

GREENSCHOOL

tools for teaching

CURRICULUM

The Skyscraper Museum

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Green School Project

Introduction

THE SKYSCRAPER MUSEUM, located in Battery Park City in lower Manhattan, celebrates the high-rise history of New York and examines the forces and individuals that have shaped the city's successive skylines.

Dedicated to progressive and innovative education, the Museum has developed this GREEN SCHOOL CURRICULUM as a teaching tool that explores the construction of the Empire State Building in the 1930's and compares it to the recent construction of the Battery Park City Green School, P.S. 276. Our curriculum tracks the WHO, WHAT, WHEN, WHERE, WHY and HOW of both projects, drawing connections between the past and present.

The curriculum contains construction photographs of the two projects and highlights the importance of sustainability and the environmental impact of the construction of the Green School. Both buildings are examined from the ground up, giving the students an understanding of the construction process and sustainable building practices, as well as a look into the inner workings of building systems.

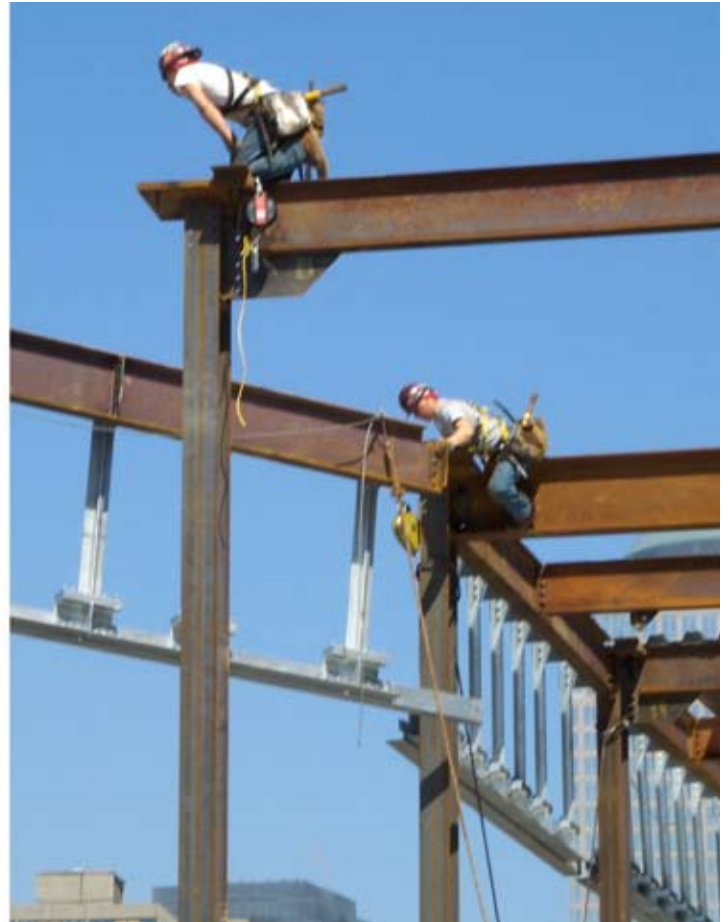
This curriculum can be used to introduce students to the topics of architecture and engineering, building principles, and sustainability. Taking a historical perspective in comparing the famous skyscraper, the Empire State Building, to an urban school, the curriculum invites students to further research buildings of the past, both inside and outside of the classroom. The material can stand alone as a curriculum, but is best used in conjunction with a visit to The Skyscraper Museum. It offers an opportunity for students to observe the built world to understand where materials come from, why buildings are constructed, how they regulate comfort, and how they are heated and cooled. Students will come to understand the motivation and method behind energy conservation and sustainable building practices.



Table of Contents

- 1 Who built the buildings?
- 2 How does the building fit into the city around it?
- 3 Where do materials come from?
- 4 What materials are used in the buildings' structures?
- 5 What materials are used in the buildings' interiors?
- 6 How do the buildings let in light and air, and keep a comfortable indoor temperature?
- 7 How are the buildings heated and cooled?
- 8 How do people get around the buildings?
- 9 Where do buildings get water and how do they use it?
- 10 Where do buildings get energy and how do they use it?
- 11 Why were the buildings constructed?

