Deploying ESS Across Grid Types in the Americas

Understanding Power Transmission Paths in North America

Before diving into the main voltage standards used in North America, it's important to first understand the overall American power transmission pathway. The diagram below illustrates a simplified path from power generation to transmission, distribution, and end-user consumption.

Taking North America as an example, the power flow can be divided into three primary stages:

Generation Stage

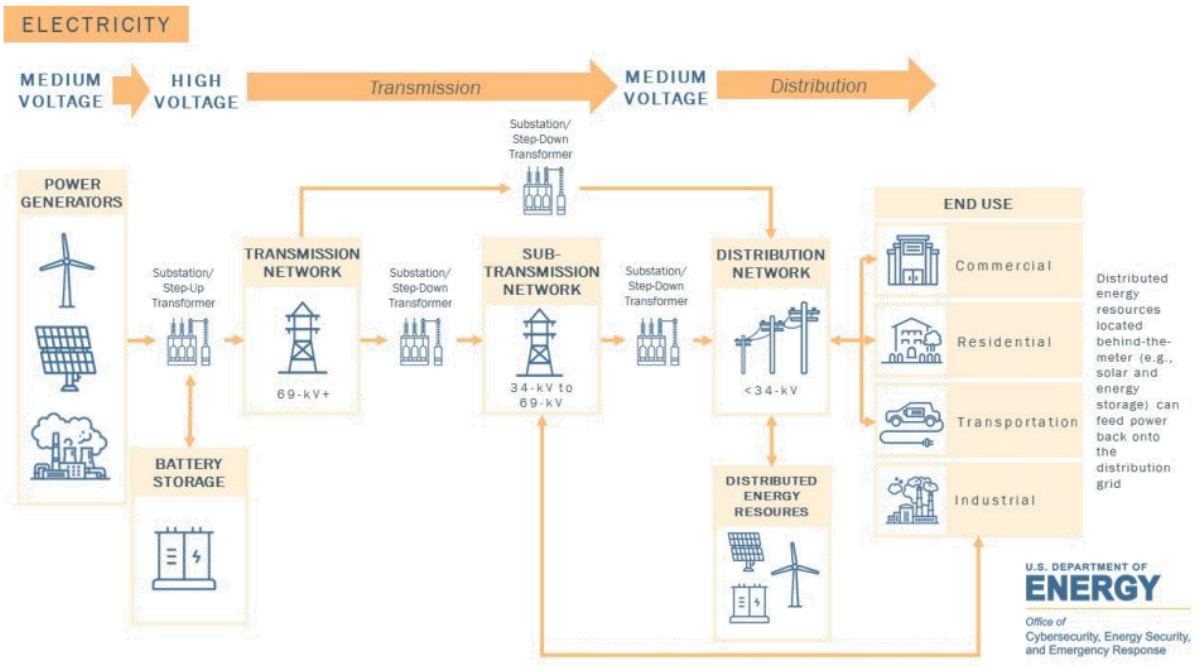
The generation stage is where electricity is produced. This includes large-scale power sources such as thermal, hydro, and nuclear power plants, as well as renewable energy systems like solar and wind (typically categorized as front-of-the-meter).

Transmission Stage

High-voltage transmission lines are used to transport electricity over long distances. This stage includes step-up and step-down transformers to manage voltage levels for efficient transmission.

Distribution Stage

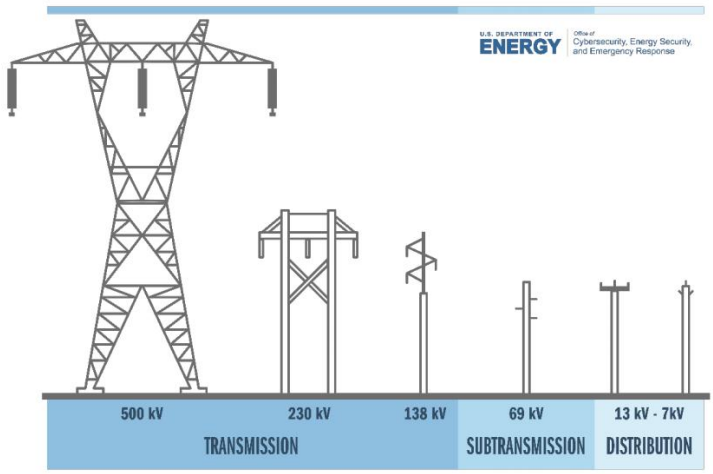
Electricity is delivered over medium- to low-voltage lines to end-users across residential, commercial, and industrial sectors. Notably, as the diagram shows, generation also occurs on the distribution side, including various new energy generation scenarios (behind-the-meter).



