

OKITSU-KAZE

Enhancing San Diego's Urban Coastal Development through the Exploration
of Wind Patterning and Adaptation



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Enhancing San Diego's Urban Coastal Development through the
Exploration of Wind Patterning and Adaptation

A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
of North Dakota State University

By
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In Partial Fulfillment of the Requirements
for the Degree of
Bachelor of Landscape Architecture

THESIS ARCHIVAL NOTE

The following thesis project, entitled OKITSU-KAZE: Enhancing San Diego's urban coastal development through the exploration of wind patterning and adaptation, was composed over the course of the 2016-2017 academic school year. The Thesis Program, as contained here, was initiated and completed in the fall semester as a part of the LA563: Programming and Thesis Preparation course. Supplemental material, including the Thesis Boards and the Thesis Presentation documents, were generated in the spring semester as a part of the LA 572: Design Thesis studio. Any inconsistencies between the different documents, in terms of research and design, should be disregarded per the evolution of the project across the two semesters.



Primary Thesis Advisor



Secondary Thesis Advisor

May 2017
Fargo, North Dakota

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Abstract

This project is concern about one big nature power, Wind power. The western coast of the North America continent is the one of the strongest wind facing area of the world. The strong wind from ocean will cause several negative effects for our living. Such as, the slat in the wind accelerate the decay of the building material, the wind contains a lot of humid, creates fog in the morning, directly affected tropical cyclone to the shore line. On the other hand, such strong wind area is moderate to construct wind farm, the cluster of wind turbines for exchanging wind blowing power to the electricity. In my program, I approached how to treat such big power source to the city benefit.

Key words:

Wind energy, Morphology, Wind Turbine, Urban, Connection



Problem Statement

How can wind patterns be better applied and utilized as a part of urban design?

Statement of Intent

Project Typology

A coastal wind in urban environment.

Claim

The coast line of Pacific Ocean is good place to collecting wind and its resilience is often under pressure of fear for natural disasters such as hurricane, typhoon developed by tropical cyclone. Landscape Architecture is capable to decrease the damage from low pressure air flow by reorganizing the formation of facilities and making people aware of the issue through design features focused on well deal to wind in the city.

Theoretical Premise

A city of San Diego always face in front of effect of wind from Pacific Ocean. System strategy able to create an effective wind treat that provides comfort living society between natural environment and people in the city.

Project Justification

A separation of circulation ground level and wind track will create comfortable outdoor area, which encourages more frequent outside activities.

Narrative

Imagine the scene what you feel nature in your life. For me, it is on the grass paved ground near the forest. Wind bring the smell of flower, able to feel the sense of season, especially in early spring. But such relaxing time is made by calm comfortable wind. The strong wind gives negative effect to us. For example, tiny dust endangers our sensitive organs like eyeball, sudden wind pushes our body out of control direction, and fast wind take the heat from our body mostly in winter. In order to apply such strong wind power for positive way in people life, ancient people approached in many ways. Since Egypt Era, wind energy was already used by human mainly for removing water or milling grains. Even today, the wind is close to our life. Along with developing human technology in the world, the total amount of energy consumption gets more and more. Our live are taken place by a bunch of tools that we do not consume energy by own self. Especially, power of the nature such as solar power and wind power is applied to human life in ancient history. For my thesis, I chose the study of wind energy as the subject because this is the closet energy I'm able to feel through my daily life. My hometown is getting developed gradually, I can see the skyscrapers creating stronger wind in downtown and surroundings. so I wondered if I apply such strong energy to confident way.

User: Client Description

Client

The client is the city of Eureka and other organizations working with the technology about power plant of wind, California's Redwood Coast Department, and California Natural Diversity Database (CNDD).

Users

Urban Dwellers

The definition of this group is that residents and college students who live in the city of San Diego and around the city. This group may use personal transportation, bike, or walk to the site. Structures designed for them include bike and walk traffics public transit access, eating availability, open green spaces. Further research will determine the quantity of urban dwellers, but anticipated peak usage will be spring to fall. On the other hand, adding winter value at the city is also important, will attract people through the year.

