A Lifecycle Analysis Approach to the Sharing Economy:

Lessons from airbnb

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Table of Contents

Executive Summary

The rise of the sharing economy has led to an increased interest in whether or not these new services will benefit the environment, such as ridesharing and Airbnb. In the case of Airbnb, travelers rent rooms in residential units rather than hotels -- which are specifically designed for these rentals. Along with the financial repercussions of the sharing economy, we sought to determine if sharing can cut down on CO2 emissions.

Our study seeks to answer two important questions regarding Airbnb and its impact on the hospitality industry. The first point, which is more easily answerable, is whether Airbnb will reduce lifecycle greenhouse gas emissions in the hospitality sector. The second point will require further research and examination of the industry, as we would like to determine whether Airbnb is shifting demand away from hotel construction altogether. Airbnb is still a young company and its impact on the hospitality industry may not yet be fully realized, especially because hotels take many years to enter construction after being designed.

To answer these questions, we used an economic input-output lifecycle analysis (EIO-LCA) to conduct a comprehensive study of these sectors. The EIO-LCA approach uses the economic impact of an industry to determine how many inputs – and what type – are incorporated into an industry. This is especially useful when conducting a decomposition analysis is either too costly or time-intensive. We bounded our study within the city of Los Angeles because Airbnb data were available in this geographic area, and the study could provide valuable information to an already struggling housing market. Additionally, we determined that a functional unit of square feet would be most valuable in comparing the different sector qualities.

We conducted a thorough literature review of the environmental impact of the hospitality industry and residential sector. Some useful information included independent lifecycle assessments to compare with our own results, but also economic impacts of these industries. After determining the costs associated with construction and usage of these structures, we could effectively determine the inputs based on economic indicators. Ideally, we would have included demolition in our analysis, but the EIO-LCA tool does not account for this activity.

We conclude that Airbnb is effectively reducing greenhouse gas emissions, energy consumption, and water usage throughout the hospitality sector, on a per-square foot basis and through lifecycle emissions accounting. In many cases, Airbnb may even be reducing emission by over 75% of the hospitality industry. These are massive savings that come as a result of shifting demand away from structures specifically designed for short-term stays. Despite this, we fail to conclude whether demand for hotel construction has decreased due to Airbnb's prevalence in Los Angeles. Further research is needed to ascertain whether demand for hotels are truly depreciating, or whether Airbnb represents an alternative to traditional hotel demand.

Introduction

The "sharing economy" has exploded in popularity over the past few years. Traditional services from dedicated industries, such as hotels and taxis, have been subjected to intense restructuring due to the sharing economy. Companies such as Uber and Lyft have redefined the transportation industry and have left taxi companies reeling. In the hospitality sector, Airbnb has redefined how and where people "rent" rooms. This sector is where our analysis is based because of Airbnb's disruption of the hospitality industry.

An important implication of the sharing economy is how environmental impacts are affected. On a smaller scale, a person may forgo purchasing a new vehicle when they can use ridesharing services instead. Someone may choose to do this because of any number of reasons – cost and convenience being the most prominent. Yet when a person does not purchase a new vehicle, that results in one less car being manufactured, driven thousands of miles, and ultimately destroyed and recycled. The environmental impacts could be massive; the sharing economy might be drastically reducing environmental impacts, such as greenhouse gas (GHG) emissions. On a grander scale, we seek to answer a fundamental question about Airbnb and the hospitality industry: is Airbnb shifting market demand away from construction of new hotels?

We accomplished our study through a lifecycle assessment approach because it fully integrates each of the product stages -- manufacturing, use, and demolition. It is impractical to discuss products without accounting for each stage of their lifetime. We seek to answer our proposed questions above through this lens.

Goal and Scope

The goal of this study is to identify whether hotel or Airbnb has the least environmental impacts, as measured by GHG emissions, energy consumption, and water consumption. In addition, we try to determine economic impact, as measured by the number of employees demanded, which is important in the context of the sharing economy. Additionally, we refrain from isolating the impact of specific pollutants because it would require baselining the impacts from each sector, which is beyond the scope of this project.

We focus our study within very specific boundaries, both geographically and in principle. First, our study area is solely within the city of Los Angeles. We were able to obtain accurate data for the hospitality industry within this area, along with data for Airbnb's operations. The housing market in Los Angeles is also one of the most unaffordable by population income making it extremely important to find alternative housing solutions (Valhouli, 2016).

Second, we limit our analysis to the <u>construction</u> and <u>use</u> phases of the building's life. Both of these phases are accounted for in the EIO-LCA tool. Ideally, we could also account for the decommissioning and demolition of the structures, as these will also add to environmental impacts, yet that information is not readily available. Additionally, our literature review shows that environmental impacts, including CO_2 emissions and energy use, of the demolition phases are relatively small compared to the construction and use phases (Beatriz Rosselló-Batle, et al. 2010).

Third, we assumed a useful life of 50 years for each building. The literature suggests that buildings have a useful life of 50 - 100 years, but we would be unable to accurately account for some of the usage in the extended time frame. The use phase of buildings is when most of the carbon emissions are accounted for and therefore we heavily emphasized this phase. Finally, residential homes added to the complexity of the study because of their inherent differences from hotels and apartments. Single-family homes do not reflect the construction costs nor the usage patterns of hotels and apartments, and water usage in homes is nearly double that of apartment complexes because of outdoor watering needs. Therefore, we limited our study to multifamily apartment buildings.

Literature Review

We conducted a thorough literature review to ascertain certain characteristics of the hospitality and real estate sectors. Using an economic input-output lifecycle assessment, we needed to determine how the economics of these two sectors factored into our analysis.

The Filimonau et. al. reading provided a strong background on a lifecycle approach to assessing the hospitality industry. This study was unique because, unlike our analysis, the authors used "energy consumption… per [one] guest night" as their functional unit (Filimonau et al., pg. 1922). This is an entirely valid way to perform a lifecycle analysis, and indeed, it is very accurate to use energy as a standard. While energy consumption can be transferred between different structures, such as apartments and hotels, we aimed to take *each input* into consideration to address the entire lifecycle of a building; this includes water consumption and other services because they have environmental impacts in and of themselves.