Source: U.S. Department of Energy

A simplified path from power generation to transmission, distribution, and end-user consumption

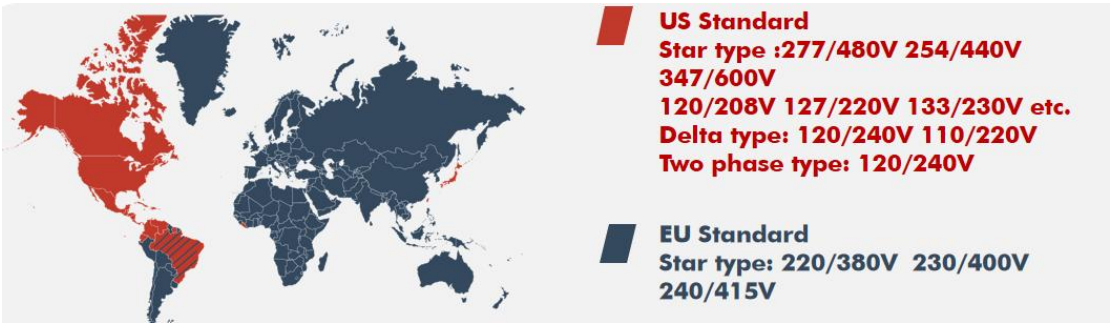
Each of these stages operates at different voltages, requiring transformers to regulate voltage levels during transmission. North America defines transmission line voltage as ranging from 34kV to 765kV, while defines distribution line voltage as typically below 34kV, with most user-side voltages being below 600V.



Source: U.S. Department of Energy. A non-exhaustive representation of the types of equipment involved in electricity transmission and distribution.

Transmission lines are often supported by steel towers, while distribution lines are more commonly found on utility poles. At the user end, electricity is usually connected after further step-down transformers reduce the voltage to the required level.

The systems discussed above all refer to three-phase AC power. This white paper focuses on user-end three-phase voltages below 600V across the Americas.

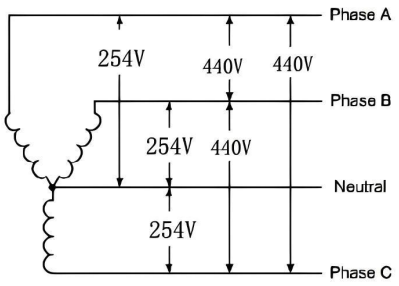


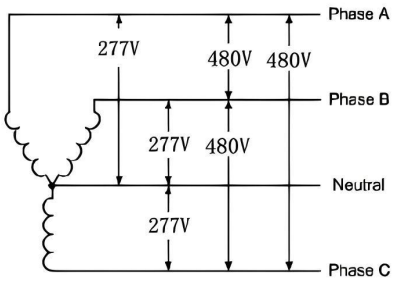
Geographical Breakdown of Grid Standards in the Americas

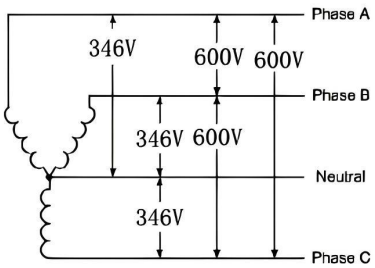
As illustrated below, the Americas are divided into North America, Central America and the Caribbean, and South America.

Influenced by the United States, the US standard voltage features a variety of user-side transformer types, including:

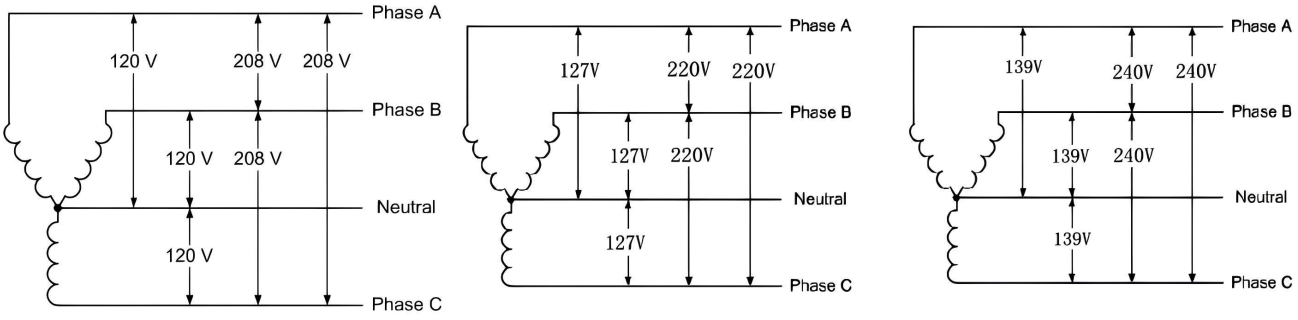
Three-phase Star (Wye): 440V, 480V, 600V