Tourists

This group is that people visit San Diego city for short term. They will stay in hotel, use public transportation often such as ferry, bus, and train. Rental bike is also accessible near hotel dense zone. The state California attracts tourists all year long, especially in summer, they get the peak of number.

Major Project Elements

Wind Turbines

This element will add the taste of characteristics of the city San Diego by their shape, color, and formations. Size and even authority is various, from governmental, public power source to private house energy source. Light poles on the sideway also has the small self-power generating turbine. This is not only for environmental solution, but also for reduction of budget of governments.

Wind Shelter/ Wall

This element will work on rising the safety level in the city of San Diego. The wind wall will use native tree to form it, it will contribute to the ecological solution too. The shelter is required the study of organic shape we are able to observe in nature.

Formation of Buildings

This element is so important even determining the appearance of the city of San Diego far from its existing. This affects width of street, distance between building to building, the roof shape especially high rises. This element will directly have connected to reducing wind speed on the ground level.

Recreational Elements

There are already existed yearly recreational activities related to the history of the city of San Diego and California state. Therefore, my projects should design to enhance these original recreations and add more new generation sense in the heritage site

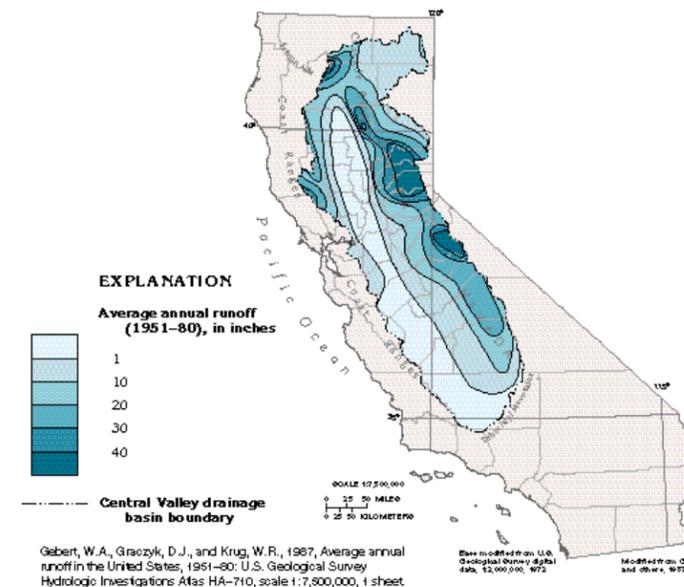
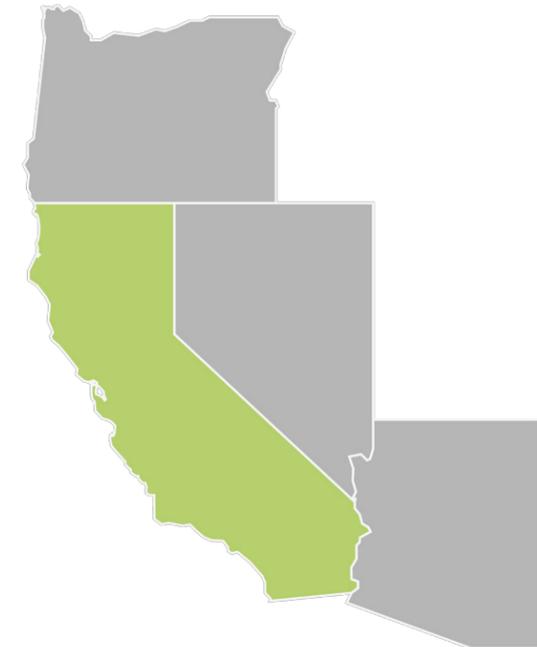
Site Information: State

California State is the most populous state in the United States and the third most extensive by area. California's diverse geography ranges from the Pacific Coast in the west to the Sierra Nevada mountain range in the east; and from the redwood-Douglas fir forests in the northwest to the Mojave Desert in the southeast. The Central Valley, a major agricultural area, dominates the state's center.