We found it particularly useful to understand Airbnb within its context in the sharing economy. Literature suggests that Airbnb actually serves as a complement to the hospitality industry, as most of the rentals (over 75%) are beyond a hotel's catchment area (Zervas et al.). This perhaps serves as evidence that Airbnb is not producing a demand-shift away from hotel construction; instead, hotels are actually decreasing their rental prices, which can have a negative impact on EIO lifecycle analysis, as carbon emissions are directly tied to economic activity. Airbnb may also be contributing upwards of 10% to the hotel industry's revenue decline (Zervas et al.).

For residential buildings, we assessed the current literature to determine whether our analysis would produce similar results. One report estimates that residential units account for 19% of all US energy use, making it critical to account for these units (Ochoa, et al.). Importantly, this study accounted for each of the three phases of the lifecycle -- construction, use, and demolition. Their research indicates that the demolition phase accounts for very little of the carbon emissions throughout the lifecycle (Ochoa, et al.). Therefore, we consider it acceptable to not include the demolition phase in our analysis. Other important inputs were discerned through other readings and included throughout the report.

Functional Unit

The functional unit for this analysis is square feet of housing unit and hotel room. The purpose of a functional unit is to find a common property of the two projects being compared in order to perform an accurate comparison. In this instance, square feet is a unit found in both hotels and residences. Specifically, we would have liked to use "useable" square feet to take into account other aspects of hotels and living spaces, yet this information is difficult to uncover. Therefore, we are assuming that all square footage within a hotel or residence is "useful" and available for the renter to utilize.

System Boundary

Creating a system boundary is the first step to isolating the functions we seek to analyze. Our study consists of assessing the construction and use phases of both types of structures. The system boundary includes both materials and labor used during construction for hotels and residences. System boundaries have been constructed in multiple readings, and our system boundary diagram has been simplified from Filimonau et al. to both account for residential uses (See Figure 1).

Figure 1: Hotel System Boundary

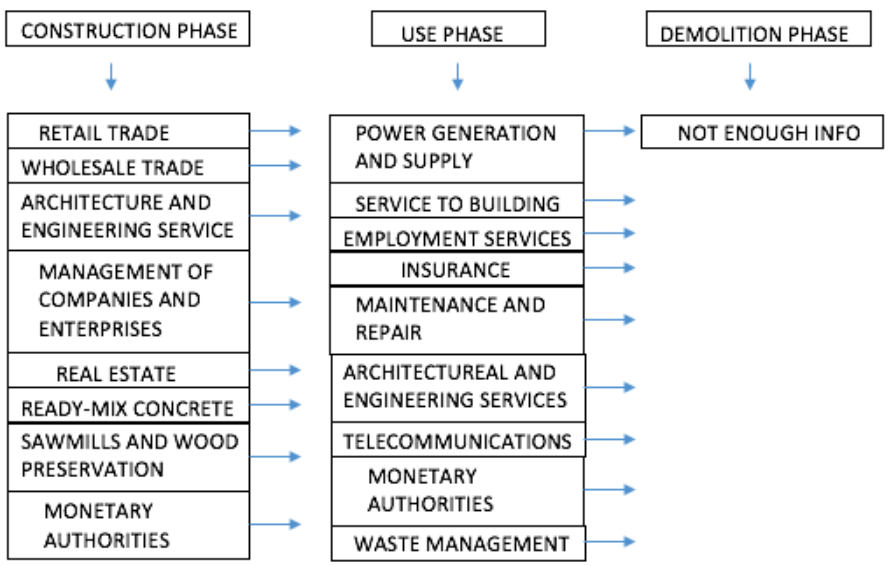
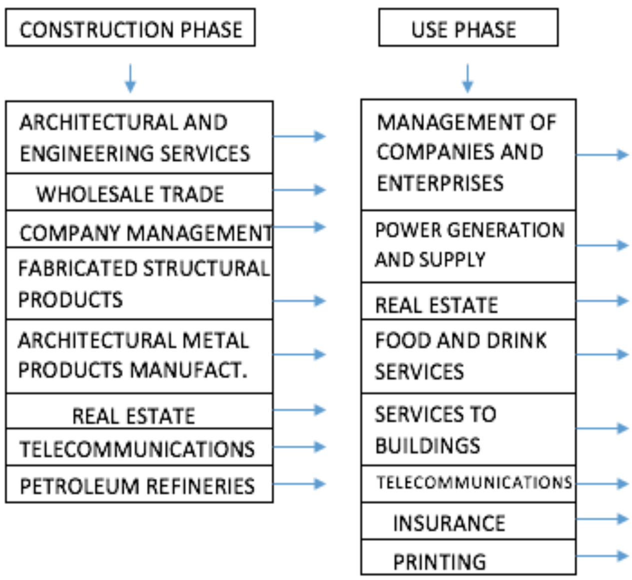


Figure 2: Apartment System Boundary



Process Flow

Our process flow diagram seeks to provide information on how much each input to hotels and residences pollute. We made multiple assumptions to create arbitrary cut-off points for the process flow because these diagrams can extend for a considerable amount of time. Our process flow diagrams end at the second stage of the cycle because it accounts for about 98% of all carbon inputs. The process flow diagrams account for tons of CO_2 equivalent for each input for the product. Both hotels and residential structures have two process flow diagrams because we have not combined the inputs from both the construction and use phases.

