

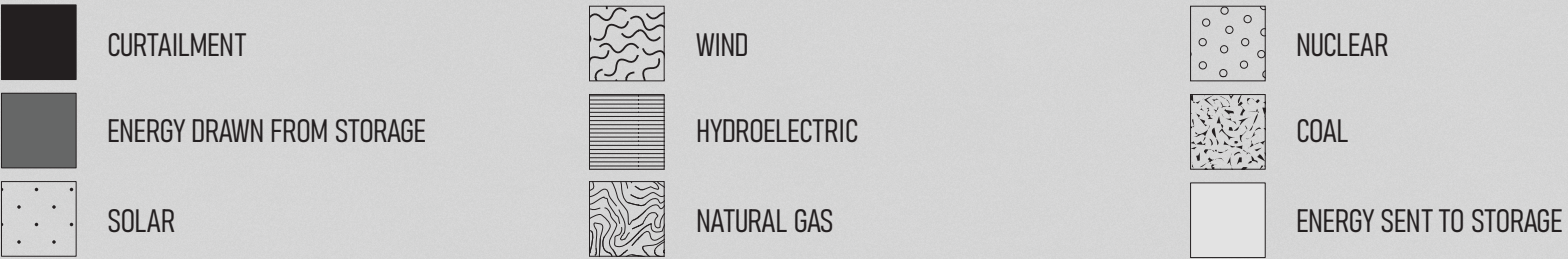


URBAN PUMPED HYDRO ENERGY STORAGE: A STORAGE SOLUTION FOR A GREENER FUTURE

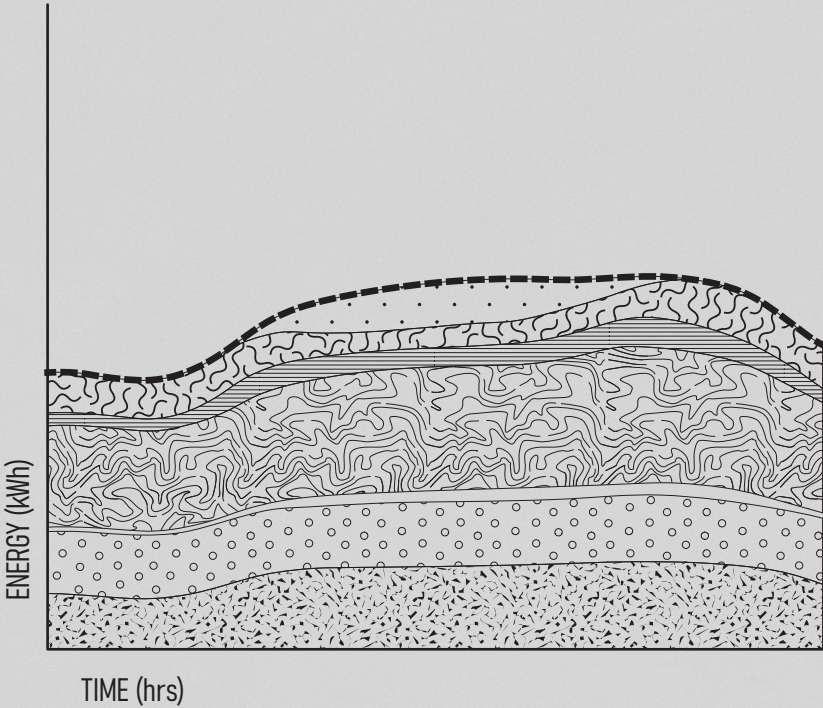
ISAAC KHOUZAM

THE ELECTRIC GRID RELIES ON INSTANTANEOUS FEED-BACK BETWEEN DEMAND AND SUPPLY. ANY MISMATCH BETWEEN THE TWO CAN BE CATASTROPHIC.

