

# Could the ocean provide a pumped storage battery that could power NYC all night long?

Energy storage is a critical part of our energy grid. It keeps our grid robust and helps serve customers during high-demand periods without increasing electricity production capacity.

These are back-of-the-napkin calculations to accompany this blog post:

<https://blog.syllablehq.com/quitting-oil-requires-energy-storage>

These calculations are intended to be ball-park estimates only. They were done quickly and they include some big WAGS (wild ass guesses). Please alert me to any errors and I will try to make updates.

-- eric@syllablehq.com

Calculations estimating the cost of submarine tanks storing enough energy to supply NYC all night long.

How: About 5 tubes, 13 meters in diameter, each 1 mile deep on the ocean floor.

Cost: Maybe \$0.2 billion.

What	Units	Value	Tube	Units	Values	Notes
Mass of Water per tube	kg	213611913.9	Diameter	meters	13	
Grav. Acceleration	m/(s^2)	9.80665	Length per tube	meters	1609.344	
Height	m	1609.344				
Height	miles	1				
Potential Energy (per tube)	Joules	3371281613288	Area X-section	meters^2	132.7322896	
Potential Energy (per tube)	kWh	936,467.86	Volume	meters^3	213611.9139	
Average US Household Daily Energy Use	kWh / year	10,400	KiloLiters	meters^3	213611.9139	
Average US Household Daily Energy Use	kWh / day	28.49315068	Kg of water	kg	213611913.9	
Average US Household at night	kWh / night	11.39726027				
Average NYC usage	MWh/day	11,000				
Average NYC usage	kWh/day	11000000	weight of steel tube / mile	tons	28719.107	See conversion
Avg NYC nightly usage	kWh/night	4400000	Price of steel tube		\$14,359,554	
Avg NYC nightly usage in tesla power walls	tesla power walls	325925.9259	Total \$ of all steel tubes		\$67,468,450	
Avg NYC nightly usage cost using tesla power	\$ billions	2.18	WAG price of construction		\$134,936,900	Wild Ass Guess. Construction cost = 2X steel cost?
			Total price		\$202,405,350	
Cost						
Number of households		82166.05057				
<b>Number of tubes: 1 mile long, 1 mile deep, At diameter (h5) required to supply New York City at night</b>		<b>4.698506131</b>				

Calculations estimating the cost of deep sea water tunnels storing enough energy to supply NYC all night long.

How: About 5 tunnels, 13 meters in diameter, each 1 mile deep underground  
 Cost: Maybe \$1 billion?

What	Units	Value	Tunnel	Units	Values	Notes
Mass of Water per tunnel	kg	213611913.9	Diameter	meters	13	
Grav. Aceleration	m/(s^2)	9.80665	Length per tunnel	meters	1609.344	
Height	m	1609.344				
Height	miles	1				
Potential Energy (per tunnel)	Joules	3371281613288	Area X-section	meters^2	132.7322896	
Potential Energy (per tunnel)	kWh	936,467.86	Volume	meters^3	213611.9139	
Average US Household Daily Energy Us kWh / year		10,400	KiloLiters	meters^3	213611.9139	
Average US Household Daily Energy Us kWh / day		28.49315068	Kg of water	kg	213611913.9	
Average US Household at night	kWh / night	11.39726027				
Average NYC usage	MWh/day	11,000				
Average NYC usage	kWh/day	11000000				
Avg NYC nightly usage	kWh/night	4400000	Price of digging per tunnel		\$105,625,000	
Avg NYC nightly usage in tesla power w/ tesla power walls		325925.9259	Price of digging for all tunnels		\$601,904,710	Add one tunnel to get down one mile first
Avg NYC nightly usage cost using tesla \$ billions		2.18	WAG price multiplier because complexity		\$300,952,355	Wild Ass Guess. 50% markup because deeper dig, sea-water complexity, etc
Cost			Total price		\$902,857,065	
Number of households		82166.05057				
<b>Number of tunnels: 1 mile long, 1 mile deep, At diameter (h5) required to supply New York City at night</b>		<b>4.698506131</b>				

