

Floating House on the Seine

ENGS 44

Prof. Cushman-Roisin

Cara Cavanaugh, Rebecca Conway, Sarah Darwin,
Julia Jackson, Michelle Wang, Zoë Thorsland (TA)

An impressionist landscape painting featuring a green field in the foreground, a line of trees with autumn foliage in the middle ground, and a small white house with a red roof in the distance. The sky is a clear, bright blue. The overall style is soft and textured, characteristic of Impressionism.

Users & Location



Users

Zoe

Studies drawing

St. Louis, MO

RISD



Hollie

Studies painting

Providence, RI

RISD

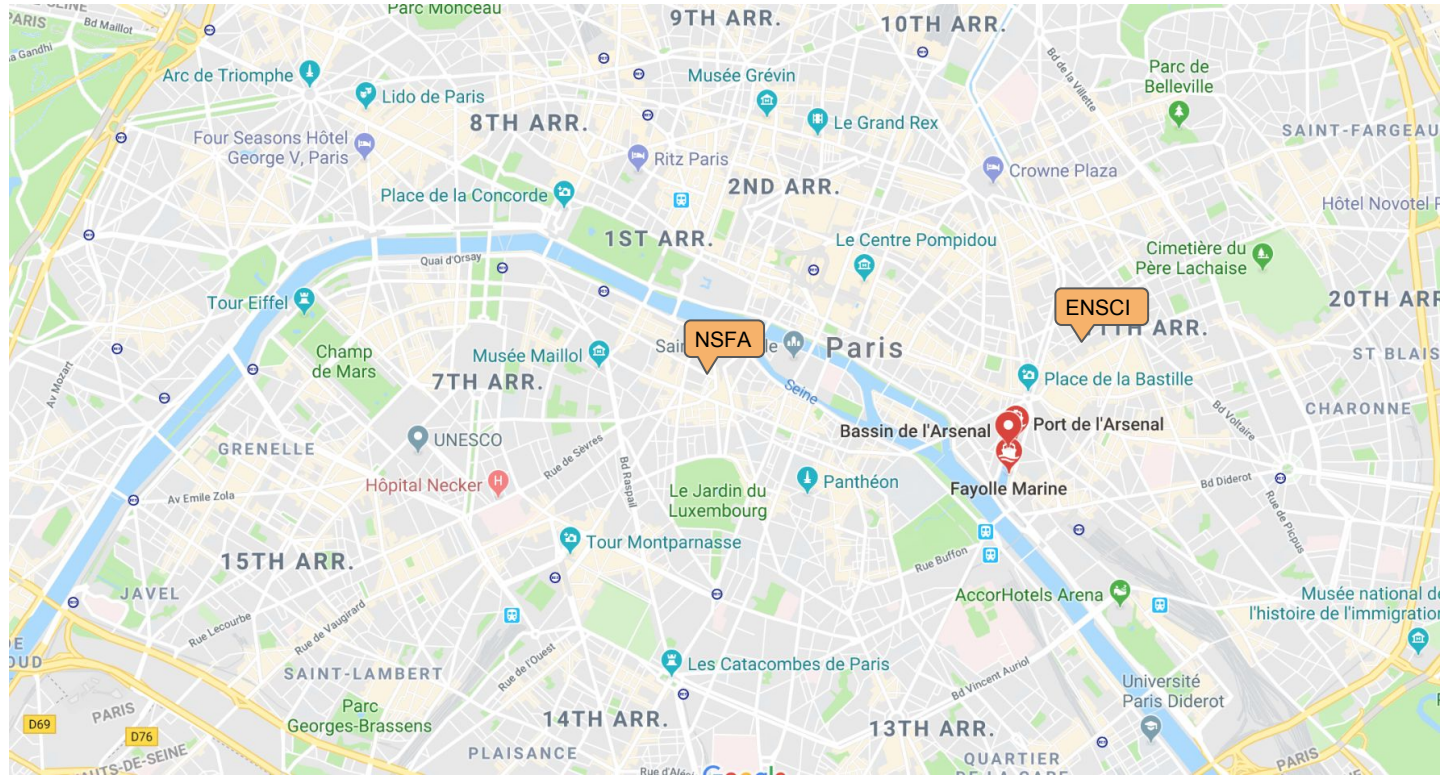


Location



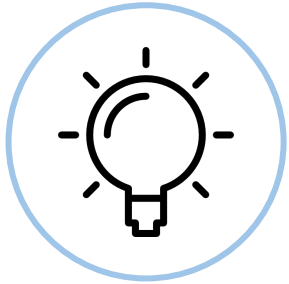
Port de Plaisance de Paris Arsenal

Location

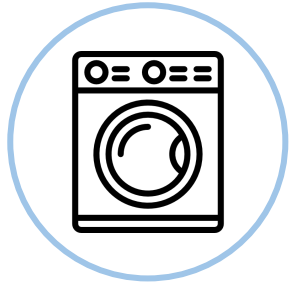


48.8566° N, 2.3522° E

Marina Amenities



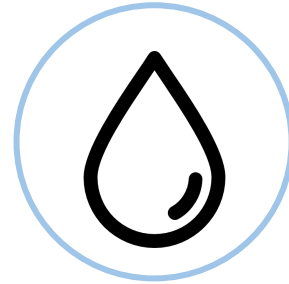
Electricity



Laundry




Sewage



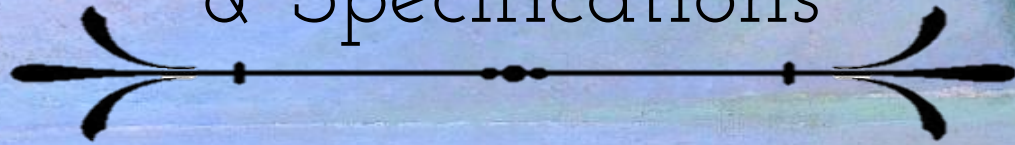
Water



Wi-Fi

The background is a soft, impressionist landscape painting by Claude Monet, featuring a body of water in the foreground and distant, hazy mountains under a pale sky. The colors are muted and blended, typical of the Impressionist style.