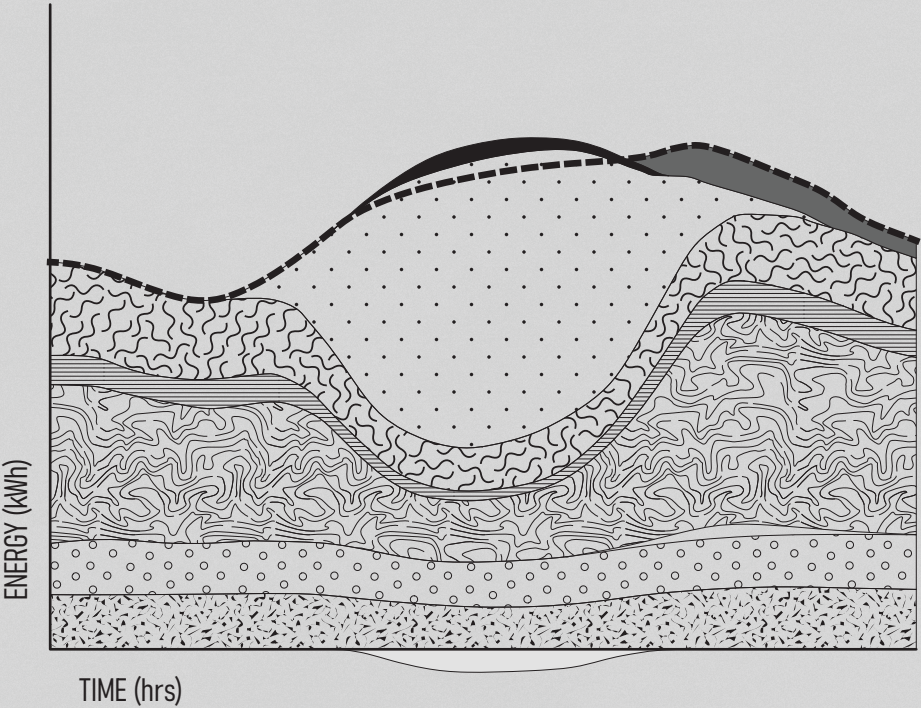
AS WE TRANSITION TOWARDS A DIVERSE ELECTRICITY GRID, WITH A LARGER RELIANCE ON RENEWABLE ENERGY SOURCES, POWER STORAGE WILL BECOME MORE ESSENTIAL THAN EVER.