Figure 3: Apartment Construction Phase

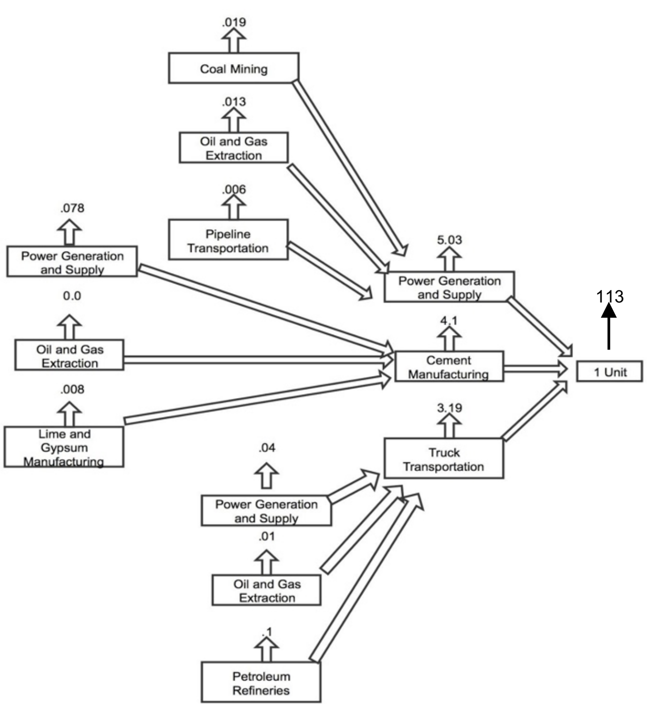


Figure 4: Apartment Use Phase

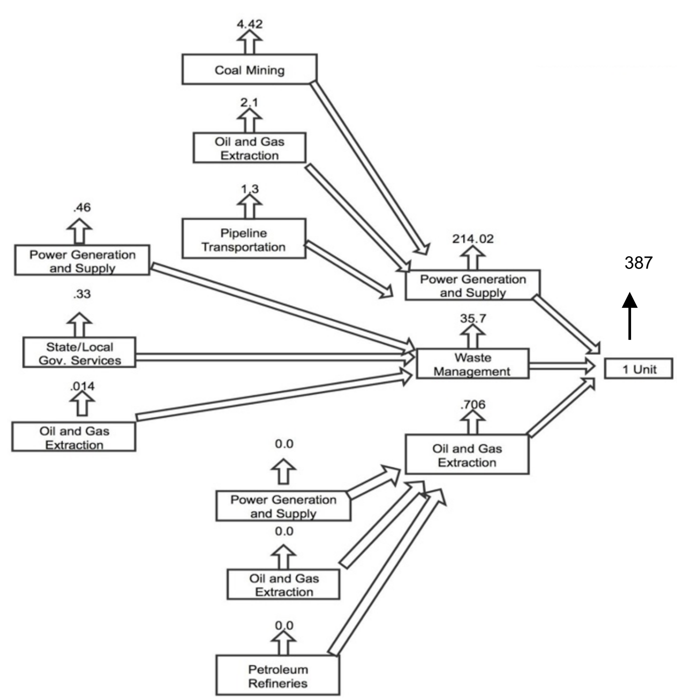


Figure 5: Hotel Construction Phase

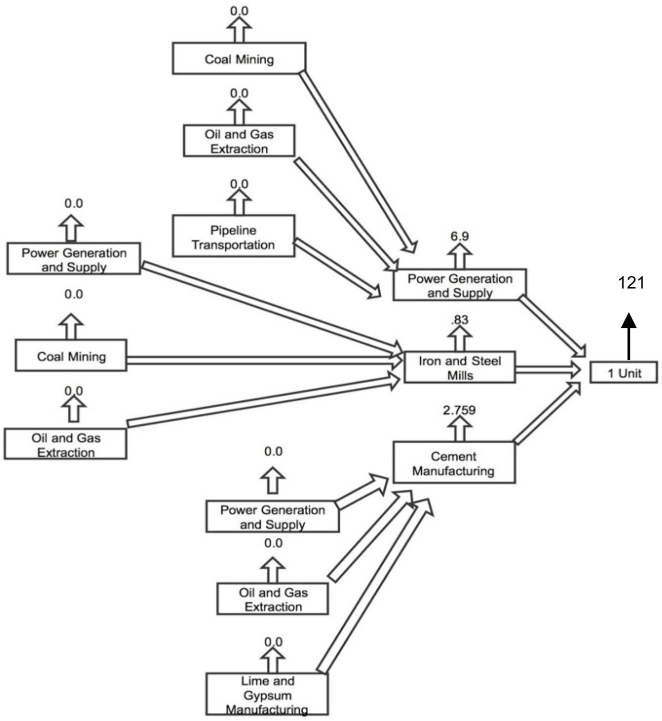
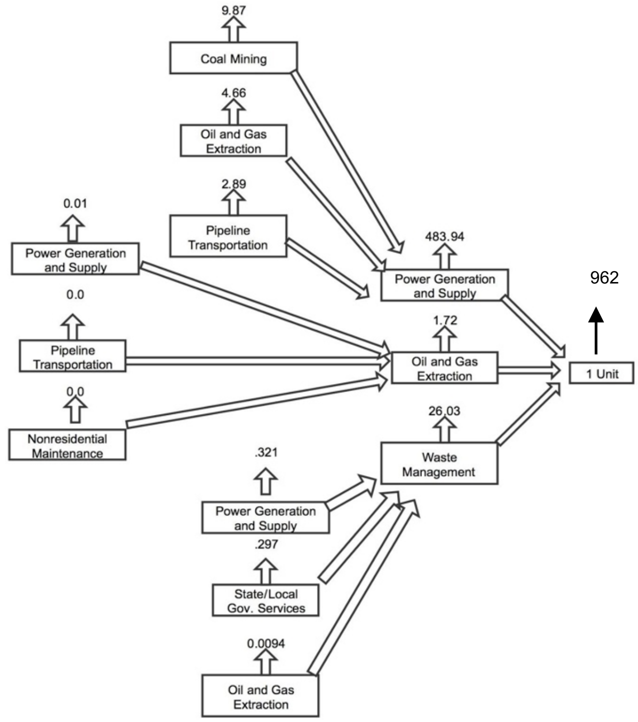


Figure 6: Hotel Use Phase



Methodology and Assumptions

The sharing economy is inherently difficult to quantify because it is the result of people *not* purchasing physical products. However, there is a large market for sharing services, and it is here that we seek to quantify the value of goods being shared. Using an economic input-output lifecycle analysis (EIO-LCA) approach, we are able to assess markets through the economic value of services, rather than the amount of goods being produced and supplied. This is especially useful for the sharing economy, where goods are not produced in each instance.

We assumed that apartment buildings were used for Airbnb because those buildings are similar to hotels when comparing these two sectors. Since the functional unit for this analysis is square feet, we identify the average sizes per room or unit. For hotels, we assumed the average size of a hotel room was about 330 square feet (CNBC, 2015). While this is the industry average throughout the entire US, we felt that it was accurate to assume the size within Los Angeles. For apartments, we assumed the average size of one bedroom was 800 square feet per unit in Los Angeles, given our research into the literature.