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Who built the buildings?

Though the **Empire State Building** and the **Battery Park City School** were constructed in very different times and places, they were both designed and built by skilled professionals. These include architects, engineers, contractors and construction trades such as ironworkers, plumbers and electricians. However, there are many new construction jobs on a green building, like installing solar panels, and new ways to do old jobs, like using water-efficient plumbing.

Coordinating different trades and scheduling men and materials in the proper sequence was so challenging that William A. Starrett, the general contractor for the **Empire State Building** claimed that "Building skyscrapers is the nearest peace-time equivalent to war."

Building green adds another layer of complexity to high-rise construction, since so many of the building's systems are integrated to provide maximum efficiency and environmental benefit. Green building designers and builders must work together much more closely throughout the construction process. Powerful software programs called Building Information Models (BIM) are often used to help all of the designers coordinate the building to make sure everything will fit and work together. These computer models are then used to assist in fabricating the components of the building increasing accuracy and reducing waste as well as the number of paper drawings.

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How does the building fit into the city around it?

The **Empire State Building** is a landmark made famous in movies and photographs of the city's skyline. The **Battery Park City School** is a much smaller and newer addition to the city, and will likely never find the same level of celebrity. However, each building is closely connected to its urban context.

Midtown Manhattan, where the **Empire State Building** is located, is the world's largest skyscraper district. Over the last century, landowners and developers have taken advantage of the high demand for office space in the area by replacing older, smaller buildings with highrises that can hold far more workers on the same plot of land.

Battery Park City is a much newer neighborhood, built on landfill from the construction of the World Trade Center. Its development has been carefully planned over the years. Most of the buildings in Battery Park City are highrises, though many more of them are residential apartment buildings than is the case in Midtown.



The density found in both neighborhoods is made possible by the extensive public transportation network that connects them to the rest of the city and metropolitan area. Dense urban development, like that around the **Empire State Building** and the **Battery Park City School**, is very important for the environment. Getting to work or school by public transportation uses much less energy than driving, and dense development within cities saves open space outside of cities from being developed.

Zoning laws have also influenced the shape, size, and location of skyscrapers within Midtown and the city as a whole. Zoning laws were first written for an environmental purpose, to keep large buildings from blocking air and light from the street and their neighbors. Now, new guidelines and laws are being put into place that encourage green building practices in new construction. One example is the New York City Green School Guide, which was used for the design and construction of the **Battery Park City School**.

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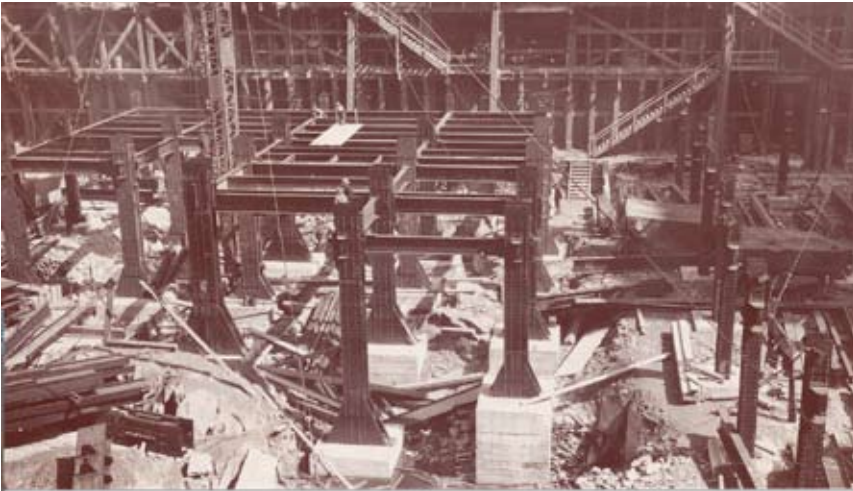
Where do the materials come from?