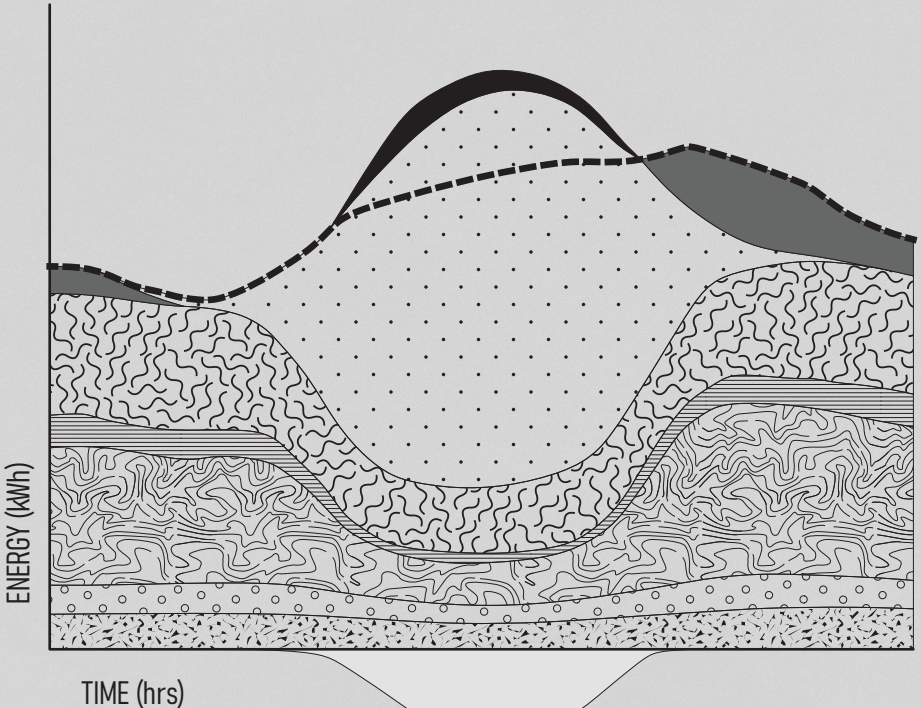
AE02022 REFERENCE CASE, 2021

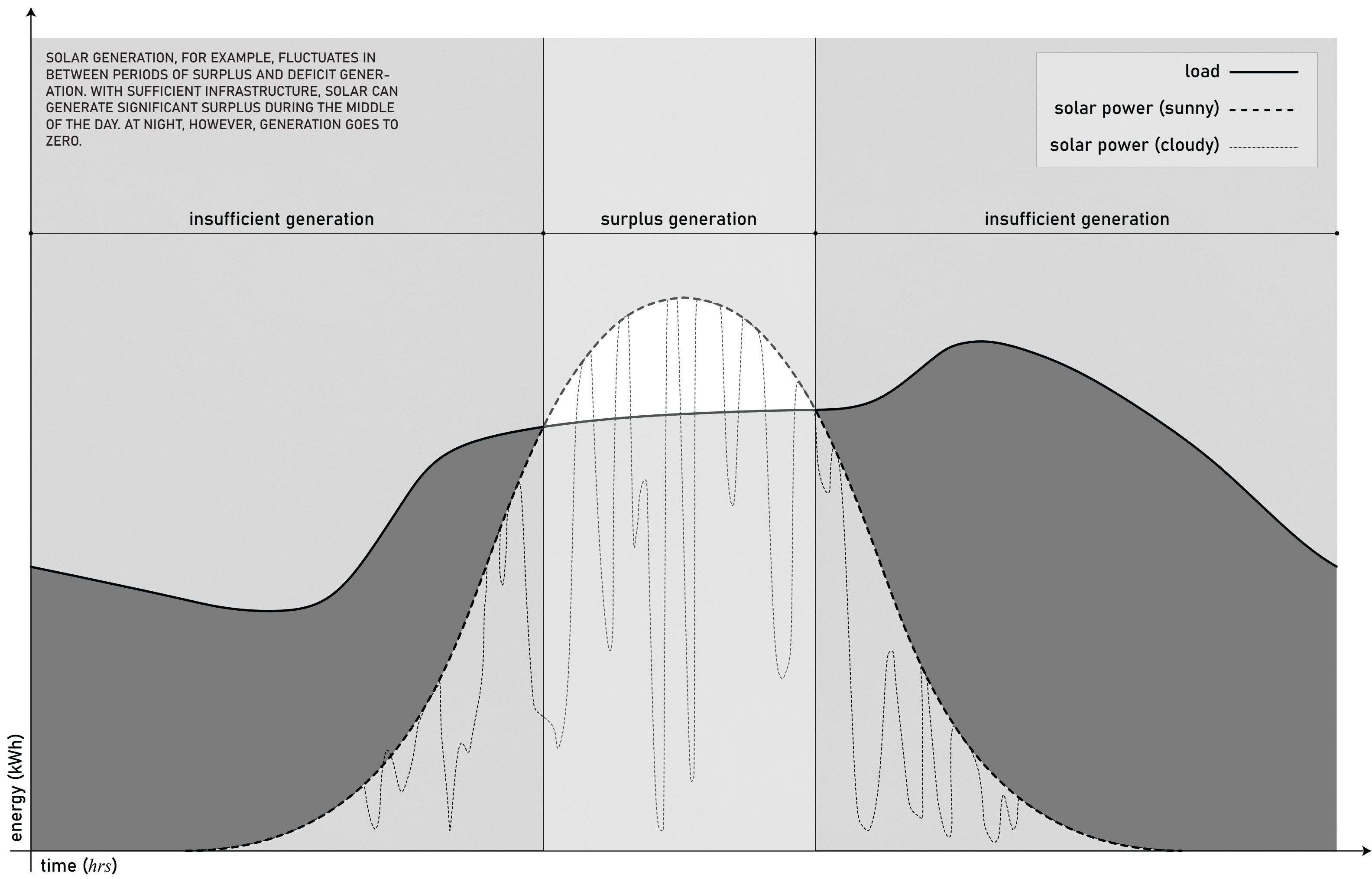


AE02022 REFERENCE CASE, 2050

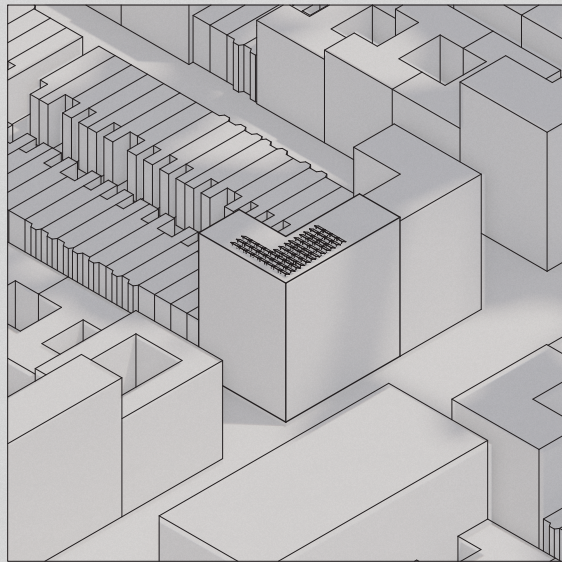
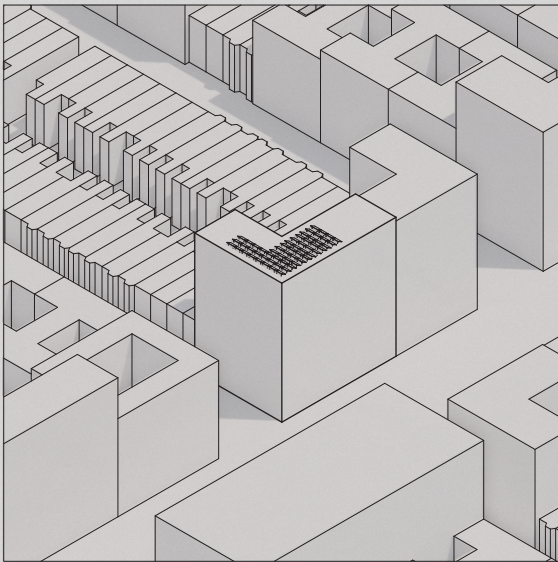
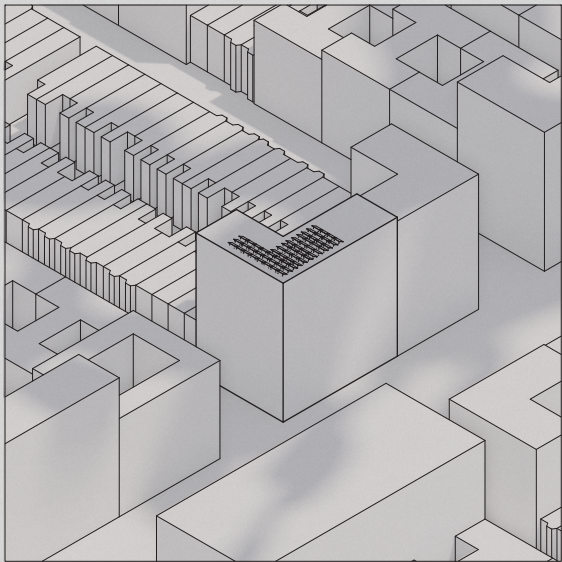