For the construction phase, we identified construction costs for hotels and apartments to run as economic activity in the EIO-LCA tool. We utilized averages for the US because data within Los Angeles County were not available. For hotels, we used data provided by HVS consulting firm (January, 2014) and chose an average construction cost per room for midscale hotels of $206,450 in the US. Since an empirical study shows that Airbnb is competing with lower-priced hotels (Zervas, et al. 2014), we believe that it is reasonable not to choose luxury hotels for this analysis. For apartments, we used an average construction cost per unit of residential buildings for five or more families in Los Angeles County, which was $171,978 (US Census Bureau, 2014-2015 average). After we ran the EIO-LCA tool for the construction sector of residential structures, we calculated the environmental impacts per square foot by the following equation:

$$\text{Environmental Impact } [-/\text{ft}^2] = \frac{\text{Environmental Impact } [-/\text{million } \$]}{(1 \times 10\text{^}6 \text{ [million \$]/Contruction Cost [\$]}) \times \text{Room Size } [\text{ft}^2]}$$

With respect to the use phase, it was critical to ascertain just how each of the inputs accounted for hotel and residential operations. For both residential and hotels, we also used averages within Los Angeles County for our calculations to account for a broad range of prices for goods. We assumed the average revenue of $148.39 to rent a hotel room per night (Los Angeles County Economic Development Corporation, 2014-2015 average) as economic activity for hotels. It is more appropriate to use the revenue rather than the average daily room rate in order to capture the economy-wide activity for hotels in Los Angeles; the revenue takes occupancy into account and is calculated as total room revenue divided by the total number of available rooms. Therefore, the revenue per square foot per year is $164.12.

For Airbnb, we assumed the economic activity is similar to the economic activity of real estate; therefore, we ran the EIO-LCA tool for the real estate sector. Additionally, we determined two kinds of economic values for Airbnb that would be suitable for this assessment: an average monthly rent fee for residence and an average revenue per available room. With an average monthly rent fee for one bedroom of $1,898 per unit (Rent Jungle, 2015), we assumed that Airbnb economic value is the same as a company's economic value by renting a room out for an entire year. We calculated the revenue per square foot per year of $28.47 by using $1,898 per unit, with the average room size of 800 ft^2. This economic value might be overestimated because rooms are also used for residence, and in that case, we would need to allocate the input. However, since these allocation data were unavailable, we used the revenue without allocation.

We found another way to determine the economic values of Airbnb by calculating an average revenue per available room for Airbnb. It might be more appropriate because it considers an important condition that rooms in apartments are shared for Airbnb and residence. In light of the nature of sharing economy, the environmental impacts of Airbnb would be small because Airbnb shared rooms are also used for residences. The annual monetary exchange – similar, yet distinct from, revenue – of Airbnb in Los Angeles was $204,818,000, and the total number of available rooms was 21,675 in 2015. These values were acquired through third party website data and (potentially) confidential resources. Though those rooms listed might include more than one bedroom, but also other style of rooms and houses, we assumed that all rooms were one bedroom with 800 ft^2 in apartments. Therefore, the revenue per square foot per year is $11.81.

After we ran EIO-LCA for the hotel service and real estate sector, we calculated environmental impacts per square foot for 50 years by the following equation:

$$\text{Environmental Impact } [-/\text{ft}^2] = \frac{\text{Environmental Impact } [-/\text{million } \$] * \text{Revenue}[\$/\text{ft}^2/\text{year}]}{1 \times 10^{\wedge}6\ [\$]} \times 50[year]$$

Lifecycle Inventory

We created a lifecycle inventory for both hotels and Airbnb within our boundaries. As we discuss previously, we ran EIO-LCA to calculate impacts of hotels and Airbnb. Figure 7 illustrates which sector in EIO-LCA and what economic activity we used. We will discuss which sector within each model contributes to the environmental and economic impacts in the later sections.

Figure 7: Lifecycle inventory

Category	Phase	Broad Sector Group in EIO-LCA	Sector (EIO-LCA 2002)	Sector (EIO-LCA 1997)	Economic Activity		Room Size
Hotel	Construction	Construction	Nonresidential commercial and health care structures	Commercial and institutional buildings	Construction cost per room	$206,450 [$/room]	330 [ft2]
	Use	Arts, Entertaiment, Hotels, and Food services	Hotels and motels, including casino hotels	Hotels and motels, including casino hotels	Revenue per available room	$148.39 [$/room/night]	330 [ft2]
Airbnb	Construction	Construction	Residential permanent site single- and multi-family structures	New multifamily housing structures, nonfarm	Construction cost per room	$171,978 [$/unit]	800 [ft2]
	Use1 (Apt1)	Finance, Insurance, Real Estate, Rental and Leasing	Real estate	Real estate	Monthly rent fee	$1,898 [$/unit/month]	800 [ft2]
	Use2 (Apt2)	Finance, Insurance, Real Estate, Rental and Leasing	Real estate	Real estate	Revenue per available room	$25.89 [$/room/night]	800 [ft2]

Impact Analysis

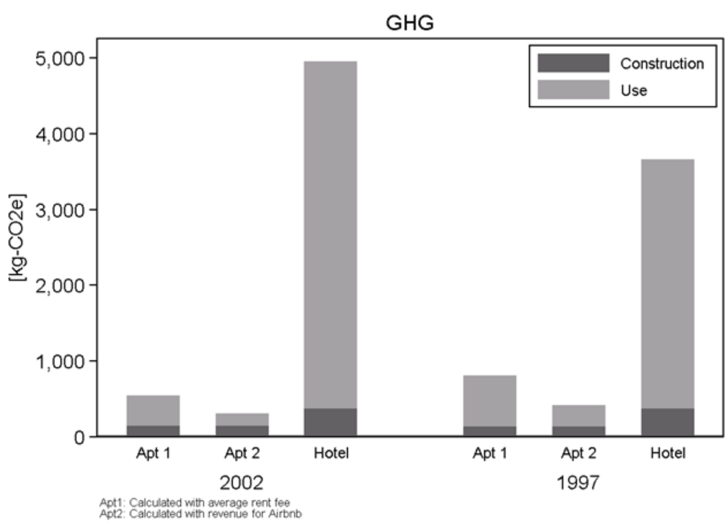
We conducted an impact analysis for GHG emissions, energy consumption, water usage, and job creation. We ran both the 2002 EIO-LCA and 1997 EIO-LCA for each impact analysis. However, water usage can be calculated only in the 2002 EIO-LCA, while the number of employees can be calculated only in the 1997 EIO-LCA. As mentioned above, we have two methods to calculate impacts for Airbnb, which are shown in Figures 8-11 as Apartment 1 and Apartment 2.