Modern construction projects incorporate materials from diverse geographic and industrial sources. This was certainly the case for the **Empire State Building**, which used materials from around the United States, such as Indiana limestone and steel from Pennsylvania, as well as specialty items from abroad, such as European marble for the lobby.

However, as the economy has become more globalized, a much greater proportion of construction products and materials have come from far off international sources, increasing the environmental impact of transporting materials to the construction site.

Green building standards, including those used by the **Battery Park City School**, emphasize sourcing materials that are produced regionally, typically defined as within 500 miles of the project site. More than 10% of the materials used in the Green School will meet this standard, though this is likely a much smaller proportion than was the case for the **Empire State Building**.

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What materials are used in the buildings' structures?

Steel and concrete are the key ingredients of all high-rise buildings. In both the **Empire State Building** and the **Battery Park City School**, steel is used for most structural purposes and concrete is used for floors and foundations.

The production of each material has changed considerably over time. Each can now be made stronger and for a wider variety of uses thanks to new technology and production methodology. The production and use of both materials has also become much more widespread internationally since the 1930s, with steel in particular becoming a global commodity.

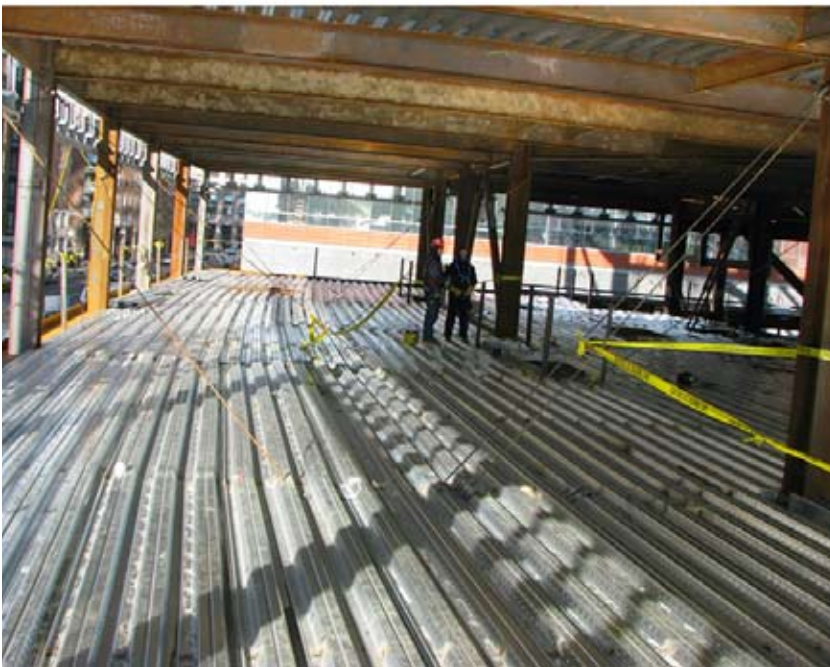
Today, most of the steel and concrete used in high-rise construction contains high amounts of recycled material, reducing its environmental impact. However, both materials still require tremendous amounts of energy to produce and transport, and the extraction of raw materials for each is a major source of pollution and environmental damage worldwide.

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What materials are used in the buildings' interiors?