Area:
land: 163,696 mi²
Water: 4.7%

Population:
39,144,398

Density:
246/mi²



California's interconnected water system serves over 30 million people and irrigates over 5,680,000 acres of farmland. As the world's largest, most productive, and most controversial water system, it manages over 40,000,000 acre feet of water per year.

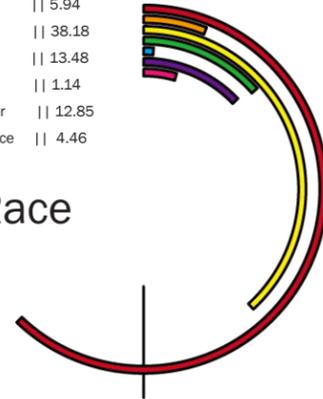


Male : Female = 49.7; 50.3

Total Population :
39,144,398

From top:	%
White	62.13
Black	5.94
Hispanic	13.48
Asian	1.14
Native	12.85
One Race, Other	4.46
Two or More Race	

Population: Race



Population: Age

From top:	%
75~	5.42
65-74	6.71
55-64	11.32
45-54	13.79
35-44	13.60
25-34	14.48
15-24	14.70
10-14	6.70
5-9	6.65
~5	6.62



Population: Income

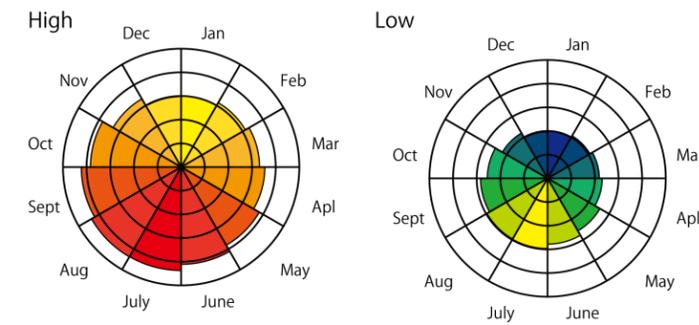
From top:	%
200k more	7.6
150k-200k	6.9
100k-150k	14.91
75k-100k	12.34
50k-75k	16.73
40k-50k	7.92
30k-40k	8.74
20k-30k	9.28
10k-20k	9.87
~10k	5.8



The United States Census Bureau estimates that the population of California was 39,144,818 on July 1, 2015, a 5.08% increase since the 2010 United States Census. Between 2000 and 2009, there was a natural increase of 3,090,016 (5,058,440 births minus 2,179,958 deaths). During this time period, international migration produced a net increase of 1,816,633 people while domestic migration produced a net decrease of 1,509,708, resulting in a net in-migration of 306,925 people.

Although most of the state has a Mediterranean climate, due to the state's large size, the climate ranges from subarctic to subtropical. The cool California Current offshore often creates summer fog near the coast. Farther inland, there are colder winters and hotter summers. Northern parts of the state have more rain than the south. California's mountain ranges also influence the climate: some of the rainiest parts of the state are west-facing mountain slopes. Northwestern California has a temperate climate, and the Central Valley has a Mediterranean climate but with greater temperature extremes than the coast.

Temperature Average



Top 10 Industry in the State

Educational Service, Healthcare, Social Assistance	21.01 %
Professional, Scientific, Management, Administrative, Waste Management Services	12.71 %
Retail trade	11.13 %
Arts, Entertainment, Recreation, Accommodation, Food Services	10.05 %
Manufacturing	09.88 %
Finance, Insurance, Real Estate, Rental, Leasing	06.31 %
Construction	05.92 %
Public Administration	04.62 %
Transportation, Warehousing, Utilities	04.62 %
Wholesale Trade	03.13 %

Site Information: City

San Diego is a major city in California, United States. It is in San Diego County, on the coast of the Pacific Ocean in Southern California, approximately 120 miles south of Los Angeles and immediately adjacent to the border with Mexico.