With respect to GHG emissions, most of the GHGs are emitted in the use phase for both hotels and Airbnb. Compared with residential homes, hotels have a much bigger impact than Airbnb in 2002 and 1997; though solely in the construction phase, the difference between hotels and Airbnb is not so large. This is simply because economic activity per square foot in the use phase of hotels is much larger than that of Airbnb. Additionally, for the 2002 EIO-LCA, the hotel service sector has bigger impact than the real estate sector at the same level of economic activity. For instance, GHG emissions from the hotel service sector is 1.97 times larger than GHG emissions from the real estate sector for $1 million of economic activity. With respect to the time trend, the 2002 EIO-LCA has bigger impacts than the 1997 EIO-LCA for hotels, while the 2002 EIO-LCA has smaller impacts than the 1997 EIO-LCA for Airbnb. Therefore, the difference between hotels and Airbnb is smaller in 1997 compared to the difference in 2002, though there is still a significant gap between hotels and Airbnb in 1997. As shown in Figures 8-11, we observe the same kind of trends for energy consumption, water usage, and the number of employees as GHG emissions.

Since the use phase for both the hotel sector and Airbnb accounts for the majority of the lifecycle impacts, we also examined which sector had the greatest impact directly and indirectly. Our study includes the top five direct and indirect contributors for each of the metrics because of space and impact considerations. However, the top five contributors account for at least 50% of the impacts in most of the metrics.

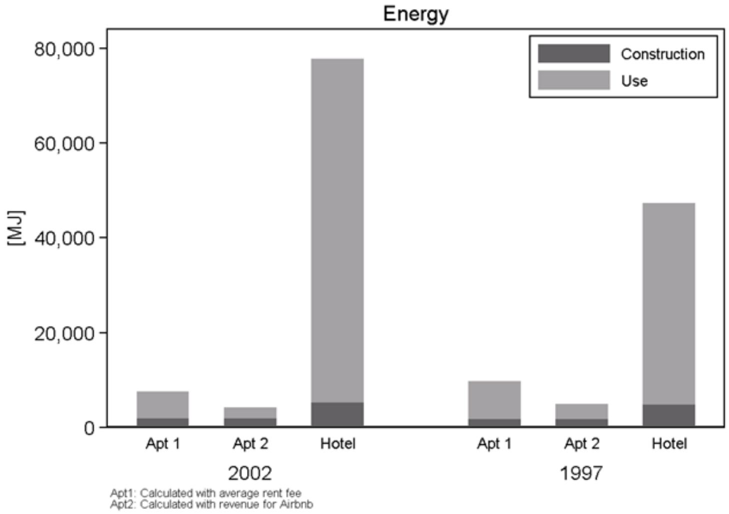
Overall, direct impacts accounts for 70-94 % of each total impact for hotels and Airbnb. For hotels, the power generation sector has the largest impact both directly and indirectly for GHG emissions, energy consumption, and water usage, while other sectors have the largest impact for employees. Although we have two economic values to calculate impacts for Airbnb, we show only the detailed use phase calculated with the average rent fee. This is because we used the real estate sector in EIO-LCA for both of the economic values and sectors with the largest impacts on the environment and economy are the same for both of the values (only the amount of impacts is different.). The power generation sector has the largest environmental impacts both directly and indirectly, just like the hotel industry, while other sectors account for majority part for job creation. See the Appendix for a more detailed impact assessment of the phases.

Figure 8. Lifecycle GHG emissions per square foot



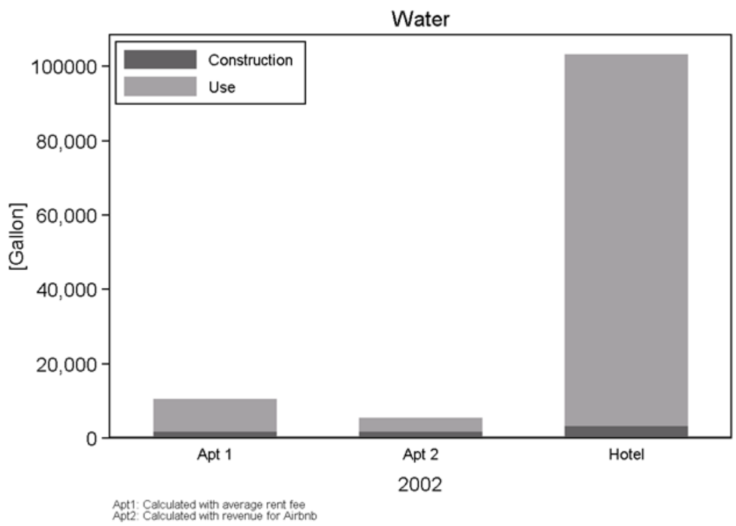
	EIO-LCA (2002)			EIO-LCA (1997)		
Phase	Apt 1	Apt 2	Hotel	Apt 1	Apt 2	Hotel
Use	405	168	4,587	672	279	3,283
%	74%	54%	93%	83%	67%	90%
Construction	142	142	368	138	138	375
%	26%	46%	7%	17%	33%	10%
Total	547	310	4,956	810	416	3,657

Figure 9. Lifecycle energy consumption per square foot



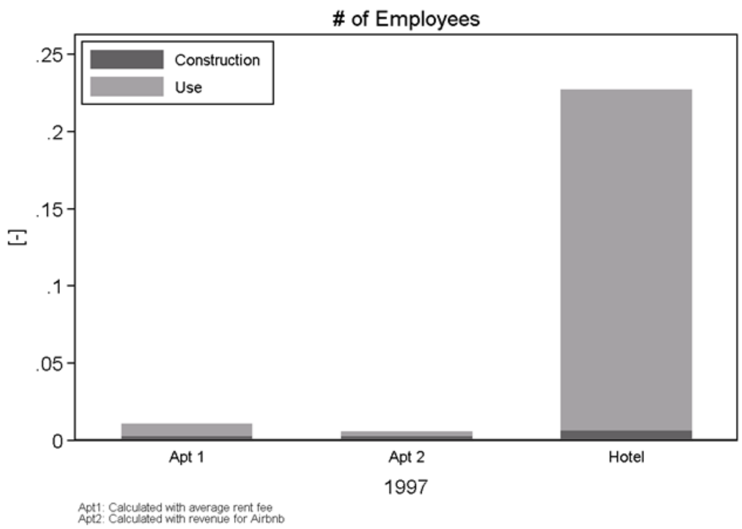
	EIO-LCA (2002)			EIO-LCA (1997)		
Phase	Apt 1	Apt 2	Hotel	Apt 1	Apt 2	Hotel
Use	5,651	2,345	72,627	7,991	3,316	42,592
%	75%	55%	93%	82%	66%	90%
Construction	1,915	1,915	5,218	1,698	1,698	4,830
%	25%	45%	7%	18%	34%	10%
Total	7,567	4,260	77,845	9,690	5,014	47,421