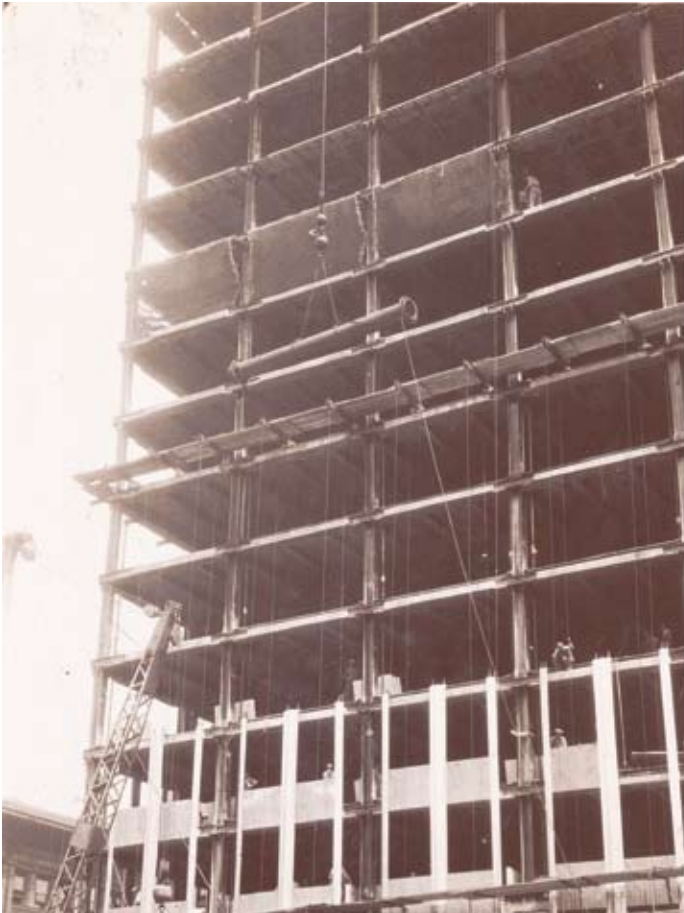
Think of the wide variety of materials found inside a building like the **Empire State Building** or **Battery Park City School**: carpeting, furniture, paint, and many others. Not only does each of these materials have an environmental impact in the place they were produced, many affect the environment inside the building itself. This is because many common materials, like those listed above, are made with harmful chemicals that are emitted into the air around them. These emissions can cause respiratory problems, especially for people with asthma.



When the **Empire State Building** was built, these issues were not understood. Paints and other materials often contained high levels of toxic chemicals. However, many of the harmful chemicals now commonly found in things like furniture did not exist at the time of the **Empire State Building's** construction.

Interior materials with the lowest possible amounts of harmful chemicals will be used in the **Green School**. Moreover, many of these materials will contain recycled content, reducing their broader environmental impact.

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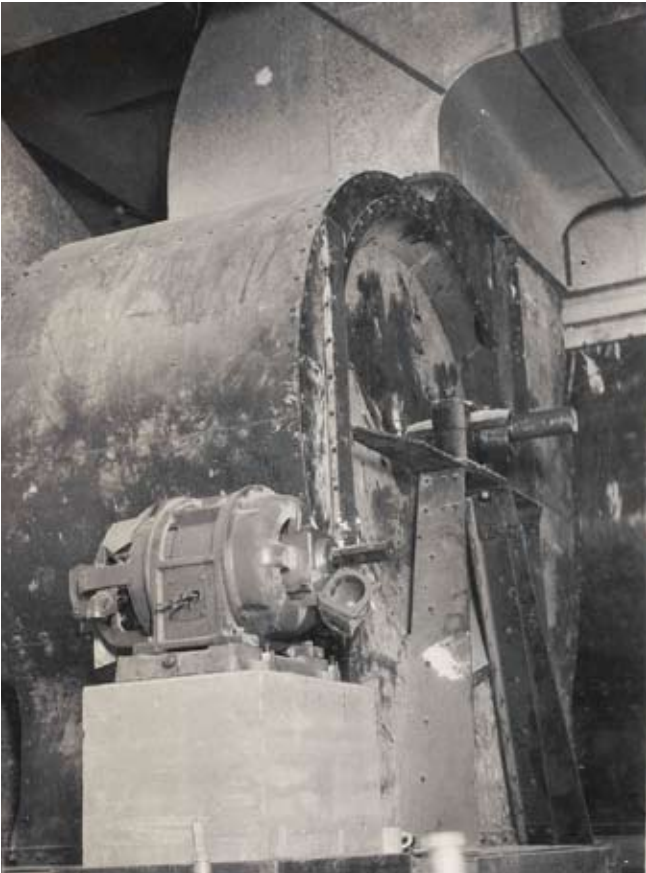
How do the buildings let in light and air, and keep a comfortable indoor temperature?

All buildings need to protect the people inside from outdoor weather, like wind, rain, and snow. They also need to let in fresh air and sunlight, while maintaining a comfortable indoor temperature. These are some of the functions of the walls, roof, windows, doors, and other openings in a high-rise, which together form the building envelope.