With an estimated population of 1,307,402 in 2016. San Diego is the eighth-largest city in the United States and second-largest in California. It is part of the San Diego-Tijuana conurbation, the second-largest trans-border agglomeration between the US and a bordering country after Detroit-Windsor, with a population of 4,922,723 people. San Diego has been called "the birthplace of California". It is known for its mild year-round climate, natural deep-water harbor, extensive beaches, long association with the United States Navy, and recent emergence as a healthcare and biotechnology development center.

Area:

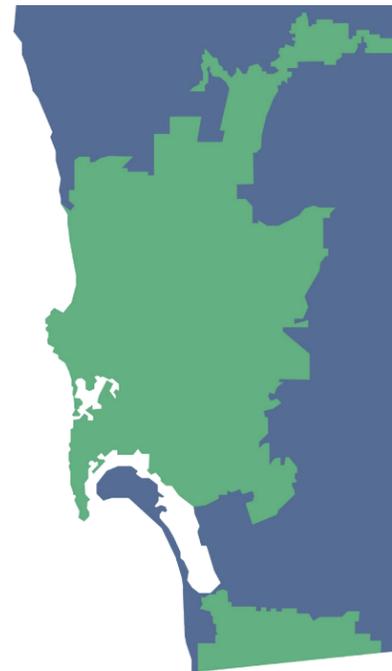
land 325.19 mi²
 water 47.21 mi²
 Total 372.40 mi²

Population:

1,381,049

Density:

4,003/mi²



The wind steady blow from west or north west, from Pacific Ocean going through peninsula and inlet to the site. The average wind spend in San Diego is 6 to 8 mph, but the site paced at shore line, it is estimated around 8 to 10 mph. the fastest season is in May, calmest season is December. The site is moderate to control wind direction because there is no cause of wind destruction in around. However, the wind from sea brings salt to the surface of the ground, the material of the buildings and plant species should be selected carefully.

Male : Female = 49.8 : 50.2

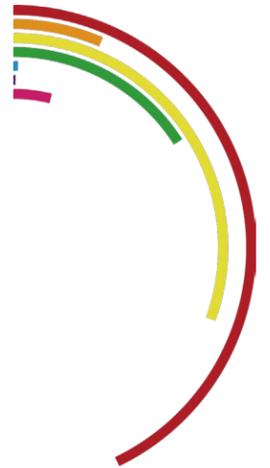


Total Population :

1,307,402

Population: Race

From top:	%
White	42.8
Black	6.4
Hispanic	30.5
Asian	15.9
Native Hawaiian	0.4
American Indian	0.2
Two or More Race	3.9



Population: Age

From top:	%
75~	5.15
65-74	4.69
55-64	10.34
45-54	13.45
35-44	14.33
25-34	17.77
15-24	14.95
10-14	5.98
5-9	5.97
~5	6.41



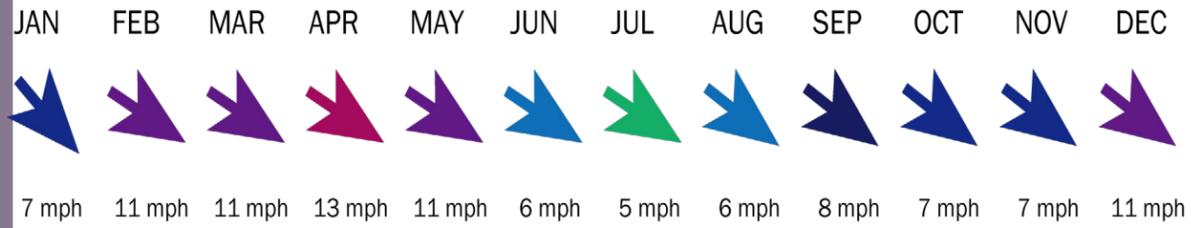
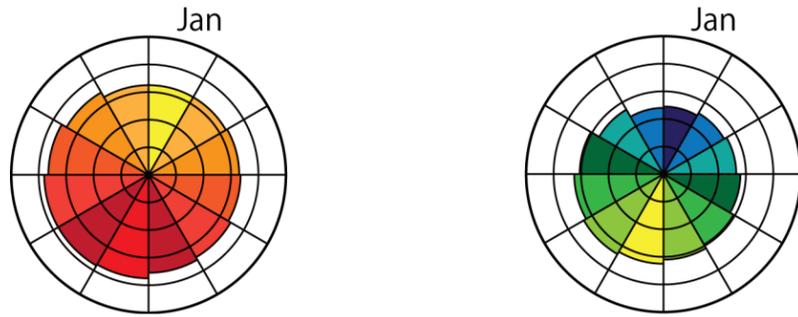
Compare to the data of the California state, the rate map of population is pretty close to the state average. And citizens are mostly white, close feature to that cities in the north middle of the state. The San Diego population density is 4,003 people per square mile, which is much higher than the state average density of 232.55 people per square mile and is much higher than the national average density of 82.73 people per square mile.