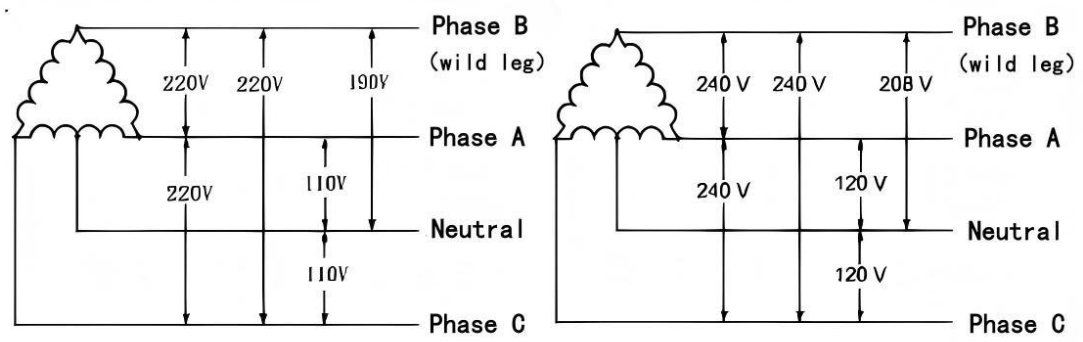




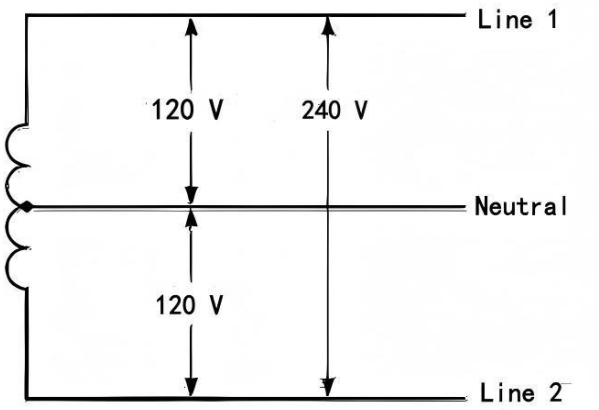
Three-phase star: 208 V, 220 V, 240 V



High-leg Delta (Split-phase): 220V, 240V



Residential Split-phase: 120/240V



It's clear that North America, Central America, the Caribbean, and some northern parts of South America (e.g., Colombia, Ecuador) adhere to the US voltage standard. For the US standard, step-down transformers are used from the distribution side to the user side.

Industrial step-down transformers are typically:

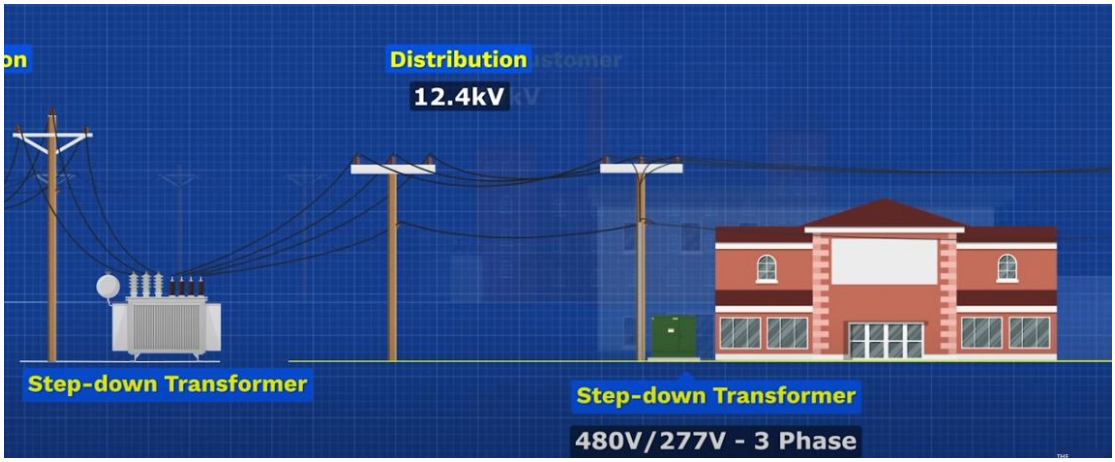


Image of industrial step-down transformer

Commercial step-down transformers are similar to the above, converting 12.4kV to 208V, 220V, or 240V three-phase before supplying the user.

Residential step-down transformers are generally similar. However, some countries following the US standard for residential use also adopt two-phase grids, which are actually two single-phase grids. This is achieved by a single-phase to two-phase transformer on the utility pole, as shown below:

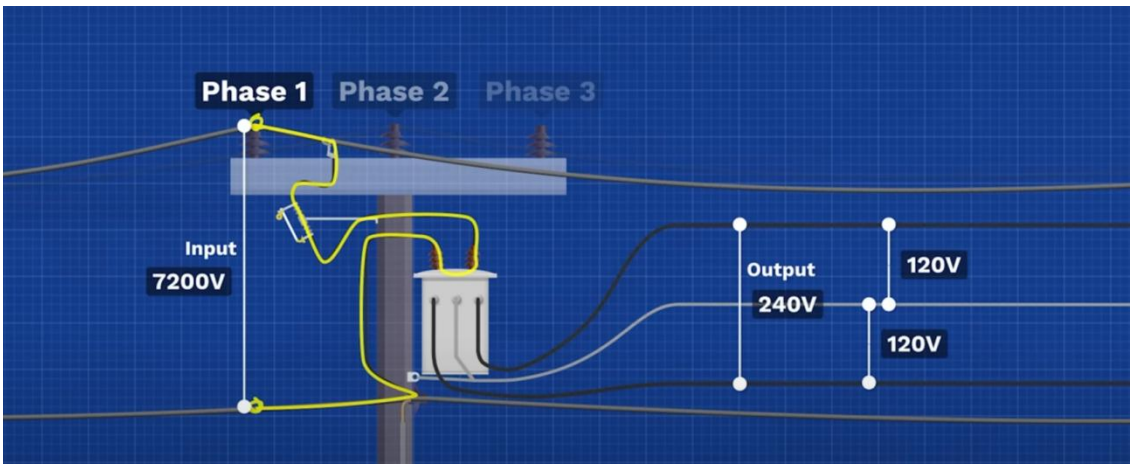


Image of residential step-down transformer on utility pole

From the picture above, a single-phase 7.2kV to two-phase 240V (two single-phase 120V) step-down transformer is directly used on the distribution pole, then electricity is delivered to the home or via another transformer, to meet household electricity needs.

Due to the historical influence of European countries such as Spain, Portugal, France, and the Netherlands in the Americas, most countries and regions in South America operate on the EU standard of 220/380V. Notably, countries like Peru and Brazil utilize both EU- and US- standard distribution grids.

ATESS Product Voltage Coverage

Product Series	Voltage Levels Supported
HPS30KTL-US-208 HPS30KTL-US-208A	208/220/240V 3P Star 220/240V 3P Delta 240V 2P
HPS60KTL-US-480A	480V 3P Star
HPS50/100/150-US-220Y	208/220/240V 3P Star
HPS50/100/150-US-220D	220/240V 3P Delta
HPS50/100/150-US-480	480V 3P Star
PCS100/250/500/630/1000-US-480	480V 3P Star
HPS30KTL-US-208 HPS30KTL-US-208A	208/220/240V 3P Star 220/240V 3P Delta 240V 2P
HPS60KTL-US-480A	480V 3P Star

As electricity demand rises across the Americas, challenges such as unstable grid voltages, aging transmission and distribution infrastructure, power shortages due to energy issues and droughts in some regions, and unbalanced solar-plus-storage ratios are becoming more prevalent. In response, ATESS offers a comprehensive product line covering all the aforementioned voltages. These products can accommodate a wide range of grid voltages, enable peak shaving and valley filling for arbitrage, handle highly inductive loads, and provide complete solutions for frequent power outage scenarios. This ensures the normal operation of customer facilities and a significant increase in economic benefits.