only 737 sq ft.

The average apartment complex has 113 units with the largest apartment complex having 644.

Furthermore, the average house has 1643 square ft, with the largest one having a whopping 12,012 square ft.

Commercial buildings average about 70,000 square ft., but the largest commercial complex is 1.4 million square ft.

**Prelim Parking Solutions**

Using only the ECAD data there are about 970,000 parking spaces in Austin taking up about 2.16% of the developed Austin land area.

Furthermore, parking takes up about 157 million sq ft. while the ECAD buildings take up 346 million sq ft. So, 31% of the square footage used by housing and commercial buildings is taken up by parking.

**Zoning Data**

Had to clean up the zoning data to break it down by the zones given in the zoning document.

The zoning document also gave minimum lot sizes which I used to determine the maximum number of lots per type.

Using that information and the parking requirements from the city codes, I estimated the number of parking spots from the number of zones.

For single family houses this resulted in a vast overestimation as most houses aren't on the minimum lot size.

However, it works out well for multifamily buildings since I was able to extrapolate the number of units per lot from the ECAD data

It also severely overestimated the number of parking spots for commercial property as well, due to the varying lot sizes of commercial property.

**Land Use and Zoning Results**

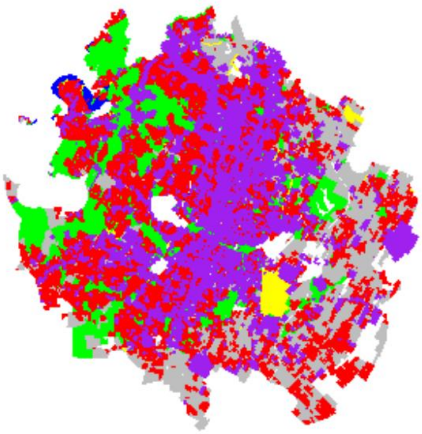
| Type | Land Use Area | Land Use % | Zoning Area | Zoning % |
|---|---|---|---|---|
| Single Family | 152.4 sq. mi.* | 58.5%* | 105.9 sq. mi. | 37.4% |
| Multi Family | | | 13.0 sq. mi. | 4.6% |
| Commercial | 98.23 sq. mi. | 37.74% | 52.6 sq. mi. | 18.6% |
| Park/Rec | 111.1 sq. mi. | 19.2%** | 1.878 sq. mi. | 0.66% |
| Transportation | 9.74 sq. mi. | 3.74% | N/A | N/A |
| Other | 169.7 sq. mi. | 30.4%** | 105.8 sq. mi. | 37.5% |

*Single Family and Multi Family are combined in the land use data

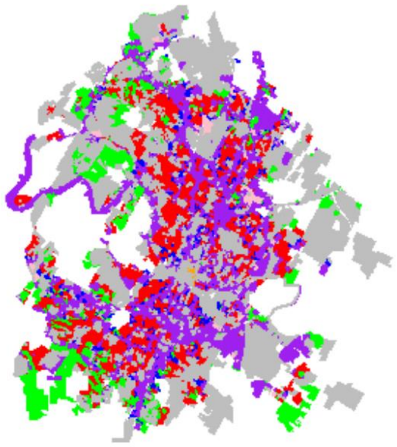
** These percentages include undeveloped land and water

The Austin land use data takes into account land and water area all around the city of Austin. The Zoning data only takes into account the City of Austin. Based on the land use data the parks make up 20% of the land in Austin almost more than housing area. Housing makes up almost 60% of the developed land while commercial use makes up almost all of the rest. For the land that is actually zoned housing makes up almost 44% and commercial uses are zoned for almost 20%. However, the zoning for parks and other recreation is spread out among numerous codes and makes up more land than single family housing.

Therefore, most of Austin's land use is actually parks and other trails and the like. The next highest use are single family housing which houses about 44% of the households. While multifamily housing which houses 56% of the people actually is the fourth largest zoned type coming in behind commercial zoning. As Austin expands, it will have to change the zoning from single family to multifamily though it can probably keeps its parks.



Land Use Map



Zoning Map

Red – Single-Family, Blue – Multi-Family, Green – Rural Family, Purple/Pink – Commercial, Grey – Other, Yellow - Transportation

**Housing Data**

To get a more accurate number of housing spots, I went to the census data there about 400,000 households and 44% of them own homes. So there are about 180,000 homes and with about two parking spots per home means there about 360,000 parking spots.

For the multifamily units the ECAD data gives a total number of 168,000 units which is a about 50,000 less than expected but is close enough to give a conservative estimate of parking spots based on the city of Austin requirements. They require 1.5 for a 1 bedroom, 2 for a 2 bedroom, 2.5 for a 3 bedroom, and 0.5 more spaces for each additional bedroom after that. The ECAD data doesn't include the average number of bedrooms but based on the average square footage of the apartment in a given complex, I calculated the average number of bedrooms.