Population: Income

From top:	%
200k more	9
150k-200k	8
100k-150k	15
75k-100k	13
50k-75k	17
40k-50k	7
30k-40k	8
20k-30k	8
10k-20k	9
~10k	5



High and Low Average Temperature in San Diego



Top 10 Industry in the City

Educational Service	22.5 %
Professional, Scientific, and technical Services	16.7 %
Arts, Entertainment, and Recreation	13.1 %
Healthcare	12.6 %
Management of companies nad enterprises	12.2 %
Social Assistance	10.3 %
Mortor vehicle and parts dealers	09.1 %
Finance, Insurance	06.3 %
Repair and mentenance	05.6 %
Real estate and rental and leasing	03.9 %

Project Emphasis

The emphasis of this project will be to formation and shape of facilities to divert the wind brown to the city upward. The goal of my project is to make calm wind street that will reconnect the urban community to the mid-west coast in order to successfully complete this task, a strategic plant will be implemented that include recreational and environmentally friendly elements, wind farms, wind walls, and layout of the buildings used to unify San Diego city forms.

Plan for Proceeding

Research Direction

This thesis will use a mixed approach of quality and quantity. Especially the simulation of the wind is the biggest factor for my project, research the field not only in landscape architect, even physics and morphology are in researching range.

Design Methodogy

The method that will be utilized is a mixed-method approach, which uses both much volume and highly quality of data. Analysis, interpretation, and report results will occur through the process and will be presented in both text and graphics. The research will be guided by the theoretical premise. Quantities of data given by US governmental research gathered from direct observations and srchival searches.

Documentation

Progress in thesis research, analysis, graphics, text, drawings, photos, 3D models, or sketches will be documented digitally on a weekly basis to ensure the project is current. At the conclusion of the project, a digital presentation will be given. All final research, analysis and design work will be compiled and stored digitally in NDSU's Library Archive for future viewing.

Research Results

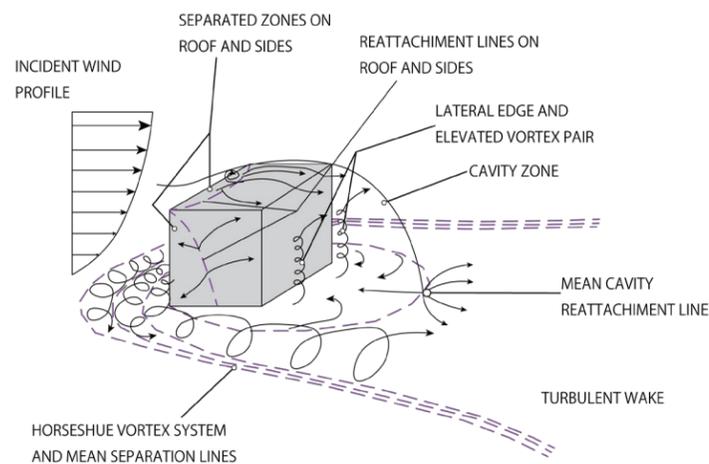
In the research phase, it's began with know the wind feature and how to apply for city systems. The wind as the subject is major, but makes hard to choose critical study report for my thesis because of its vastness of study field. From such dessert of wind study reports, handful of sand that I grabbed research papers are sorted to three project elements, wind turbines, wind shelter, and formation of buildings.