The Empire State Building and the **Battery Park City School** have building envelopes that are similar in many ways. The both have masonry outer walls (Indiana limestone for the **Empire State Building** and brick for the **Battery Park City School**) with inner walls behind them. They both have many windows and each has doors that are opened and closed many times every day. In the **Empire State Building**, the windows and doors were the building's main source of fresh air.

In the **Battery Park City School**, the building envelope has been carefully designed to be as tight as possible, to keep cold air from coming into the building in the winter and hot air in the summer. Windows let in sunlight, but are insulated so that they do not let in too much heat. Fresh air is brought through vents by special heating and cooling equipment. In the **Battery Park City School**, like most green buildings, the building envelope and the heating and cooling system were designed to work together to maximize comfort and minimize energy use.

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How are the buildings heated and cooled?

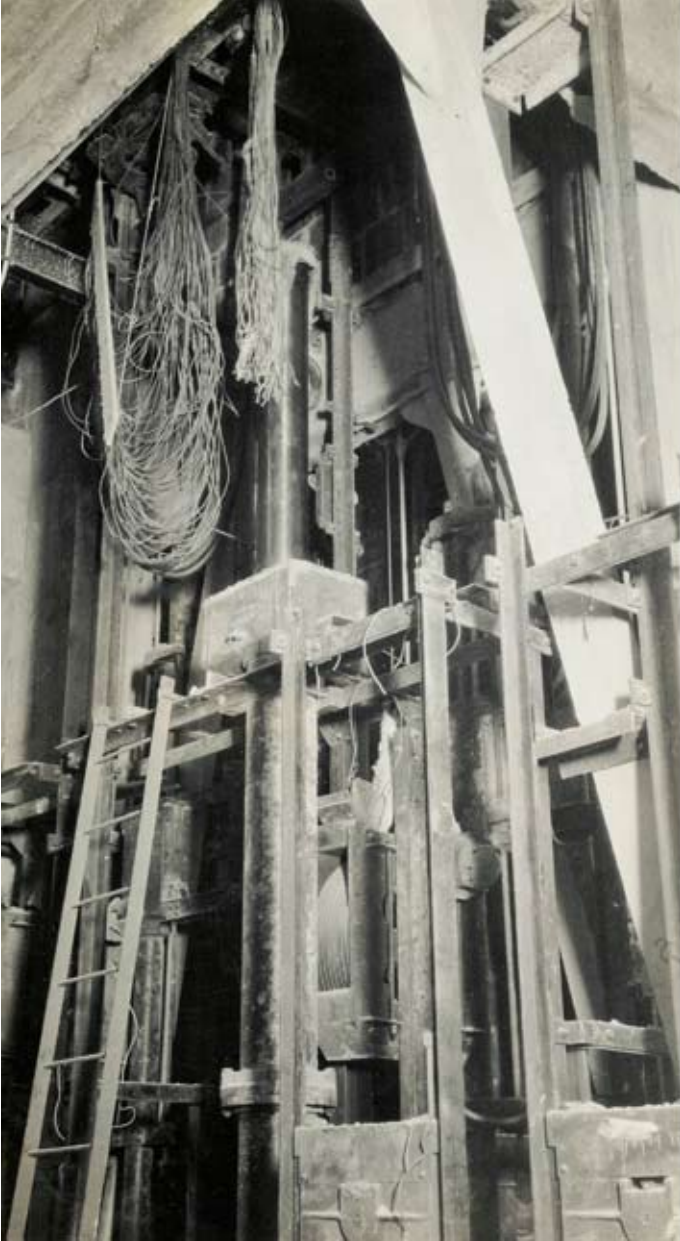
Whether they are office towers or schools, all buildings need to keep the people using them comfortable no matter what the temperature is outside. The technologies for doing so have probably evolved more than any other used in high-rise construction during the skyscraper era.

In the **Empire State Building**, offices and other interior spaces are heated by steam through radiators throughout the building. Windows can be opened to let in fresh air. When the building was originally built, breezes from open windows and electric fans were the only way for building occupants to cool down in the summer.