**https://www.census.gov/quickfacts/fact/table/austincitytexas/LND110210**

**http://www.civicdashboards.com/city/austin-tx-16000US4805000/**

**Commercial Data inventory**

There is about 300 million square feet of commercial real estate in the Austin area, but that includes San Marcos, Bastrop and a lot of the surrounding areas. Meaning that the ECAD data which included 187

million square feet of commercial real estate should be close to the amount of commercial real estate in the city of Austin. To calculate parking spaces I used that data alone.

**http://www.trcaustin.com/wp-content/uploads/2016/05/HCP-Advisors-Market-Overview-2016-Austin-MSA.pdf**

**Parking Solution**

After, compiling and cleaning all the data. I was able to determine the following key points of information with the following assumptions

Assumptions

Parking spot is 18 ft. x 9 ft. = 162 square ft.

https://qcode.us/codes/temecula/view.php?topic=17-17_24-17_24_050

| Type | ECAD / Census Units | Parking Spaces | Square Ft. of Parking |
|---|---|---|---|
| **Single Family Housing** | 26,000 / 180,000 | 360,000 | 58,320,000 |
| **Multi Family Housing** | 168,000 / 220,000 | 684,000 | 110,808,000 |
| **Commercial** | 187 M / 300 M* | 682,000 | 110,000,000 |
| **Total** | 626 M* | 1,725,818 | 280,000,000 |

*Commercial and Total data is in square feet not number of units

4.00% of Developed Austin Land taken up by parking

5.75% of Developed Zoned Austin land taken up by parking

40.2% of developed building square footage is used for parking (excludes single family housing)

**Comparing Results**

Seattle a city with a similar population and tech base has 1.6 million parking spots according to the following study. Des Moise also has 1.6 million parking spots even though it has a much smaller population. Philadelphia as 2 million and New York has only 1.9 million.

Seattle is probably the closest comparison to Austin and my results almost matches identically with it. It should be noted that my calculations are on the conservative side and the other study took a more exact measurement using satellite data and other resources I don't have, but we have similar results.

**https://www.fastcompany.com/90202222/heres-how-much-space-u-s-cities-waste-on-parking**

**Solar Space**

Since I have so much data on buildings in Austin calculating roof space to determine how much solar could be installed was relatively easy. However, I wanted to calculate the maximum amount of energy that could be produced not necessarily how much would be reasonable. For instance, I assumed that every house would place a solar panel on every square foot of roof space regardless if the produced power would far exceed what they would normally consume.

Nonetheless, that evens itself out when I calculated the solar capacity of the commercial buildings. While the ECAD data does tell the number of floors for the apartments which allows me to accurately

determine the rooftop space, the commercial ECAD data does not and I conservatively estimated the average number of floors for each building to be 4.

Nonetheless, I came out with the conclusion that there was **about 4 GW of solar capacity** on the rooftops of a about 190,000 buildings which is surprisingly almost the exact same answer that Google's project solar came up with even though their methodology was different than mine and more conservative on the number of panels the single family households.

| TYPE | BUILDINGS | TOTAL MW POTENTIAL | PANELS |
|---|---|---|---|
| **SINGLE FAMILY HOUSING** | 180000 | 2,958 | 11,832,000 |
| **MULTI FAMILY HOUSING** | 8121 | 620 | 2,480,000 |
| **COMMERCIAL** | 2650 | 469 | 1,876,000 |
| **TOTAL** | 190771 | 4,047 | 16,188,000 |

https://www.lawnstarter.com/blog/texas/austin-tx/solar-power-in-austin/

**Final Remarks**

As a percentage of total land area parking doesn't take up that much space (less than 5%). However, of the building square footage parking is 40% of the created space which is shocking. That means that anytime someone wants to build anything almost 40% of the usable space is solely to store cars.

Other things that pop out when looking at Austin's land use map is the enormous amount of land used for single family housing which have large lots. In fact, single family zoning area is almost 7 times as large as multi family zoning even though multifamily housing houses more people. Another major thing that pops out are the immense amount of park lands Austin has. In fact there is more land used for parks and nature than there is for single family homes. As Austin becomes more dense easing the single family zoning and allowing more multi family buildings to be constructed in those areas will dramatically ease housing costs and it can be done without eating into any parkland.

However, one of the advantages of having so much single family housing it means there is a ton of potential for rooftop solar with the housing roof space accounting for a whooping ¾ of the 4 GW of rooftop solar potential in Austin.

All in all, if I was writing Austin's codes, I would reduce the size of the single family lots, encourage more multifamily lots, eliminate parking requirements entirely (let the market decide how much parking to build), encourage all homeowners to put solar on their rooftops, and then upgrade the grid to spread all of that solar energy across the city.