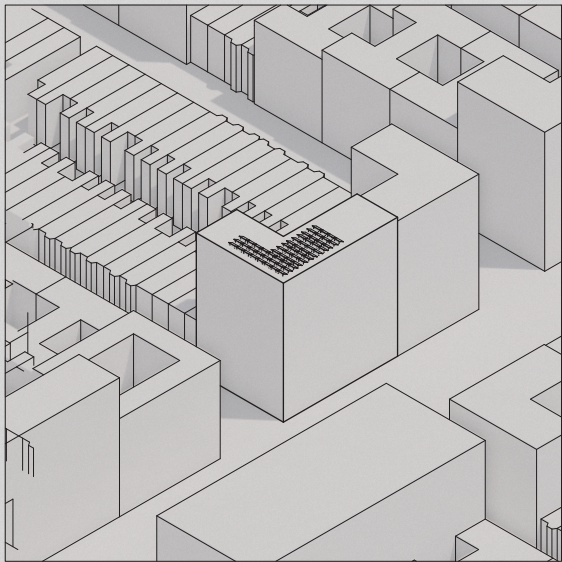


AE02022 LOW RENEWABLES COST CASE, 2050





ON A SHORTER TIMESCALE, VARIABLE CLOUD COVER
CAN TEMPORARILY REDUCE POWER GENERATION SIG-
NIFICANTLY.



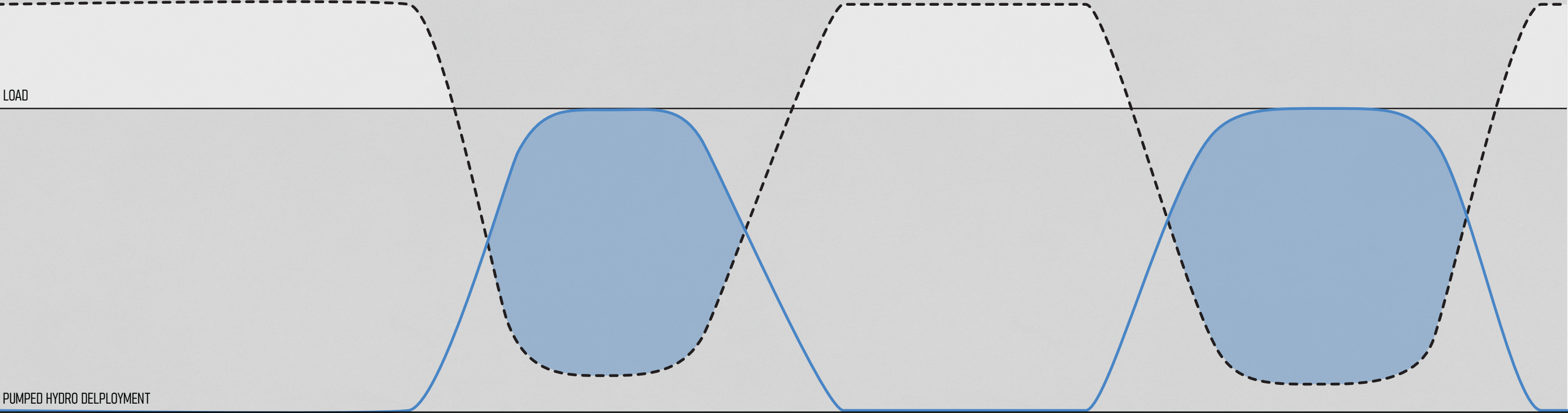
energy (kWh)