Figure 10. Lifecycle water consumption per square foot



	EIO-LCA (2002)		
Phase	Apt 1	Apt 2	Hotel
Use	8,740	3,626	100,119
%	83%	68%	97%
Construction	1,746	1,746	3,147
%	17%	32%	3%
Total	10,486	5,372	103,266

Figure 11. Lifecycle number of employees per square foot



	EIO-LCA (1997)		
Phase	Apt 1	Apt 2	Hotel
Use	0.0085	0.0035	0.2208
%	77%	58%	97%
Construction	0.0025	0.0025	0.0065
%	23%	42%	3%
Total	0.0110	0.0061	0.2273

Sensitivity Analysis

We have established that hotels use considerably more natural resources over their lifetimes -- and pollute significantly more -- than residential structures. However, it is interesting to consider how differently the sectors would pollute when changing certain inputs. Should the size of a hotel room or apartment increase, we would typically assume that environmental impacts would increase with it. However, exactly the opposite happens through the EIO-LCA tool. The environmental impacts *decrease* because a larger hotel room or apartment means that fewer residences can fit inside a single structure. This example illustrates how changing inputs can have drastic impacts on the lifecycle analysis of these sectors. Unlike other sectors where a greater number of inputs have the potential to be updated, there are few things to adjust in a sensitivity analysis for this industry.

A challenge with the sensitivity analysis is that the economic components are heavily influenced through the EIO-LCA tool. When assessing the sensitivity of the economic components of the hospitality and residential sectors, the economic indicators are directly tied to the environmental impacts. For example, we sought to determine whether an increase in hotel price is associated with increased or decreased environmental impacts. When increasing the hotel price, environmental impacts increase. However, we are hesitant to associate the increased cost directly with increased environmental impacts because the two concepts are inherently linked. Increasing the price will *always* result in an increase of environmental impacts, and vice-versa, regardless of other information. To assess how lifecycle results change based on those inputs (room size and room price), we conducted sensitivity analysis for GHG emissions in the following section. However, other environmental impacts including energy consumption and water usage would have similar results for sensitivity analysis to GHG emissions because those inputs similarly are impacted through sensitivity analysis (see Appendix).

Greenhouse Gas Emissions

For the hospitality industry, the base GHG emissions, in tons of CO2 equivalent, is 4,956; this accounts for both the construction and use phases of the hotel. The average size of a hotel room in Los Angeles is 330 square feet. However, adjusting for various room sizes allows for considerable differences in GHG emissions. We changed the base room size of 330 square feet by 20%, which means a large room is 396 square feet and a small room is 264 square feet. Larger rooms actually *decrease* GHG emissions because fewer rooms will be able to fit within the overall structure, and conversely for smaller rooms. Larger rooms account for about 4,130 tons of CO2e, while smaller rooms account for about 6,195 tons of CO2e. There is a significant difference in how room size impacts emissions.

Since cost of renting a room is also a strong determinant in assessing GHG emissions, we changed the base renting fee by 20%. However, there are serious drawbacks to this study. The EIO-LCA tool linearly associates cost to GHG emissions, which means that *any* increase in cost will result in an increase in GHG emissions. Conversely, a reduction in economic impact will also produce a decrease in GHG emissions. This is not always accurate and the opposite may actually be true. Hotel rental costs are associated with the quality of the building, which includes retrofits and energy-efficient appliances. In general, more expensive rooms indicate that more efficient fixtures are in place at the hotel. Therefore, higher price does not mean that GHG emissions have increased. Despite this, we have included the results in our study.

Figure 12: Hotel Sensitivity Analysis

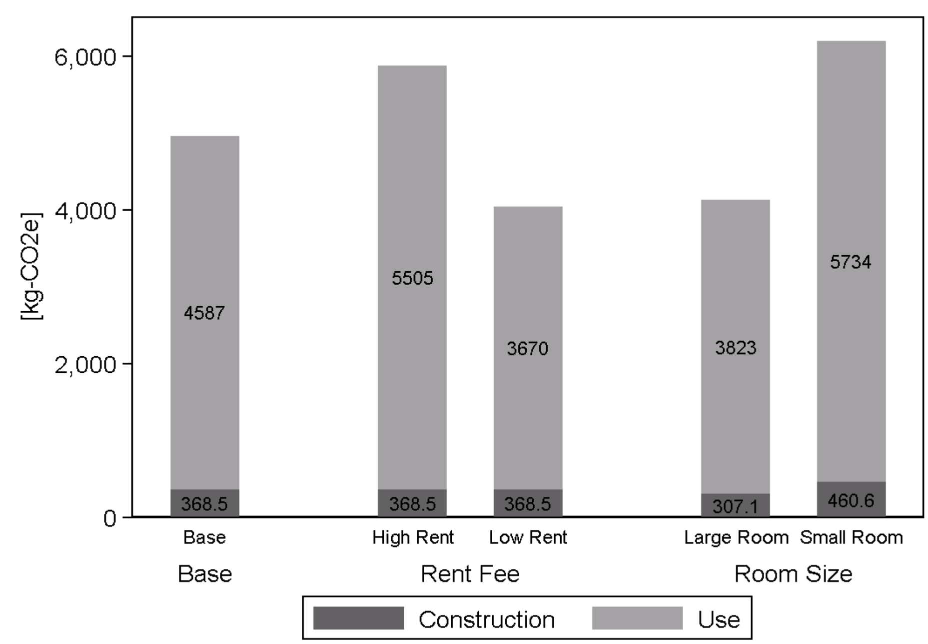
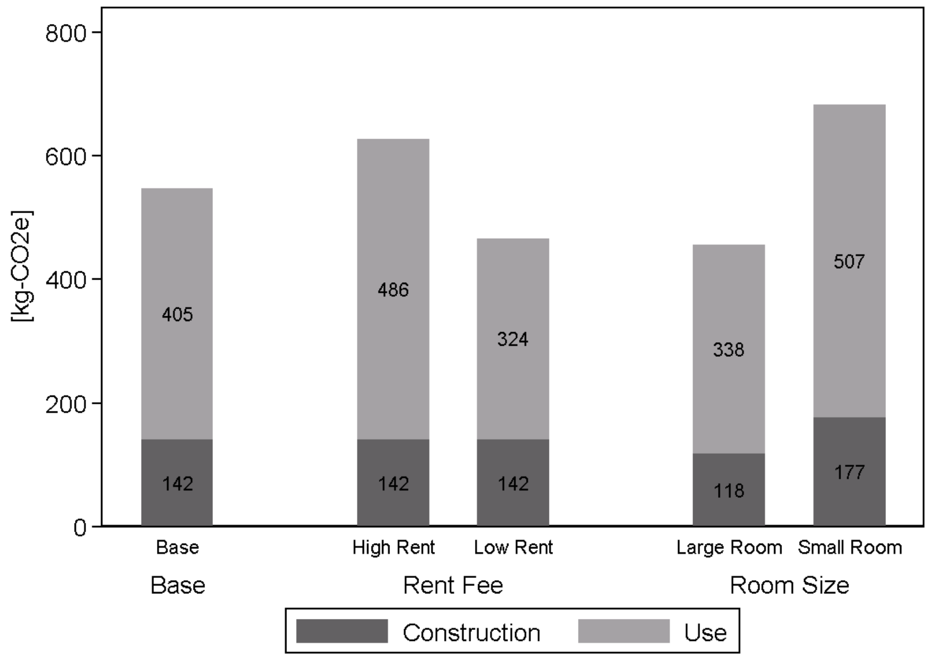