In the decades that followed, heating and cooling technology developed to the point where all the airflow in most skyscrapers was controlled by mechanical systems, and most windows could not be opened. Typically, energy efficiency was not a priority in the engineering of these systems, making them the largest users of energy in many buildings.

In the **Battery Park City School**, the heating and cooling systems are engineered to operate at maximum efficiency, which, with other efficiency measures, will reduce energy use by more than 26%. At the same time, the building will be more comfortable than many other high-rises, as much of the efficiency comes from providing just the right amount of hot or cold air to each part of the building.

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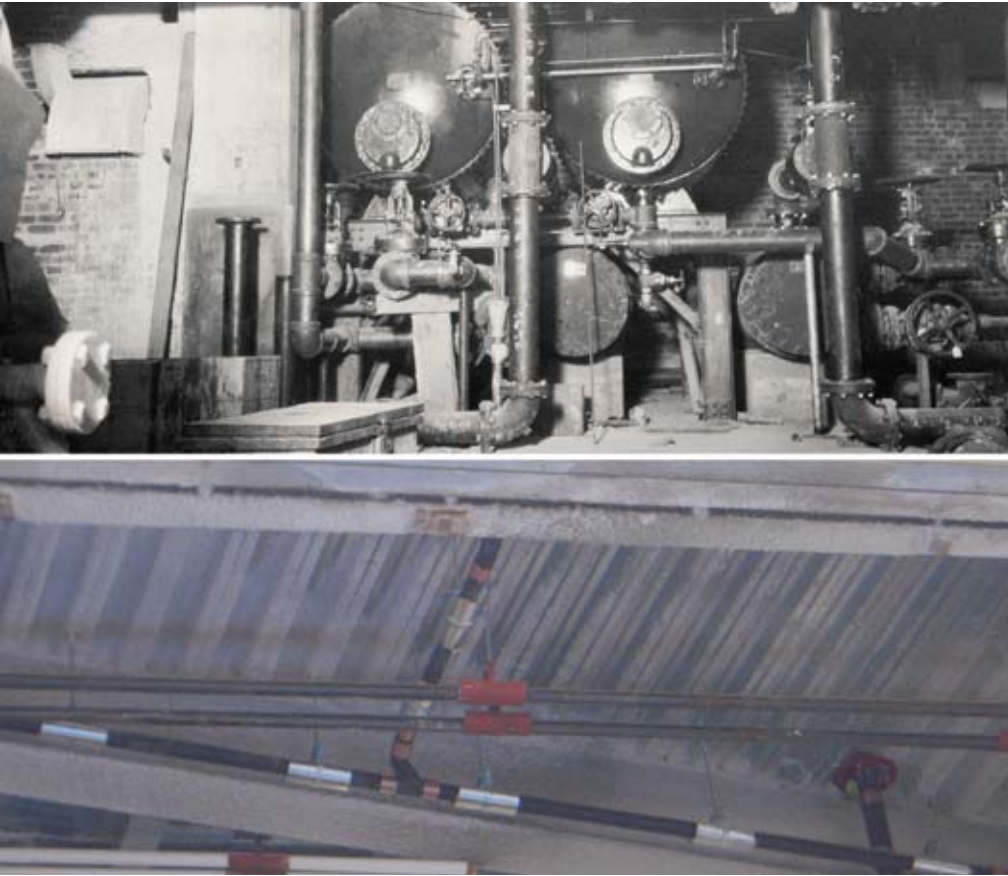


How do people get around the buildings?

One characteristic shared by all modern high-rise buildings is that they use elevators to move people from floor to floor. This was especially the case for the **Empire State Building** due to its unprecedented size and height, which required 69 separate elevators. Elevators use a considerable amount of energy.

The **Battery Park City School** will also have elevators, but the building has been designed to encourage students, staff, and visitors to use the stairs as much as possible in order to save energy. Stairwells have windows to make them more inviting and attractive to use while reducing the number of electric lights. Architects call using windows to provide natural light instead of electric lights daylighting.