SOLAR POWER GENERATED

LOAD

PUMPED HYDRO DELPLOYMENT

time (minutes)

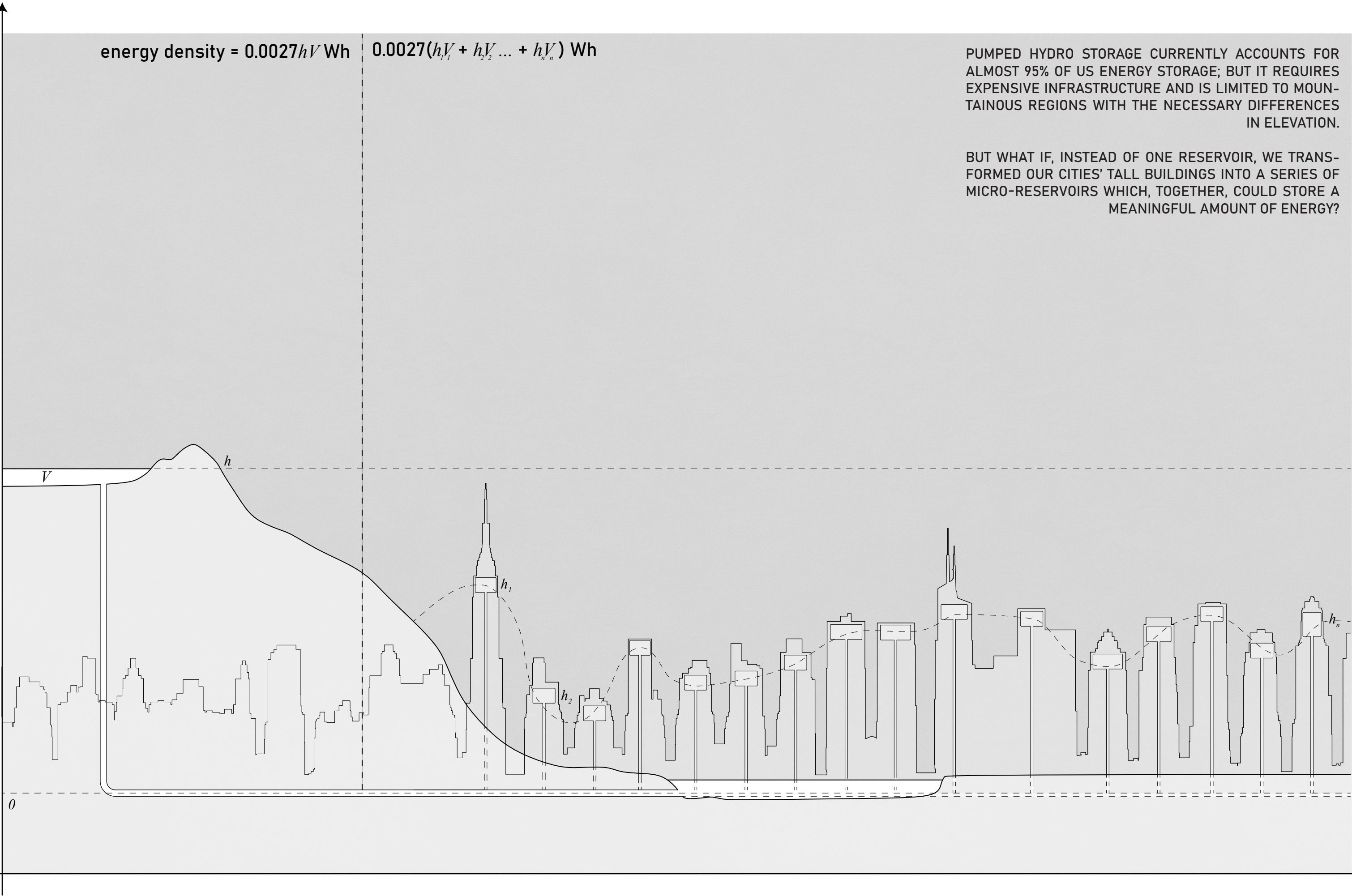


energy density = $0.0027hV$ Wh

$0.0027(h_1V_1 + h_2V_2 \dots + h_nV_n)$ Wh

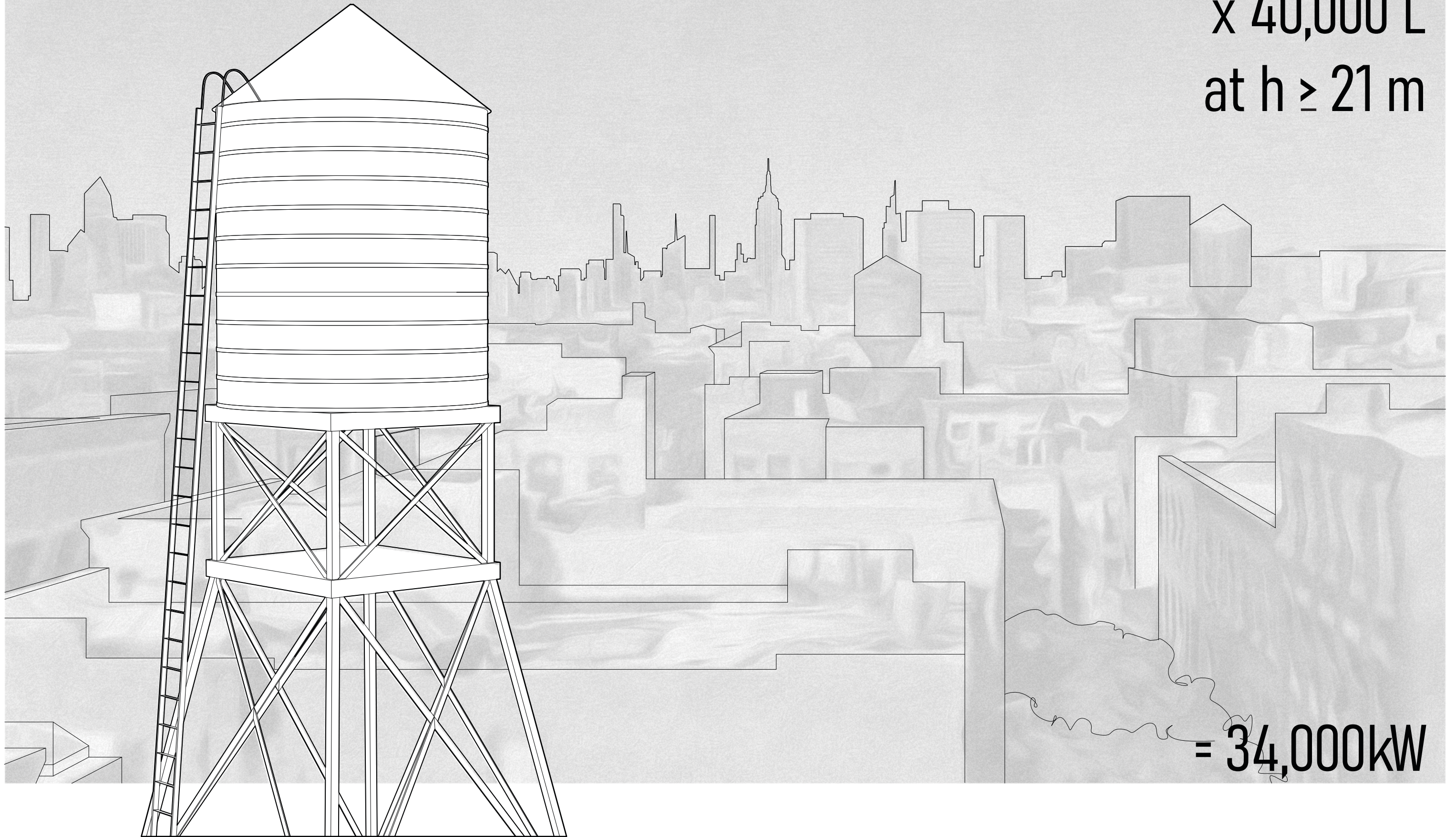
PUMPED HYDRO STORAGE CURRENTLY ACCOUNTS FOR ALMOST 95% OF US ENERGY STORAGE; BUT IT REQUIRES EXPENSIVE INFRASTRUCTURE AND IS LIMITED TO MOUNTAINOUS REGIONS WITH THE NECESSARY DIFFERENCES IN ELEVATION.