For the premise knowledge, the study of wind fearture is the most important for my project. From morphology field, I collected several study papers that simulating wind blow around the object. The wind, movement of air occur by the difference of air pressure in the place. The reason why the gap of air pressure happem is varied, but the change of air temperature is the common on the ground. The other common reason of wind blow is the power of the earth telecentricity. Telecentricity affected the stronger the father from its core, so the higher in the sky wind blow, the faster of the speed.



The wind blow on the ocean is stronger than that blown above the ground. Because the ground surface and trees distract the wind path, wind trapped several times on the way.

Basically, same reason of the difference of the wind speed between on the sea and ground, the total wind speed is slower than prairie wind blow. However, the structures in urban area break the wind, and condenses winds narrow space, create topical strong blew between buildings.



When the wind hit the object, they spread side and upward of that. In that phase, escaped wind runs along with spring like track on the surface. After they blow through the object, a part of air vaccumed for the back side of the ofject because of lower pressure. Togerthering air comes from a lot of direction, it creates spiral updraft right behind of the object.

Well, we get well knowledge of wind feature, now we should know how such unique character apply in each specific field. The combination of wind technology creates multiply benefits to the city. In body section, arguing wind tech sorted by three special fields.

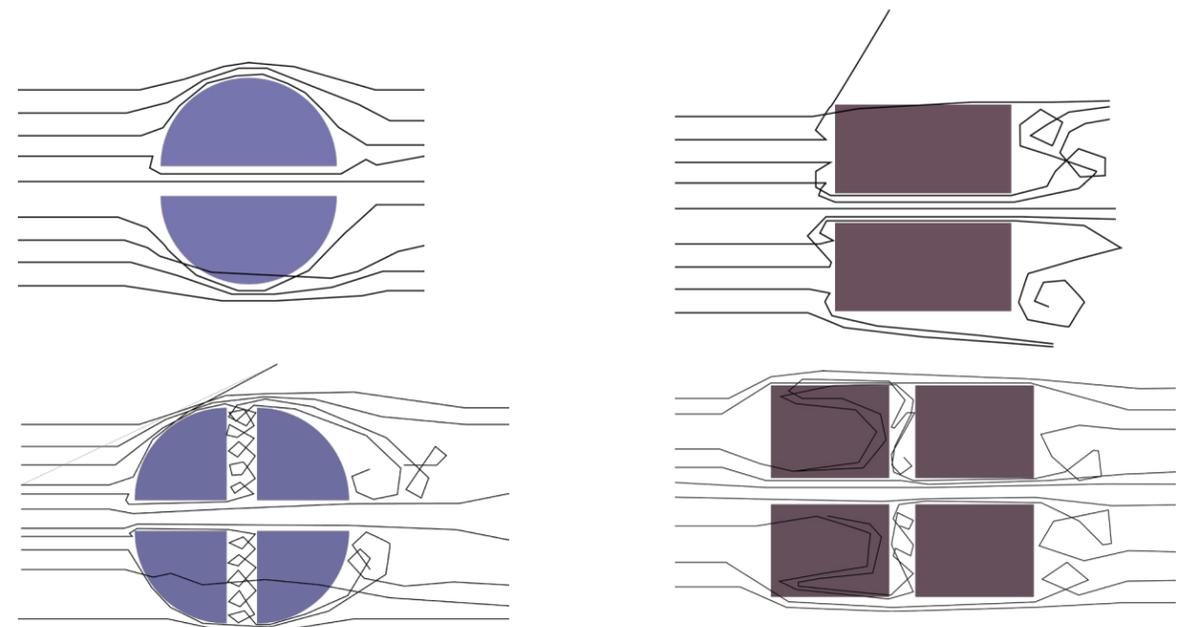
The first field of wind technology is preventing wind. It perhaps sounds like gave up to use wind energy, but knowing how to bare the wind should be the primal task in protecting, safety view point. According to research of Maatouk, the effect of the wind speed velocity on the stack pressure in medium-rise building, "Numerical simulation has been carried out to evaluate the total infiltration and the effect of the wind speed velocity on the stack effect in medium-rise building."