Conversions			
Description	Units	Value	Notes
Joules to kWh	kWh	2.78E-07	
lbs to tons	tons	0.0005	
Miles to Meters	Meters	1609.344	
% of energy used at night	-	0.4	This is a wild-ass-guess. Demand is generally lower at night.
Tesla power wall storage in kWh	-	13.5	<a href="https://www.tesla.com/powerwall">https://www.tesla.com/powerwall</a>
cost of tesla power wall	\$	\$6,700	<a href="https://www.tesla.com/powerwall">https://www.tesla.com/powerwall</a>
Tesla boring machine tunnel cost	\$	\$10,000,000	Per mile of tunnel in shallow ground, ~4 meter diameter: <a href="https://www.forbes.com/sites/sebastianblanco/2018/12/19/elon-musk-boring-company-first-tunnel/#2910d8d87d6f">https://www.forbes.com/sites/sebastianblanco/2018/12/19/elon-musk-boring-company-first-tunnel/#2910d8d87d6f</a>
Tesla tunnel mentioned above X-section area	m^2	12.56637061	
Tesla tunnel cost per square meter per mile	\$	\$795,775	
Price of steel per ton (HY 100 steel)	\$	\$500	Really rough guess based on <a href="https://www.alibaba.com/showroom/hy-100-steel-plate.html">https://www.alibaba.com/showroom/hy-100-steel-plate.html</a> . HY 100 or HY 80 steel is a kind of very strong steel used in submarines. From very quick searches, it seems that a submarine hull of this kind of steel is about 2 inches thick and can withstand depths of 1 mile.
weight of steel tube / mile (13m diameter)	lbs	57438214	<a href="https://www.onealsteel.com/calculators.html">https://www.onealsteel.com/calculators.html</a>
	tons	28719.107	
<div> <h3 style="text-align: center;">CALCULATORS</h3> <div style="display: flex; justify-content: space-around; border-bottom: 1px solid black; padding-bottom: 5px;"> <span>WEIGHT</span> <span style="background-color: #ffc107; padding: 2px 5px;">CONVERSION</span> <span>MISCELLANEOUS</span> </div> <p>Select Your Metal: <input type="text" value="Stainless 400 Series"/></p> <p>Select a Shape: <input type="text" value="Round Tubing"/></p> <p>Number of Pieces: <input type="text" value="1"/></p> <p>Enter size information:</p> <p>Outer Diameter: <input type="text" value="13"/> m</p> <p>Wall Thickness: <input type="text" value="2"/> in</p> <p>Length: <input type="text" value="1609.344"/> m</p> <p>Calculated Weights</p> <p style="text-align: right;">26053803 Approx. weight in kg*</p> <p style="text-align: right;">57438214 Approx. weight in lbs*</p> <p style="text-align: center;"> <input type="button" value="Calculate"/> <input type="button" value="Reset"/> </p> <p style="text-align: center;"> <input type="button" value="Register &amp; Search PRONTO"/> </p> <p style="text-align: center; font-size: small;">*These weights should be used for estimation purposes only. Plate weight does not allow for kerf.</p> </div>			
New York State Current Storage Capacity	MW	60	<a href="https://www.governor.ny.gov/news/governor-cuomo-announces-new-york-energy-storage-roadmap-achieve-nation-leading-target-1500">https://www.governor.ny.gov/news/governor-cuomo-announces-new-york-energy-storage-roadmap-achieve-nation-leading-target-1500</a>
New York State Pledged Storage Capacity	MW	1,500	todo: find citation again
Average NYC usage	MWh/day	11,000	todo: find citation again
Average US Household Daily Energy Use	kWh / year	10,400	todo: find citation again
Hoover Dam Capacity (at 20%)	MW	2,080	<a href="https://www.utilitydive.com/news/los-angeles-considers-3b-pumped-storage-project-at-hoover-dam/528699/">https://www.utilitydive.com/news/los-angeles-considers-3b-pumped-storage-project-at-hoover-dam/528699/</a>
Hoover Dam Possible Capacity after 3 billion retrofit	MW	10400	
gain per \$billion	MW	2773.333333	
Our Target Capacity to supply NYC at night	MW	936.467864	
gain per \$billion	MW	936.467864	

Total Grid Capacity				
1,082		27.05		
cost to put NY on batteries				
		325.7		
		8.623		
		0.026475284		
		2.5		
height	volume	mass	area (constant)	
0.5	0.5	2.5		0.625
0.5	1	1		0.5

### CALCULATORS

**WEIGHT**   **CONVERSION**   **MISCELLANEOUS**

Select Your Metal:

Select a Shape:

Number of Pieces:

Enter size information:

Outer Diameter:

Wall Thickness:

Length:

Calculated Weights

26053803   Approx. weight in kg\*

57438214   Approx. weight in lbs\*

 

\*These weights should be used for estimation purposes only.  
Plate weight does not allow for kerf.