BUT WHAT IF, INSTEAD OF ONE RESERVOIR, WE TRANSFORMED OUR CITIES' TALL BUILDINGS INTO A SERIES OF MICRO-RESERVOIRS WHICH, TOGETHER, COULD STORE A MEANINGFUL AMOUNT OF ENERGY?



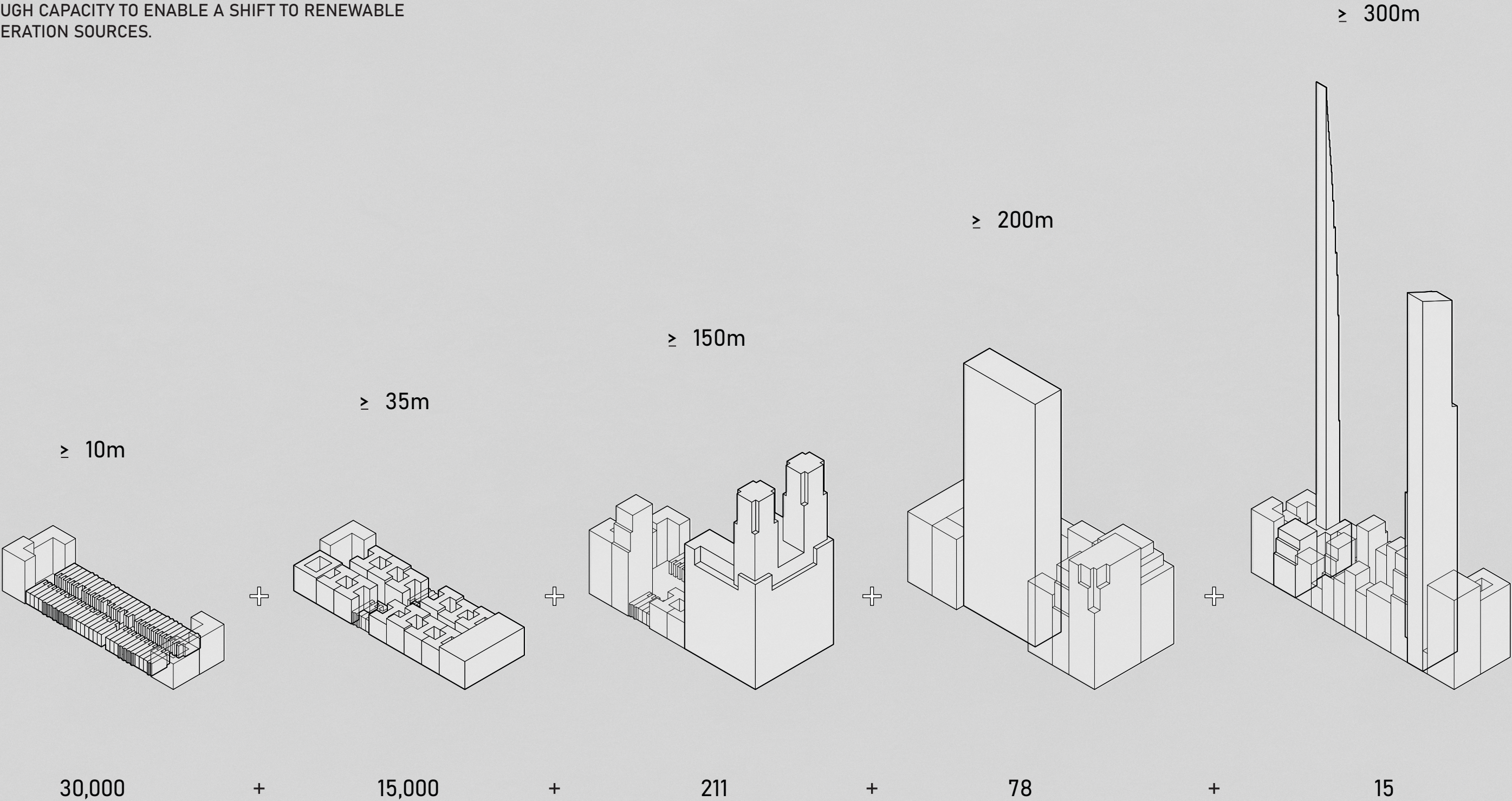
IN NEW YORK, THE INFRASTRUCTURE ALREADY EXISTS TO ELEVATE MILLIONS OF LITRES OF WATER. AT THE MINIMAL COST OF THE INSTALLATION OF A SMALL GENERATOR, THESE WATER TOWERS COULD BE TRANSFORMED INTO AN ENERGY STORAGE SYSTEM