Targets, Limitations, & Specifications



Targets & Limitations

Size

<400 sq ft

**River
Suitability**

Buoyant, stable in currents and flooding, water resistant

Energy

Off Grid, 12+ Points on the LEED system

Cost

<\$150,000 in construction costs

Materials

Materials sourced from France

**Carbon
Footprint**

Reduce environmental impacts

Targets & Limitations

Size

<400 sq ft & fits in
14.4' x 49.2' mooring

Energy

~~Off Grid~~ 12+ Points on
the LEED system, **Grid**
Tied, avg. renewability:
100% May-Sept.,
50% Oct.- April

Materials

Materials sourced from
~~France~~ primarily from
Europe

River Suitability

Buoyant, stable in currents and
flooding, water resistant, **freezing**
resistant, easily towable

Cost

<\$150,000 in construction,
affordable for students, owner
turns a profit after 10 years

Carbon Footprint

~~Reduce environmental impacts~~
Reduction of CO2 emissions
compared to typical 2 person
apartment

Specifications

Type	Description
Fit with Architecture	Does the structure blend with the city and surrounding boats
Aesthetics	Is the home visually pleasing
Innovation	Does the structure inspire creativity
Compatible w/ Energy Tech.	Tilted roof for solar panels & water collection
Insulation	Could materials be chosen for this design that provide good insulation
Occupant Privacy	Both between individuals and from outside
Natural Lighting	Minimal electricity usage for lighting throughout the day
Quality Studio Space	At least 100 ft ² of studio space
Outdoor Space	At least 100 ft ² of outdoor well-lit studio space
Durability	Should last a full year between routine maintenance, structure lasts 50 years

Studio Requirements

“Lighting is really important. You don’t want to leave finished paintings in the sun, but it’s always nicer to work near windows.”

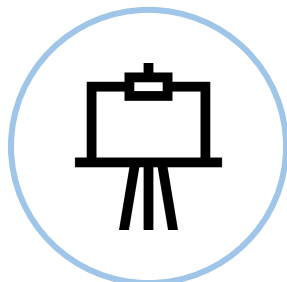
“I’ve always had a large blank wall to hang my pieces on. I want to see how they look from a distance.”

“Artists like modular pieces, especially if you’re sharing space. You want to make it your own and move things around.”

Studio Requirements



Tables



Easels



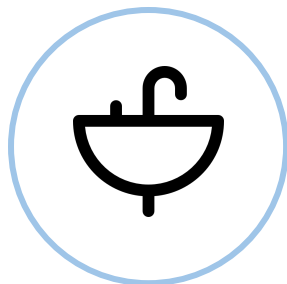
Tools



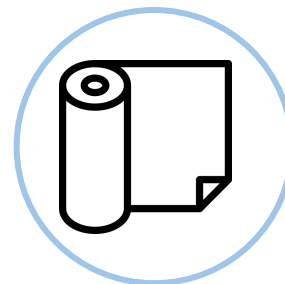
Tool Storage



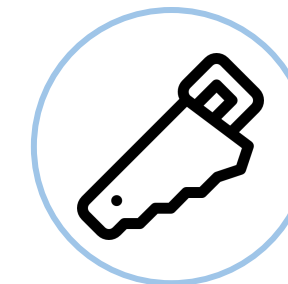
Lighting



Sink & Drying Rack



Paper & Canvas Rolls



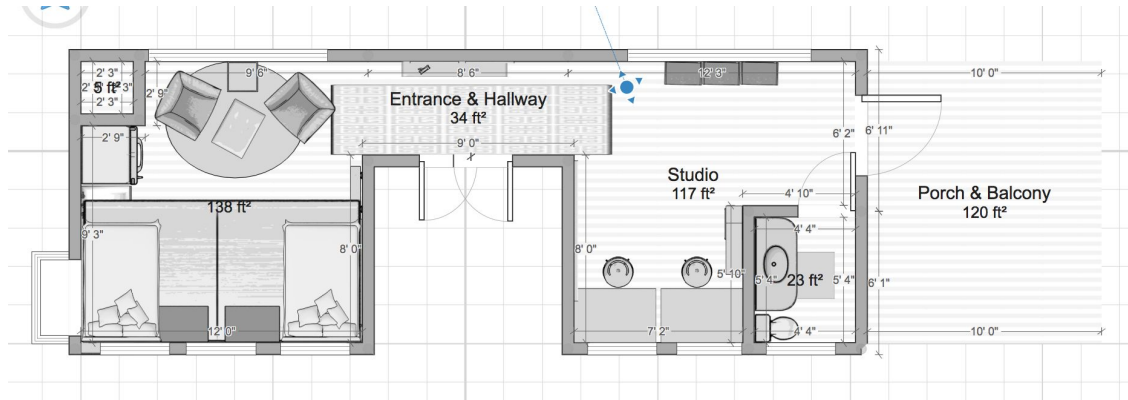
Bandsaw



Final Design



Final Design



Final Design: Virtual Tours

Exterior:

<https://www.useloom.com/share/b3c0d9b14ff64a3684cd968d65ccb31f>

Interior:

<https://www.useloom.com/share/5ec732116c7a4c31817c5b8067c1b109>

Final Design



Final Design



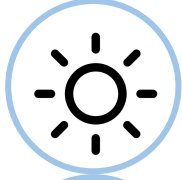
172 ft² living space



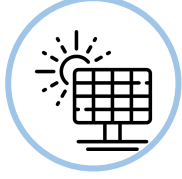
117 ft² studio



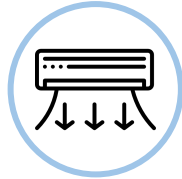
Tightly sealed building envelope



French style windows



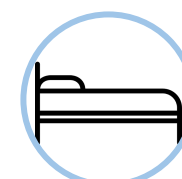
Solar panels



Air source heat pump



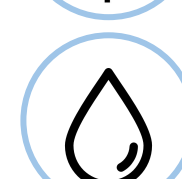
120 ft² Outdoor Space



Lofted sleeping space



Native plant species in window boxes and on patio



Water collection system

An impressionist painting of a harbor scene, likely by J.M.W. Turner. The scene is dominated by a large, dark, vertical structure, possibly a lighthouse or a tower, on the left. The water is rendered with vibrant, textured brushstrokes in shades of blue, green, and yellow, suggesting a bright, sunny day. In the background, a cityscape with several tall, pointed spires is visible against a hazy, pinkish-orange sky. The overall style is characteristic of the Impressionist movement, with a focus on light and color over fine detail. A decorative horizontal line with ornate flourishes at both ends is superimposed over the center of the painting, with the word "Materials" written in a serif font above it. In the bottom right corner, the artist's signature "J.M.W. Turner 1845" is visible.