And follows:

At high wind speed velocity, the effect is very strong. Therefore, the pressure difference curves are not linear in shape and strong disturbances on the curve occur.

The gradient of the pressure between the stairwell ad outside is small in case of unheated stairwell compared with heated one.(Khoukhi, Yoshino, and Liu 1087)

The wind has possibility growing to serious disaster called hurricane or typhoon. The record of damage by Hurricane Catrina in southern US is still clear in our memory. Therefore, the wind shelter prays important roll to decrease people who get damaged by strong wind. The Model-Simulation Hao Wang conducted reveals what type of shape more perform nicely for shelterbelt. "The simulations also demonstrated that shelterbelt shape significantly affects perturbed pressure field and that the pressure-loss coefficient is a function of shelterbelt shape. Smooth- shaped or streamlined shelterbelts have significantly smaller pressure-loss coefficients than shelterbelts that are either rectangle shaped with both vertical sides or triangle shaped with the windward side vertical." (Wang and Takle 704)



Secondly, the heavily attraction, converting wind energy to different format. Such as windmill in Nederland, human used wind energy as one of the power sources. Recently, the energy of wind is remarked because it able to provide electric energy more stable rather than other renewable energy resources.

Propellers the most important tool when studying humans' way to use wind energy. In Henrik report, he shows The energy plan model from wind energy to other type of energies. "General inputs are demands, capacities and the choice of a number of different regulation strategies, putting emphasis on import/export and excess electricity production. Outputs are energy balances and resulting annual productions, fuel consumption and import/exports."(Lund 3) He tried to find out high efficient converting method because "the technical analysis has compared the different systems on their ability to integrate wind power expressed in terms of ability to reduce excess electricity production and the domestic CO2 emission."(Lund 3)

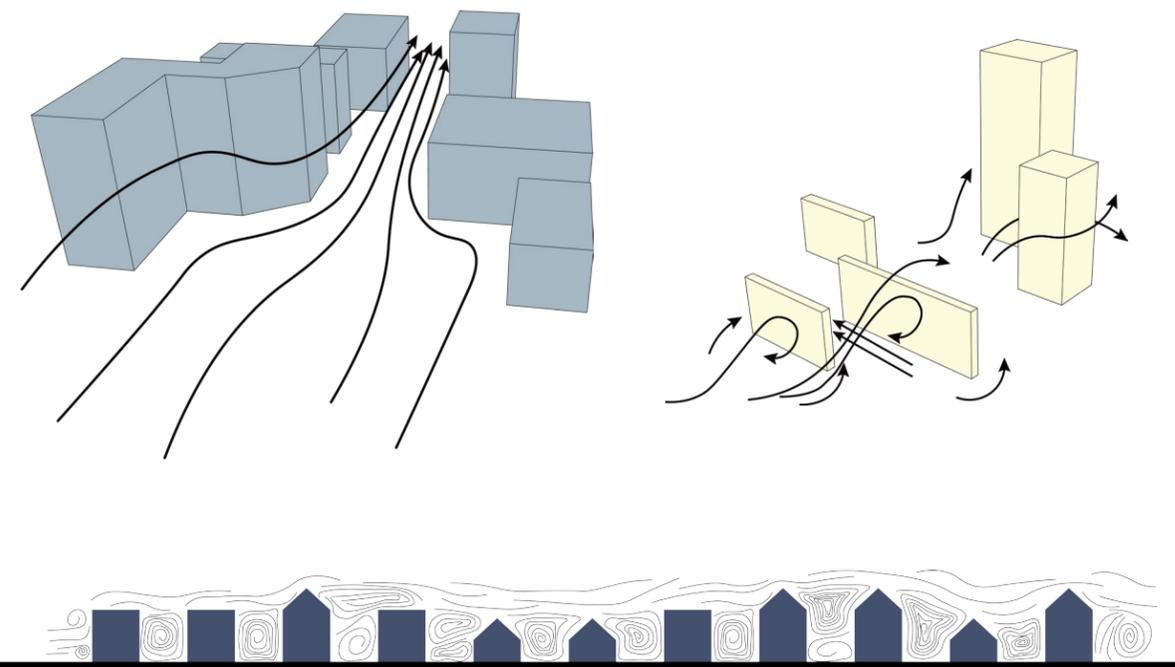
According to Toshio's research, the size of wind turbine gets smaller. "We found that a diffuser can influence wind speed and that the wind speed is highest at the entrance of the diffuser and lowest at the rear of the diffuser outlet. Analysis also showed that longer the main body, the higher the wind speed, and that maximum wind speed can be obtained along the inside of the diffuser near the entrance, regardless of the length of the diffuser."(Matsushima, Takagi, and Muroyama 1346)