Figure 13: Apartment Sensitivity Analysis



Limitations of Current Study

Our study aims to be as comprehensive as possible, given time constraints and informational deficiencies. There were, however, some difficulties in conducting this analysis based on currently available information.

While using an economic input-output lifecycle analysis was the most comprehensive and accessible way to conduct this study, there were some inherent flaws in this method. The EIO-LCA tool from Carnegie Mellon University was last updated in 2002, indicating that we had to assume that hotel and residential construction and usage were economically equivalent in 2015 (where we obtained economic data for Airbnb and the hospitality industry). Also, though we assumed that Airbnb economic activity is similar to real estate economic activity, it might be not true. However, there is no other sectors that represent Airbnb activity in EIO-LCA.

Another limitation is that the EIO-LCA data are for the entire US and does not necessarily reflect the Los Angeles energy mix. The Los Angeles Department of Water and Power is currently operating with approximately 30% renewables and has pledged to decommission all coal-fired power plants by 2030 (Tucker, LADWP). Unfortunately, the analysis may not necessarily reflect that energy mix at this time, and more importantly, does not reflect the *future* energy mix of 2030. This is a major aspect of lifecycle emissions that must be considered, but it can only be accomplished through a tool designed for the local level and not national.

Moreover, hotels are more than just a place for someone to sleep; they can act as restaurants, bars, recreational facilities, and a host of other potential uses. Residential housing, however, generally acts only as the foremost type. Thus, it would be worth to allocate or expand the system based on their functions in order to compare with them more appropriately in the future research.

Finally, while our study is inherently focused on the economic aspects of the hospitality industry, it could be beneficial to investigate the lifecycle cost implications of Airbnb. In a traditional hospitality service, the company provides all maintenance and repairs, with the costs bundled into the hotel room price. However, with Airbnb, apartment owners and renters make the repairs, and increasing the number of occupants in apartments also increases the wear and tear on facilities. Hotels are also in a for-profit industry, which means they are always thinking of ways to improve the bottom line. Energy-efficiency projects, such as lighting and HVAC control upgrades, have high initial costs but reduce long-run costs. It would be very interesting to understand how the sharing economy influences the lifecycle costs of short-term rentals.

Results and Conclusion

Our analysis aimed to determine whether the sharing economy resulted in environmental impact reductions, which in turn should inform us whether demand for hotel construction has decreased. It was far easier to answer the former question rather than the latter, and even then, our analysis was based on many different assumptions. We can conclude that shifting demand away from hotels and into personal residences will have a strong lifecycle impact in reducing environmental impacts for GHG emissions, energy consumption, and water usage. This is an important point that reflects how construction methods and, most importantly, usage of buildings contribute to pollution. However, the shifting demand from hotels to Airbnb has negative impact on job creation, though it might be the nature of sharing economy. Given that sustainability is related not only environmental aspects but also economic and social aspects, it is important to consider other aspects beyond the environment.

We conclude that Airbnb rentals *do* result in environmental impact reductions over the lifecycle of an apartment and hotel. Residential structures are inherently less carbon intensive, and diverting some clients away from hotels and into these structures helps produce carbon offsets. However, we are unable to determine whether Airbnb is resulting in hotels *not* being constructed. Conducting a comprehensive analysis of this question would require more detailed information about a very young industry and different approaches beyond lifecycle assessment. We are hopeful that this question can be answered within the next few years as Airbnb expands and collects more data about their operations.

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Appendix I

Detailed Use Phase Analysis

Detailed use phase for the hotel sector

Hotel (EIO-LCA 2002)					
Sector	GHG [kg]	Sector	Energy [MJ]	Sector	Water [Gal]
Total	**4,587**	**Total**	**72,627**	**Total**	**100,119**
Direct Total	**3,338**	**Direct Total**	**57,615**	**Direct Total**	**76,126**
Power generation and supply	2,308	Power generation and supply	28,134	Power generation and supply	65,614
Hotels and motels, including casino hotels	643	Hotels and motels, including casino hotels	24,122	Hotels and motels, including casino hotels	8,843
Waste management and remediation services	124	Paper mills	970	Grain farming	204
Paper mills	27	Petroleum refineries	438	Paper mills	195
Petroleum refineries	26	Nonresidential maintenance and repair	298	Postal service	171
Direct Other	209	Direct Other	3,653	Direct Other	1,098
Indirect Total	**1,254**	**Indirect Total**	**15,013**	**Indirect Total**	**24,342**
Power generation and supply	401	Power generation and supply	4,887	Power generation and supply	11,398
Oil and gas extraction	159	Paper mills	978	Grain farming	6,678
Coal mining	75	Oil and gas extraction	954	Cotton farming	967
Cattle ranching and farming	68	Petroleum refineries	934	Fruit farming	768
Petroleum refineries	56	Paperboard Mills	698	Cattle ranching and farming	626
Indirect Other	495	Indirect Other	6,562	Indirect Other	3,906