Materials

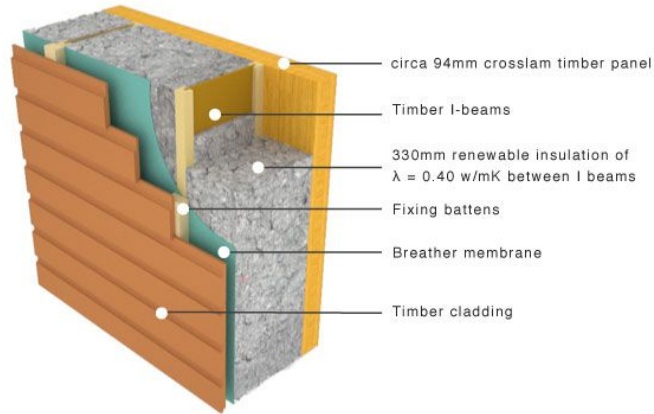
Materials

Base



- Aluminium Base
- Cellulose
- Breather Membrane
- Marine Plywood
- Total R value: 46.9

Walls



- Cedar Weatherboard
- Air gap
- Battens
- Breather Membrane
- Cellulose
- Timber I-Beams
- CLT
- Total R value: 31.3

Roof



- Zinc Roofing
- Roofing Felt
- Cellulose
- Total R value: 27.4

Materials

Doors



- Solid polyurethane insulated metal door
- Total R value: 5

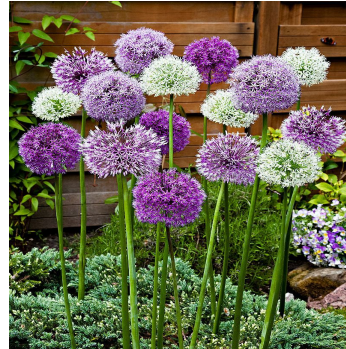
Plants



Lilium candidum

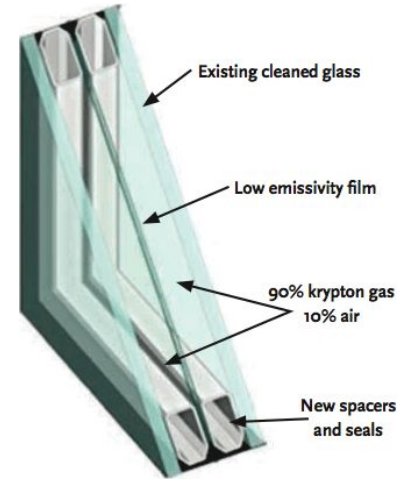


Nasturtium

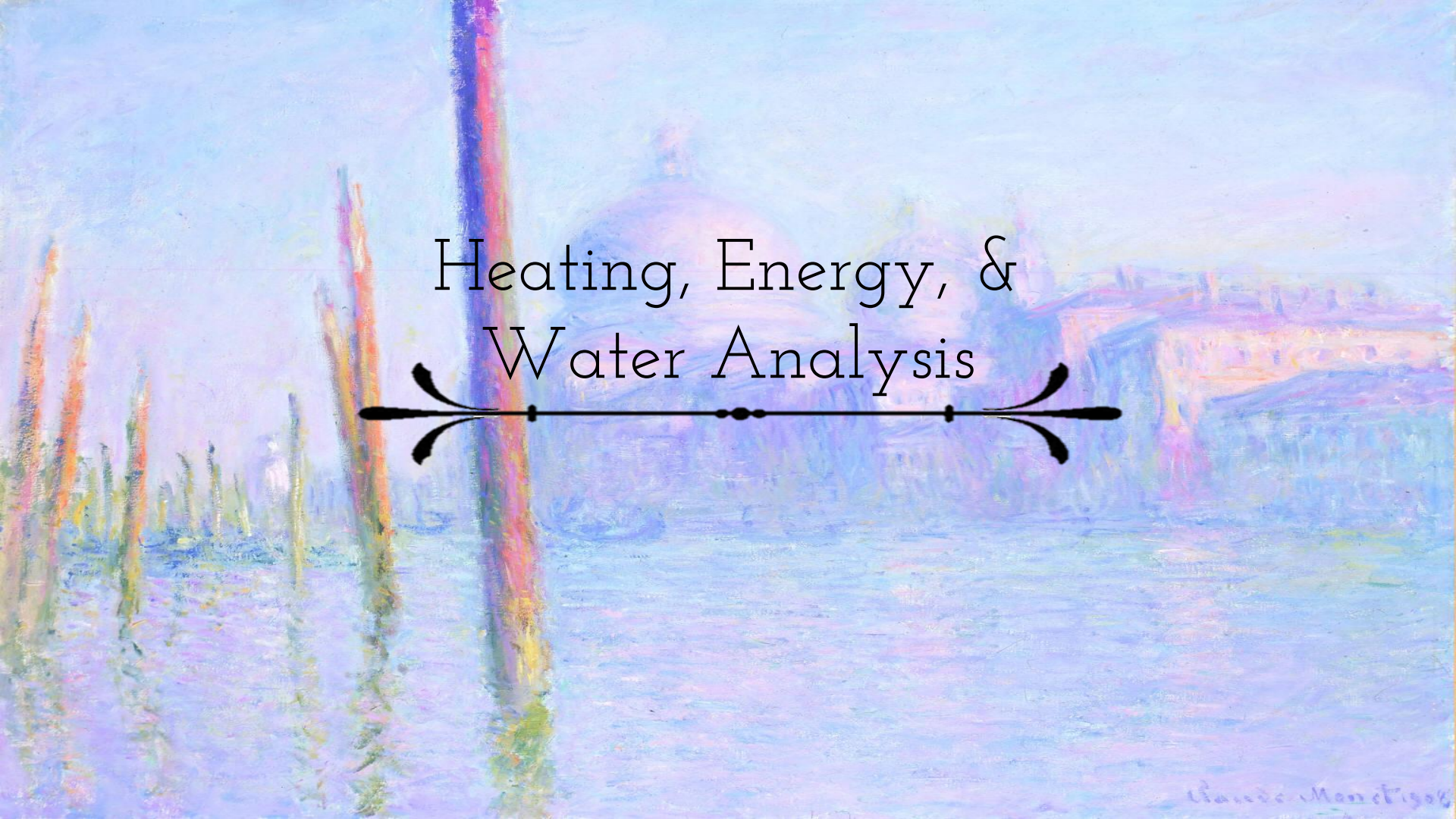


Allium

Windows



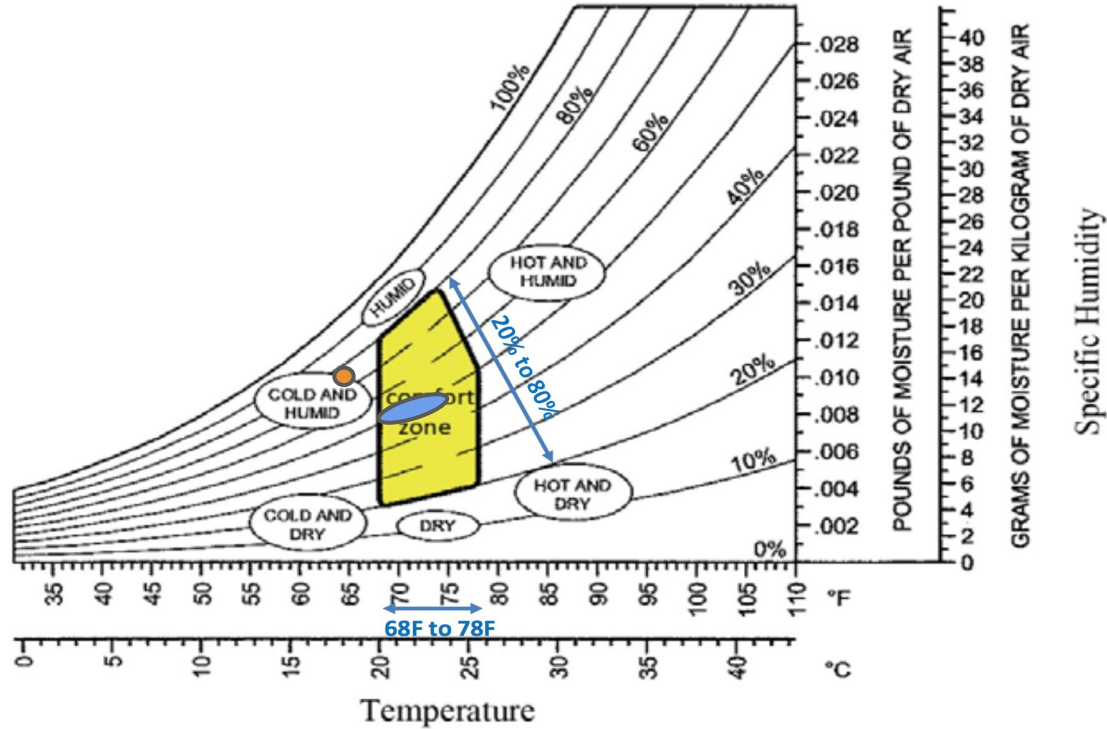
- Double Pane with suspended film and low-E
- Total R value: 4.05

An impressionist painting of a harbor scene. The foreground is dominated by a body of water with soft, shimmering reflections in shades of blue, purple, and green. In the middle ground, a large, domed building, possibly a cathedral or a government building, stands prominently. To its right, there are other buildings with warm, golden-brown tones. The background is a hazy, light blue sky. The overall style is characteristic of the Impressionist movement, with visible brushstrokes and a focus on light and color.

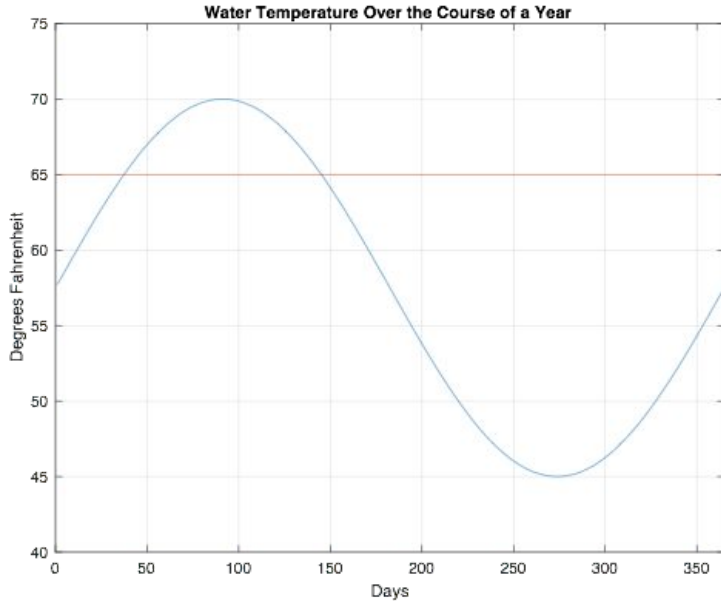
Heating, Energy, &
Water Analysis



Temperature & Humidity



Heating Analysis



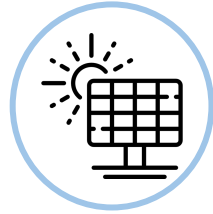