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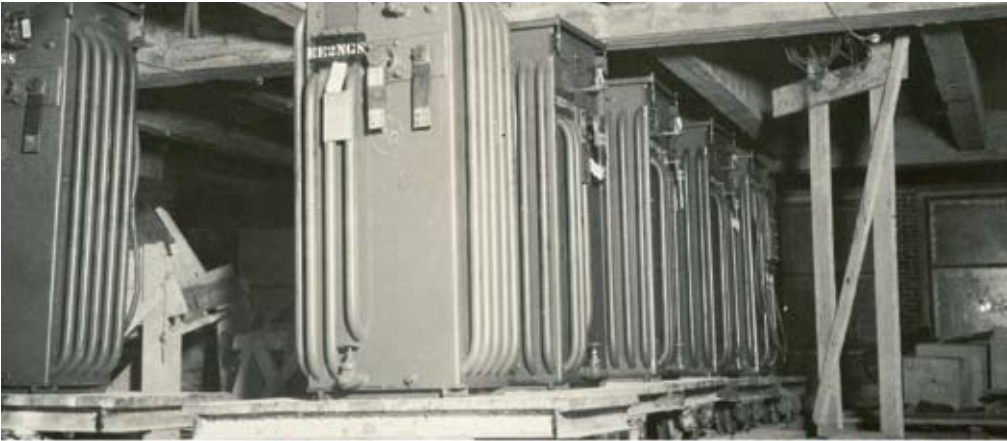
Where do the buildings get water, and how do they use it?

The **Empire State Building** and the **Battery Park City School** both get water from the New York City water supply system. The city's water comes from giant reservoirs hundreds of miles away in the Catskill Mountains. It is brought to the city by underground aqueducts and distributed by a network of pipes that covers the entire city. Without this system, the modern city and its skyscrapers could not have been built or maintained.

New York City's drinking water is some of the cleanest in the world. But sometimes in droughts it can run low. The School conserves water by using sinks and toilets that use water as efficiently as possible, using much less water than those in use when the **Empire State Building** was constructed.

One of the city's biggest environmental problems comes from what happens to water once it goes down the drain. When it rains, the city's system for treating this waste water gets overwhelmed by rainwater, and all the polluted water is released into the rivers and harbor. Reducing water use in buildings can help solve this problem.

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Where do the buildings get their energy and how do they use it?

Any office, home, or classroom requires energy to run appliances, keep the temperature comfortable, and turn on the lights. Bringing hundreds, or even thousands, of people together in a single high-rise building creates a huge demand for energy.

The environmental consequences of energy use weren't much of a concern during the construction of the Empire State Building. Global warming, which is caused primarily by the burning of fossil fuels for energy, had not been discovered. Most alternative energy sources, such as solar and wind power, had not yet been developed in their modern forms.

The building practices and technology of the time did not emphasize energy efficiency. However, the design of the Empire State Building did save significant amounts of energy by making sure all offices have natural light and windows that can be opened to let in fresh air.

The Battery Park City School uses these approaches, and many more, to prioritize energy efficiency. Extra insulation and better windows help keep the indoor temperature comfortable with less heating and cooling. Classroom lights automatically turn off when no one is in the room. Overall, the School will save over 26% on energy costs.

And the School will actually make some of its own energy. Photovoltaic panels on the roof will make electricity from sunlight, helping power the building during the day, which is when there is the most demand for energy.

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Why were the buildings constructed?

The **Empire State Building** was built, first and foremost, to make money. Skyscrapers allow builders to take advantage of sites such as midtown Manhattan where land is very expensive and demand for commercial space, such as offices, is very high. High-rise construction creates the most possible space that can be rented or sold on the smallest possible land area. In addition, building owners often hope that the prestige of a landmark like the **Empire State Building** will help attract more tenants willing to pay higher rents.

In contrast, the **Battery Park City School** is being built as a place for education, not commerce. However, the decision to build a high-rise school is based on a familiar idea: that building vertically allows land to be used most efficiently, in this case by allowing a full sized school to be built on a piece of land much smaller than would otherwise be the case.