Hotel (EIO-LCA 1997)					
Sector	GHG [kg]	Sector	Energy [MJ]	Sector	Employee
Total	**3,284**	**Total**	**42,598**	**Total**	**0.2208**
Direct Total	**2,323**	**Direct Total**	**32,707**	**Direct Total**	**0.2076**
Power generation and supply	1,352	Power generation and supply	16,031	Hotels and motels, including casino hotels	0.1894
Hotels and motels, including casino hotels	442	Hotels and motels, including casino hotels	11,824	Travel arrangement and reservation services	0.0021
Waste management and remediation services	214	State and local government electric utilities	536	Drycleaning and laundry services	0.0013
State and local government electric utilities	60	Waste management and remediation services	527	Management of companies and enterprises	0.0012
Water, sewage and other systems	31	Travel arrangement and reservation services	499	Employment services	0.0011
Direct Other	224	Direct Other	3,290	Direct Other	0.0125
Indirect Total	**961**	**Indirect Total**	**9,891**	**Indirect Total**	**0.0134**
Power generation and supply	355	Power generation and supply	4,210	Wholesale trade	0.0018
Waste management and remediation services	88	Petroleum refineries	421	Employment services	0.0011
Oil and gas extraction	52	Paper and paperboard mills	390	Agriculture and forestry support activities	0.0004
Coal mining	48	Pipeline transportation	370	Food services and drinking places	0.0004
Truck transportation	47	Truck transportation	339	Retail trade	0.0004
Indirect Other	370	Indirect Other	4,162	Indirect Other	0.0093

Detailed use phase for Airbnb

Airbnb (EIO-LCA 2002)					
Sector	GHG [kg]	Sector	Energy [MJ]	Sector	Water [Gal]
Total	**405.3**	**Total**	**5,651**	**Total**	**8,740**
Direct Total	**308.9**	**Direct Total**	**4,580**	**Direct Total**	**7,186**
Power generation and supply	224.1	Power generation and supply	2,731	Power generation and supply	6,369
Waste management and remediation services	37.4	Real estate	1,354	Real estate	549
Real estate	17.9	Other state and local government enterprises	149	Other state and local government enterprises	93
Other state and local government enterprises	8.7	Nonresidential maintenance and repair	40	All other crop farming	78
Nonresidential maintenance and repair	2.6	Hotels and motels, including casino hotels	37	Waste management and remediation services	16
Direct Other	18.3	Direct Other	269	Direct Other	80
Indirect Total	**96.4**	**Indirect Total**	**1,075**	**Indirect Total**	**1,554**
Power generation and supply	35.6	Power generation and supply	434	Power generation and supply	1,011
Oil and gas extraction	10.9	Petroleum refineries	79	Grain farming	291
Waste management and remediation services	7.3	Oil and gas extraction	65	Paint and coating manufacturing	44
Coal mining	7.0	Pipeline transportation	41	Cotton farming	24
Petroleum refineries	4.7	Iron and steel mills	30	All other crop farming	21
Indirect Other	30.8	Indirect Other	426	Indirect Other	163

Airbnb (EIO-LCA 1997)					
Sector	GHG [kg]	Sector	Energy [MJ]	Sector	Employee
Total	**671.9**	**Total**	**7,991**	**Total**	**0.0085**
Direct Total	**497.7**	**Direct Total**	**6,307**	**Direct Total**	**0.0062**
Power generation and supply	309.9	Power generation and supply	3,675	Real estate	0.0028
Waste management and remediation services	75.5	Real estate	1,993	Employment services	0.0008
Real estate	72.1	Waste management and remediation services	186	Services to buildings and dwellings	0.0005
State and local government electric utilities	13.8	State and local government electric utilities	0	Investigation and security services	0.0002
Services to buildings and dwellings	3.8	Services to buildings and dwellings	59	Agriculture and forestry support activities	0.0001
Direct Other	22.6	Direct Other	394	Direct Other	0.0018
Indirect Total	**174.2**	**Indirect Total**	**1,684**	**Indirect Total**	**0.0023**
Power generation and supply	63.0	Power generation and supply	747	Wholesale trade	0.0003
Waste management and remediation services	23.8	Pipeline transportation	74	Employment services	0.0002
Coal mining	10.3	Petroleum refineries	66	Retail trade	0.0001
Oil and gas extraction	9.7	Waste management and remediation services	59	Services to buildings and dwellings	0.0001
Pipeline transportation	9.3	Air transportation	53	Food services and drinking places	0.0001
Indirect Other	58.1	Indirect Other	684	Indirect Other	0.0015

Sensitivity Analysis

Hotel		Base	Rent Fee		Room Size	
			High Rent	Low Rent	Large Room	Small Room
GHG	Use	4,587	5,505	3,670	3,823	5,734
	Construction	368	368	368	307	461
	Total	4,956	5,873	4,038	4,130	6,195
Energy	Use	72,627	87,153	58,102	60,523	90,784
	Construction	5,218	5,218	5,218	4,348	6,522
	Total	77,845	92,370	63,319	64,871	97,306
Water	Use	100,119	120,143	80,095	83,432	125,149
	Construction	3,147	3,147	3,147	2,622	3,933
	Total	103,266	123,289	83,242	86,055	129,082

Airbnb (Apt1)		Base	Rent Fee		Room Size	
			High Rent	Low Rent	Large Room	Small Room
GHG	Use	405	486	324	338	507
	Construction	142	142	142	118	177
	Total	547	628	466	456	684
Energy	Use	5,651	6,782	4,521	4,709	7,064
	Construction	1,915	1,915	1,915	1,596	2,394
	Total	7,567	8,697	6,436	6,306	9,458
Water	Use	8,740	10,488	6,992	7,284	10,925
	Construction	1,746	1,746	1,746	1,455	2,182
	Total	10,486	12,234	8,738	8,738	13,107