- 3,604 Heating Degree Days
- 3,407 Water Degree Days
- 0.1 volume air replaced/hr

- 8.9 million BTUs/year
- 2,600 kWh/year
 - 42% through windows
 - 24% through walls
 - 13% through roof
 - 10% through doors
 - 6% through floors
 - 5% through infiltration

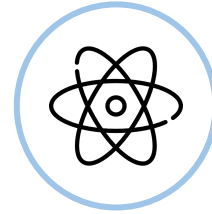
**32% Lower than Estimated Heating Energy for
304 sq-ft house in France (3834 kWh/year)**

Energy Analysis

Sources



I'M SOLAR Solar Panels
5.3' x 3.25', 300 W
18.45% efficiency



75% of France's grid energy
is from nuclear sources

Uses

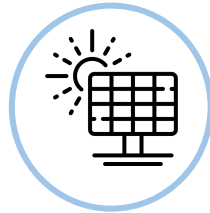
Kitchen appliances • Heat Exchanger & Ventilation • Water heater
LED lighting • Personal Electronics

Dehumidifier (studio space year round, rest of house October - February)

Heat Pump (October - May) • Air Conditioner (July- August)

Month	Energy Demand (kWh/day)	Energy Demand + System Inefficiencies (kWh/day)	Average Sun Hours (kWh/m² day)	Array Size (sqft)	Array Size (number of panels)	Percent Renewable Goal
January	5.32	7.98	0.89	510	29	50%
February	5.32	7.98	1.62	280	16	50%
March	5.28	7.92	2.62	172	10	50%
April	5.28	7.92	3.95	114	7	50%
May	5.28	7.92	4.90	92	6	100%
June	5.01	7.52	4.83	88	6	100%
July	5.01	15.62	5.35	166	10	100%
August	5.01	15.62	4.61	193	11	100%
September	5.01	7.52	3.33	128	7	100%
October	5.32	7.97	2.00	227	13	50%
November	5.32	7.97	1.12	405	23	50%
December	5.32	7.97	0.72	630	36	50%