The efficiency of wind turbine is also affected layout of wind farm. Andrew study calculated more efficient formation of wind turbine using model. "A genetic model foe optimizing in-land wind farm layout was presented. The optimization model considered wind farm radius and turbine distance constraints. However, other constraints can be easily incorporated in this model. The model maximizes the energy production by placing wind turbines in such a way that the wake loss is minimized."(Kusiak and Song 694)

The third field is how to create the wind path. Along with M. Gaumond paper, "The rising demand for wind power together with social, environmental and economical constraints currently lead to an increase in the size of wind turbines and wind farms. In large offshore wind farms, the average energy loss due in size of wind turbine wakes is approximately 10 to 20% of the annual energy production."(Gaumond et al. 1169)

In Ahmud research paper, it is described that "Local wind flows inside the street canyons are greatly affected by the mechanical turbulence induced by moving vehicles." (Ahmad, Khare, and Chaudhry 699) Also mentioned in conclusion, "Flow and dispersion patterns inside the canyon depend on its geometry, i.e., aspect ratio, and length-to-depth ratios, and above the building and roof shapes. In deep canyons, the vortices interact poorly with the external wind flow above the canyon and do not significantly contribute to the removal of exhaust gasses. Relatively short canyons provide better ventilation at corners, due to formation of corner vortices but this effect fades with increasing street length."(Ahmad, Khare, and Chaudhry 713)

The study of wind direction using small city models.(Hang, Sandberg, and Li) and (Xie, Huang, and Wang) will be one of the most important reference for me when I consider the formation and shape of buildings in city Eureka. The model simulated data clearly shows that the cube like flat object distorts air direction and create strong up and down flow between buildings.



Goal for Design Solution

Contributing to construct the system of sustainability of San Diego city is not a new occurrence in this region, nor is it unique to the wind farm sector. Insights were gained from the research into experiences in other landscapes across the U.S. are internationally. The project aims to use all findings to the design portion process.

Three Big Goal Combination



Site Analysis

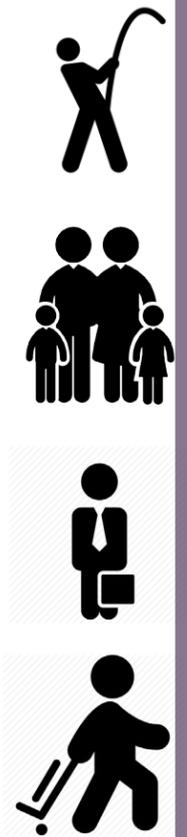


Inside of lagoon shore line area, the island is manmade, there are few heights rise in my site. Within the half mile circle, which means take them minutes to walk, there are several public transportation terminals, such as bus, train, and ferry. And more, the rental cycling station is placed in front of island. People are able to enjoy the cycling along with the shore line. In the south eastern of the site, big shopping mall attracting people not only for citizens, but also visitors. The entrance of the site is connected to the green elongated park. Many pedestrians will be there and walk in to restaurant at tip of the island.

Site Inventory Map



Estimated User



Area: 7.3 Acre (0.114 mile²)
Port, Storage, Office field
0.3mile to closest station(6 min to walk)
Route 5 is major road for car access

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