15,000 units
x 40,000 L
at $h \geq 21$ m



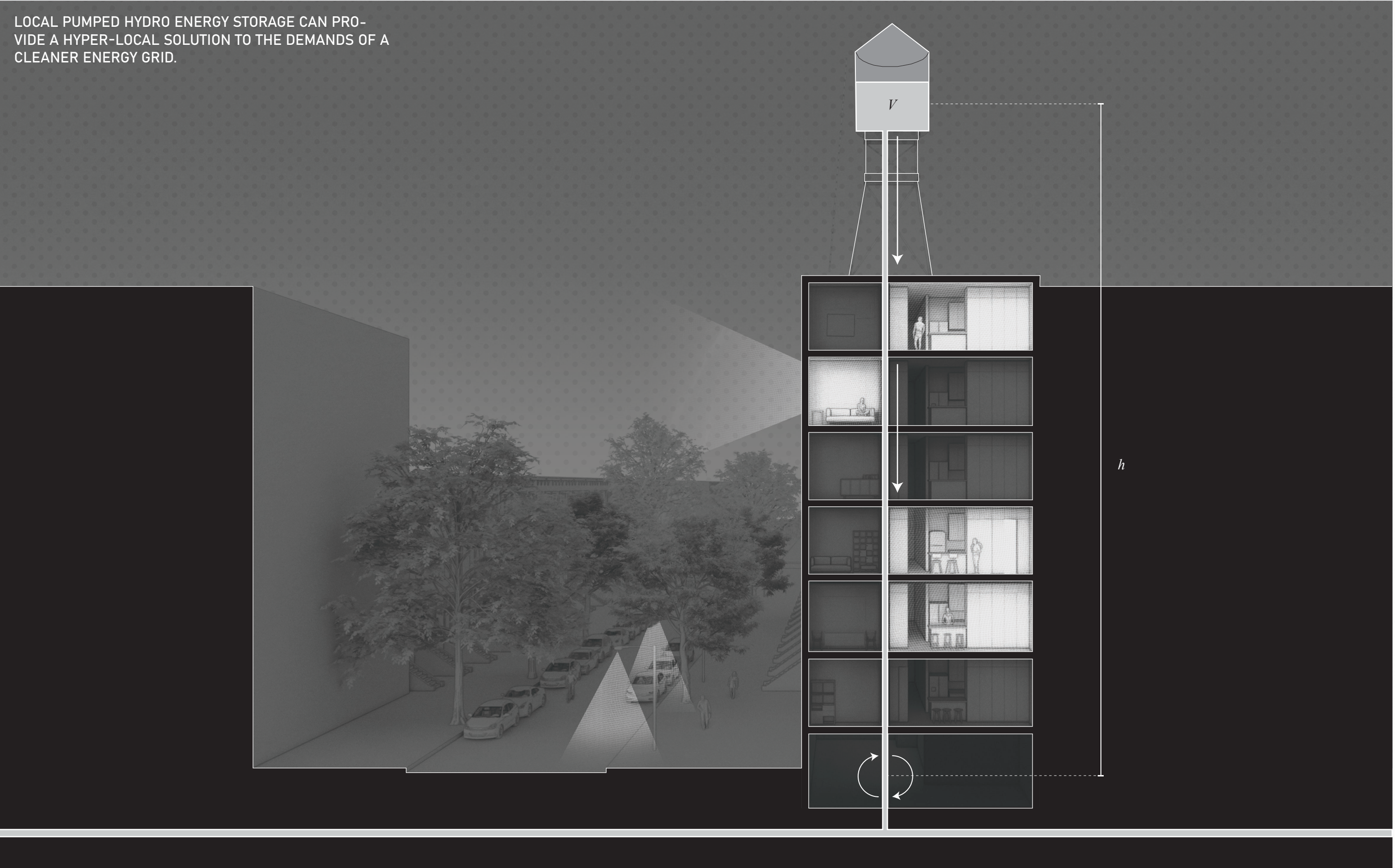
= 34,000kW

IF THIS INFRASTRUCTURE WERE EXPANDED TO A LARGER PROPORTION OF THE EXISTING BUILDING STOCK IN MANHATTAN, THE CITY COULD BECOME A BATTERY WITH ENOUGH CAPACITY TO ENABLE A SHIFT TO RENEWABLE GENERATION SOURCES.



257,000 kWh
33 minutes

LOCAL PUMPED HYDRO ENERGY STORAGE CAN PROVIDE A HYPER-LOCAL SOLUTION TO THE DEMANDS OF A CLEANER ENERGY GRID.



AND WITH THOUSANDS OF TALL BUILDINGS AROUND THE COUNTRY, THE HYPER-LOCAL COULD BE DEPLOYED ON THE NATIONAL SCALE.

Cities with ≥100 Tall Buildings (≥35m)