Energy Analysis



14 solar panels

Percent Renewable

October - April: 77.0%

May - September: 100%

Yearly: 86.6%



LEED v4 for BD+C: New Construction and Major Renovation
Project Checklist

Project Name: Float Project Name: Floating House on the Seine
Date: May 22, 2018

Y ? N

Y	?	N	Credit	Integrative Process	1
---	---	---	--------	---------------------	---

7 0 0 Location and Transportation 16

Y	?	N	Credit	LEED for Neighborhood Development Location	16
Y	?	N	Credit	Sensitive Land Protection	2
Y	?	N	Credit	High Priority Site	1
Y	?	N	Credit	Surrounding Density and Diverse Uses	5
5	?	N	Credit	Access to Quality Transit	5
1	?	N	Credit	Bicycle Facilities	1
1	?	N	Credit	Reduced Parking Footprint	1
Y	?	N	Credit	Green Vehicles	1

3 0 0 Sustainable Sites 10

Y	?	N	Prereq	Construction Activity Pollution Prevention	Required
Y	?	N	Credit	Site Assessment	1
Y	?	N	Credit	Site Development - Protect or Restore Habitat	2
Y	?	N	Credit	Open Space	1
3	?	N	Credit	Rainwater Management	3
Y	?	N	Credit	Heat Island Reduction	2
Y	?	N	Credit	Light Pollution Reduction	1

9 0 0 Water Efficiency 11

Y	?	N	Prereq	Outdoor Water Use Reduction	Required
Y	?	N	Prereq	Indoor Water Use Reduction	Required
Y	?	N	Prereq	Building-Level Water Metering	Required
2	?	N	Credit	Outdoor Water Use Reduction	2
6	?	N	Credit	Indoor Water Use Reduction	6
Y	?	N	Credit	Cooling Tower Water Use	2
1	?	N	Credit	Water Metering	1

5 0 0 Energy and Atmosphere 33

Y	?	N	Prereq	Fundamental Commissioning and Verification	Required
Y	?	N	Prereq	Minimum Energy Performance	Required
Y	?	N	Prereq	Building-Level Energy Metering	Required
Y	?	N	Prereq	Fundamental Refrigerant Management	Required
Y	?	N	Credit	Enhanced Commissioning	6
Y	?	N	Credit	Optimize Energy Performance	18
1	?	N	Credit	Advanced Energy Metering	1
Y	?	N	Credit	Demand Response	2
3	?	N	Credit	Renewable Energy Production	3
Y	?	N	Credit	Enhanced Refrigerant Management	1
1	?	N	Credit	Green Power and Carbon Offsets	2

1 0 0 Materials and Resources 13

Y	?	N	Prereq	Storage and Collection of Recyclables	Required
Y	?	N	Prereq	Construction and Demolition Waste Management Planning	Required
Y	?	N	Credit	Building Life-Cycle Impact Reduction	5
Y	?	N	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
1	?	N	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
Y	?	N	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
Y	?	N	Credit	Construction and Demolition Waste Management	2

5 0 0 Indoor Environmental Quality 16

Y	?	N	Prereq	Minimum Indoor Air Quality Performance	Required
Y	?	N	Prereq	Environmental Tobacco Smoke Control	Required
Y	?	N	Credit	Enhanced Indoor Air Quality Strategies	2
Y	?	N	Credit	Low-Emitting Materials	3
Y	?	N	Credit	Construction Indoor Air Quality Management Plan	1
Y	?	N	Credit	Indoor Air Quality Assessment	2
1	?	N	Credit	Thermal Comfort	1
1	?	N	Credit	Interior Lighting	2
2	?	N	Credit	Daylight	3
1	?	N	Credit	Quality Views	1
Y	?	N	Credit	Acoustic Performance	1

0 0 0 Innovation 6

Y	?	N	Credit	Innovation	5
Y	?	N	Credit	LEED Accredited Professional	1

0 0 0 Regional Priority 4

Y	?	N	Credit	Regional Priority: Specific Credit	1
Y	?	N	Credit	Regional Priority: Specific Credit	1
Y	?	N	Credit	Regional Priority: Specific Credit	1
Y	?	N	Credit	Regional Priority: Specific Credit	1

30 0 0 TOTALS Possible Points: 110

Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110

Water Analysis



- Annual Rainfall:
24 to 25 in
- Monthly Rainfall:
varies between 1.5
to 2.2 inches
- Cistern Size:
36 cubic ft



- Annual Water
Needs:
25,888.86 gal/yr
- Adjusted Water
Needs:
15,288 gal/yr



- Cost of rainwater
harvesting
system:
\$3000 - \$4000

The background is a painting of a pond with water lilies. The water is a mix of blue and green, with visible brushstrokes. There are several green lily pads and some pink and white flowers. A decorative horizontal line with curved ends and small dots is centered over the text.

River Compatibility

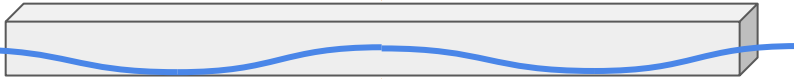
Claude Monet 1906

Buoyancy

For the house to float,

$$\text{Weight of House} = \text{Buoyancy Force}$$

Weight of House

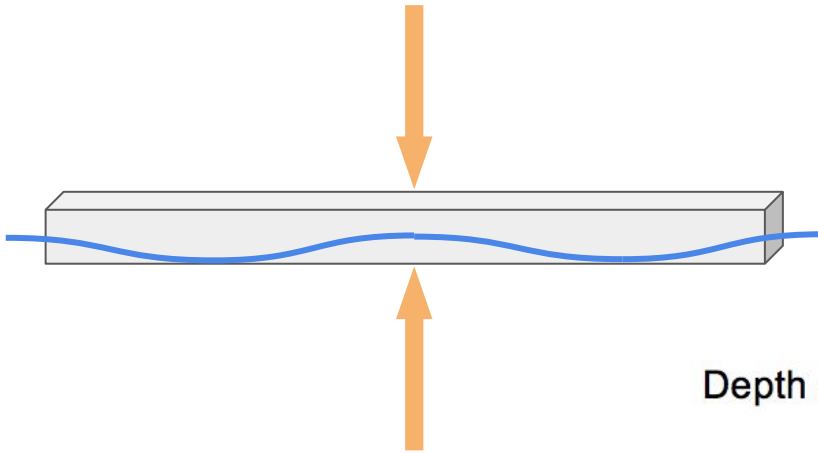


Buoyancy Force

Feature/Appliance	Weight (lbs/device)	Total Weight (lb)	Room	Weight by Room (lb)	Mass by Room(kg)
Platform		1414.913374			
Walls		6545.517307	Walls+Roof	7189.797307	3261.426913
Roof		644.28			
Louvre		59.25	Louvre	59.25	26.87691131
Windows		714.8897664			
Solar Panels (14x)	42	588	Solar Panels	588	266.7278287
Refrigerator	214	214			
Convection Oven	119	119			
Counters/Cabinets	44	88	Kitchen	421	190.9734964
Toilet	67	67			
Sink	44	44			
Shower	33	33	Bathroom	144	65.32110092
Beds	114.64	229.28			
Loft	307.174	307.174			
Ladder	6.65	13.3	Bedroom	549.754	249.3787258
Studio Cabinets	44	44			
Table	53	53			
Easels	2.7	5.4			
Canvas Roll	8	8			
Paper Roll	6.2	6.2	Studio	116.6	52.89194699
Heat Exchanger	42	42			
Water Collection Containers	3004	3004	Water Tanks	3004	1362.670744
Water Heater	5.3	5.3			
Air Source Heat Pump	90	90			
Dehumidifier	46	46	HVAC	183.3	83.14831804
Occupants	150	300			
TOTAL		14685.50445	TOTAL	14685.50445	6661.620264
TOTAL + 20% Safety Margin		17622.60534	20% Margin	17622.60534	78420.59375

Buoyancy

Weight of House



Buoyancy Force

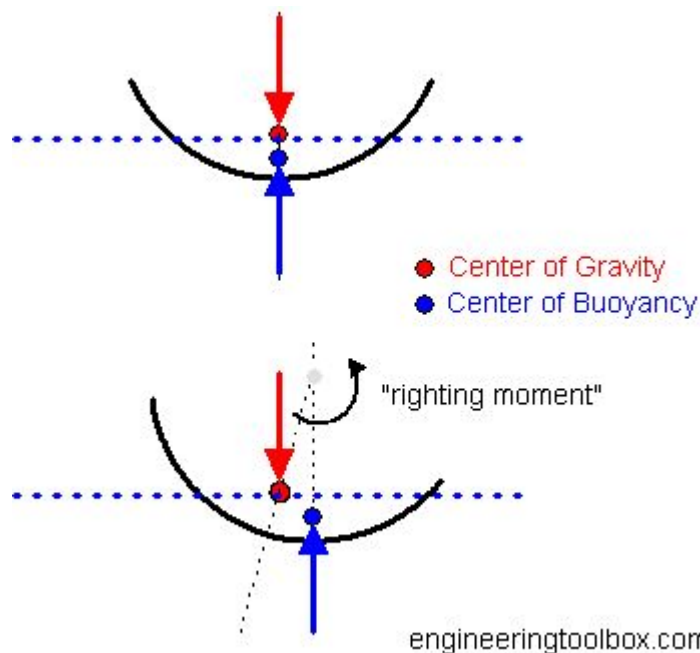
$$\text{Buoyancy Force} = \rho_{H_2O} \cdot g \cdot V_{\text{displaced } H_2O}$$

$$V_{\text{displaced } H_2O} = \frac{78420.59 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}}{\left(1000 \frac{\text{kg}}{\text{m}^3}\right) \cdot \left(9.81 \frac{\text{m}}{\text{s}^2}\right)} = 7.99 \text{ m}^3$$

Depth of Platform Submerged

$$\frac{V_{\text{displaced } H_2O}}{A_{\text{barge}}} = \frac{7.99 \text{ m}^3}{57.26 \text{ m}^2} = 0.14 \text{ m} = 0.458 \text{ ft} = 5.50 \text{ in}$$

Stability



Center of Buoyancy \approx Center of Gravity

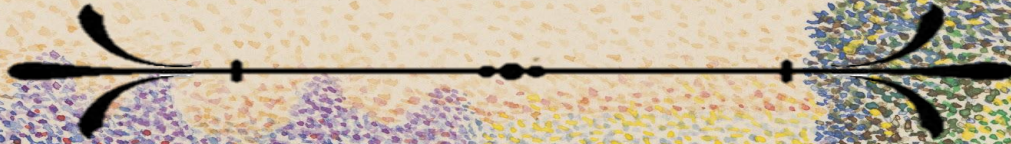
$$x_{CB} = 22.00 \text{ ft} \approx x_{CG} = 22.08 \text{ ft}$$

$$y_{CB} = 7.00 \text{ ft} \approx y_{CG} = 7.01 \text{ ft}$$

$$z_{CG} = 4.88 \text{ ft}$$

\therefore relatively low center of gravity

Economic Analysis



Economic Analysis

Construction
Costs:



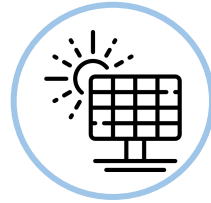
\$130,260

Yearly Fees
& Upkeep:



\$9,444

Yearly Solar
Earnings:



\$582.84

Monthly
Rent:



\$2,300

Payback
Time:



~ 9.5 Years

Profit After
20 Years:



~\$185,000

Cost of Living

Parisian Apartment

2 bedroom, District 4

Rent: \$2,945/mo

Utilities: \$210/mo

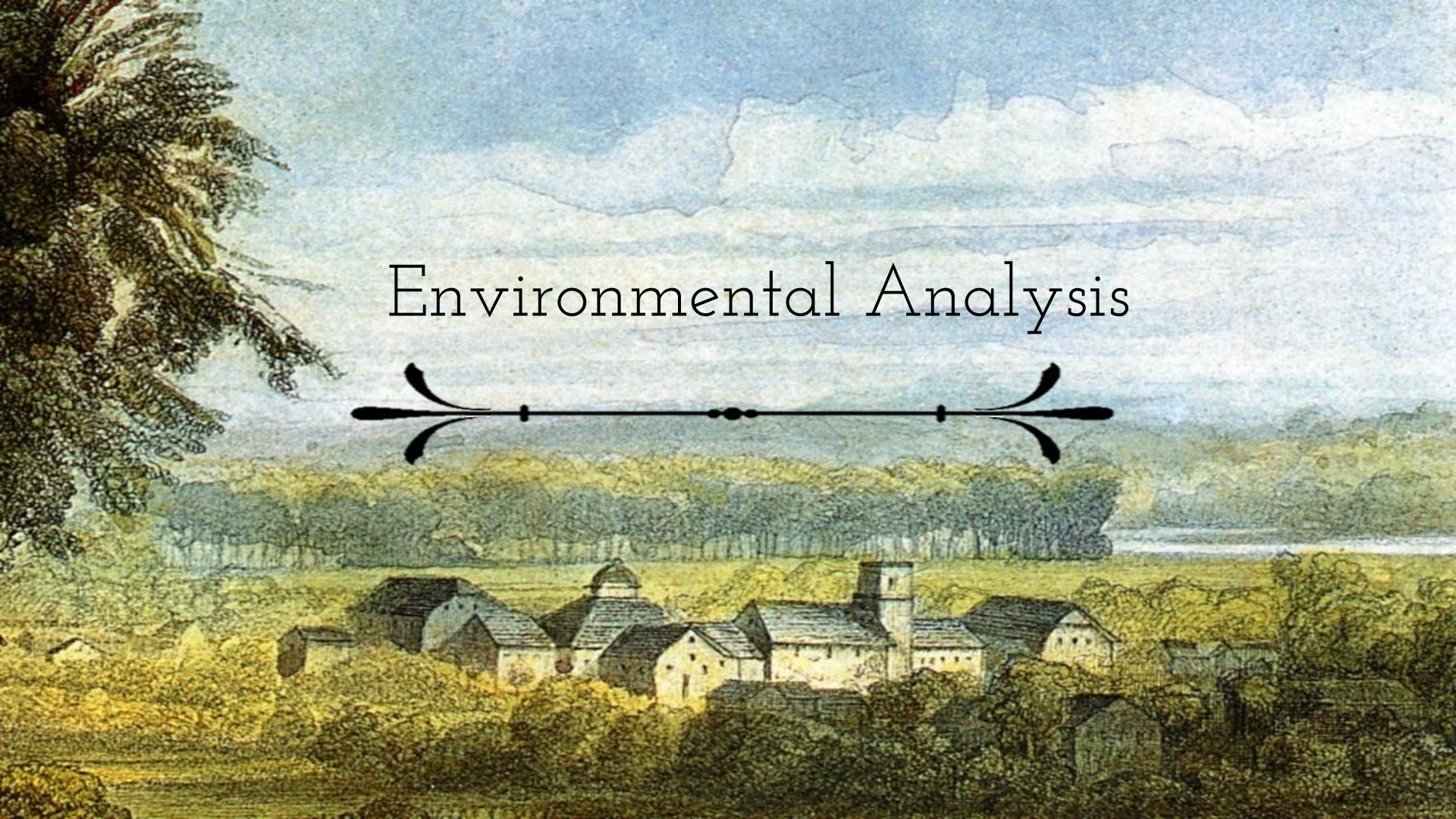
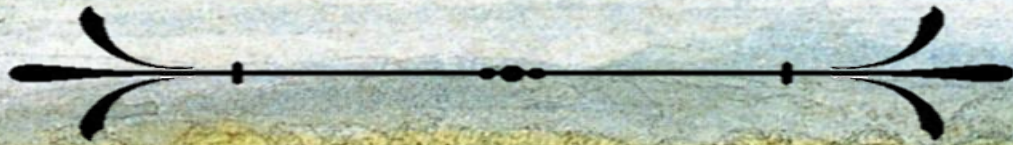
Our Floating House

2 person loft, 308 ft²

Rent: \$2,300/mo

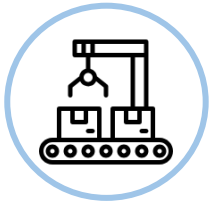
Utilities: \$11.40/mo

Environmental Analysis



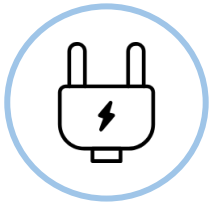
Environmental Impacts & Benefits

Materials



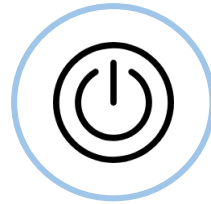
- CLT: 0.420
- Wood: 0.310
- Steel: 1.46
- Aluminium: 9.16
- Polycarbonate: 1.34
- Glass: 0.91
- Total GHG Emissions: 0.398 tons

Electricity



- Average Parisian:
6938 kWh/capita/yr
- Average Global Citizen:
3125 kWh/capita/yr
- Our Users:
800.73 kWh/capita/yr

Energy Use Intensity



- Average Parisian Flat:
Source EUI: 114.9 kBtu/ft²/yr
Site EUI: 73.9 kBtu/ft²/yr
- Our Users:
Source EUI: 26.4 kBtu/ft²/yr
Site EUI: 17.7 kBtu/ft²/yr

Water usage



- Average Parisian:
1786 m³/capita/yr
- Average Global Citizen:
1002 m³/capita/yr
- Our Users:
527.4 m³/capita/yr

How Our Design Stacks Up

Target/Specification	Goal	Our Design
Size	Inner: < 400 ft ² Outer: <14.4' x 49.2' mooring	Inner: 308 ft ² Outer: 14' x 44'
Energy	12 points on LEED system 100% renewable May - Sept. 50% renewable Oct. - April	30 points on LEED system 100% renewable May - Sept. 77% renewable Oct - Apr.
Materials	Sourced primarily from Europe	Sourced primarily from Europe
River Compatibility	Buoyant Stable Water proof & freeze resistant	Buoyant Stable Water proof & freeze resistant
Cost	< \$150,000 in construction Affordable for students Profitable after 20 years	\$129,515 in construction (including labor) \$2300 / mo Profitable after 9.5 years
Carbon Footprint	Reduction of CO2 reduced compared to equivalent house	78.7% reduction of CO2

An aerial view of Paris, France, at sunset. The sun is low on the horizon, casting a warm orange glow over the city. The Eiffel Tower is prominent in the center-right of the frame. The sky is filled with soft, colorful clouds. A decorative horizontal line with leaf-like flourishes at both ends is positioned across the middle of the image, separating the two text elements.

Thank You!

Questions?

Bibliography

<https://weatherspark.com/y/47913/Average-Weather-in-Paris-France-Year-Round>

<https://www.gaisma.com/en/location/paris.html>

<http://www.wearerhino.com/renewable-energy/air-source-heat-pumps/>

<https://smarterhouse.org/heating-systems/types-heating-systems> <https://www.greenmatch.co.uk/blog/2014/08/heat-pumps-7-advantages-and-disadvantages>

<http://www.fayollemarine.eu/medias/files/tarifs-plaisance-2018.pdf>

<http://www.fayollemarine.eu/en/pages/the-office/services-rates.html>

<https://weather-and-climate.com/average-monthly-Humidity-perc,Paris,France>

<http://www.cruisersforum.com/forums/f74/wood-stove-on-a-sailboat-179543.html>

<https://www.flickr.com/photos/66962690@N08/page1>

<https://www.risd.edu/academics/risd-global/>

<https://www.thespruce.com/how-much-does-a-tiny-house-cost-4139914>

http://www.kora.ch/malme/O6_map-centre/6_3_landscapes-&-landuse/landuse-and-cover/france/IFN_2006_Indicators_for_the_sustainable_management_of_French_forests-15.htm

<https://www.remodelingexpense.com/costs/cost-of-dense-pack-cellulose-insulation/>

<https://www.menards.com/main/building-materials/trusses-i-joists-engineered-lumber/i-joists-rim-boards/2-1-2-x-9-1-2-i-joist/1065882/p-1444435987801-c-5662.htm?tid=-2464434031026152344&ipos=5>

<https://www.woodlands.co.uk/blog/woodland-activities/french-forestry/>

<https://www.swfwmd.state.fl.us/conservation/thepowerof10/>

https://www.meteoblue.com/en/weather/forecast/modelclimate/paris_france_2988507

http://www.airexchangers.info/air_exchanger_basics.php

<http://www.dirkmarine.com/folio/concrete-hull-by-dirkmarine/>

http://art-monet.com/1900_95.html

<https://www.justlanded.com/english/France/Articles/Property/Houseboats>

<http://www.lodgis.com/en/paris.long-term-rentals/>

<https://www.parispass.com/images/attractions/louvre.jpg>

http://www.discoverfrance.net/France/Paris/Paris_climate.shtml

Bibliography

<http://products.geappliances.com/appliance/gea-specs/GTE18ISHSS>

https://www.lowes.com/pd/Whirlpool-Freestanding-4-8-cu-ft-Self-Cleaning-Electric-Range-Black-Common-30-in-Actual-29-875-in/50371532?cm_mmc=SCE_PLA_ONLY--Appliances--SOSRanges--50371532:Whirlpool&CAWELAID=&kpid=50371532&CAGSPN=pla&k_clickID=515cce4e-1c4f-4dd8-8e74-6390dcl4437a&gclid=CjwKCAjwiurXBRANeIwAk2GFZuBqxup7r4oaSs3wpxE5iZ92FZnMoqDTrmljiMOdiAggWlKD8IL5KxoCf4sQA vD_BwE

[https://www.acwholesalers.com/Stiebel-Eltron/DHC4-2-3-8-Kw-Point-of-Use-Electric-Tankless-Water-Heater/84085.ac?gclid=CjOKCOjwuYTYBRDsARIsA\]nrUXBE13B4Tf3lykwGlrkyiDoGMpSDQAWu2DK2aPINC_UB-ktEy9_dYwOaAvOFEALw_wcB](https://www.acwholesalers.com/Stiebel-Eltron/DHC4-2-3-8-Kw-Point-of-Use-Electric-Tankless-Water-Heater/84085.ac?gclid=CjOKCOjwuYTYBRDsARIsA]nrUXBE13B4Tf3lykwGlrkyiDoGMpSDQAWu2DK2aPINC_UB-ktEy9_dYwOaAvOFEALw_wcB)

<https://customer.honeywell.com/resources/techlit/TechLitDocuments/68-0000s/68-3076EF.pdf>

<https://www.forbes.com/sites/christopherhelman/2013/09/07/how-much-energy-does-your-iphone-and-other-devices-use-and-what-to-do-about-it/#36795d5a2f70>

https://www.energyusecalculator.com/electricity_laptop.htm

https://www.energyusecalculator.com/electricity_stovetop.htm

<https://www.energystar.gov/products/appliances/dehumidifiers>

[https://www.acwholesalers.com/LG-Air-Conditioners/LS120HXV-LS120HXV-12000-BTU-17-SEER-Ductless-Mini-Split-Heat-Pump/43939.ac?gclid=CjwKCAjwiurXBRANeIwAk2GFZuvPv\]BcV3HKehKrK8liLnuAniXOQVX15tTy2sMkCUMf3XNQclW aRhoCliQQA vD_BwE](https://www.acwholesalers.com/LG-Air-Conditioners/LS120HXV-LS120HXV-12000-BTU-17-SEER-Ductless-Mini-Split-Heat-Pump/43939.ac?gclid=CjwKCAjwiurXBRANeIwAk2GFZuvPv]BcV3HKehKrK8liLnuAniXOQVX15tTy2sMkCUMf3XNQclW aRhoCliQQA vD_BwE)

<https://www.energy.gov/energysaver/save-electricity-and-fuel/appliances-and-electronics/estimating-appliance-and-home>

<https://aristair.com/blog/whats-the-ideal-temperature-for-art-storage/>

<http://pingi.com/electric-dehumidifiers-how-much-energy-do-they-use/>

<https://www.homeadvisor.com/cost/architects-and-engineers/build-a-house/>

https://www.french-property.com/news/build_renovation_france/construction_costs_2014/

<https://www.homedepot.com/p/IELD-WEN-36-in-x-80-in-6-Panel-Primed-Right-Hand-Inswing-Steel-Prehung-Front-Door-w-Brickmould-THDJW166100278/202036444>

<https://www.improvenet.com/r/costs-and-prices/roofing-felt>

<http://www.replacementwindowsreviews.co/pricing/alpen-window-prices.html>

<https://www.improvenet.com/r/costs-and-prices/plywood-siding>

<http://www.sidingpriceguides.com/wood-cedar-siding.html>

<https://www.diyhomecenter.com/duPont-tyvek-thermawrap-r50-roll-4x40>

https://www.researchgate.net/publication/320739097_CROSS-LAMINATED_TIMBER_VS_CONCRETESTEEL_COST_COMPARISON_USING_A_CASE_STUDY

Final Design

