

Spotlight: Lineworkers

Teacher Manual: Lesson 13

Essential Question

How do lineworkers and electric utility workers contribute to climate solutions?

Learning objectives. Students will be able to

- 1. Understand why lineworkers are essential workers and how they contribute to the installation and maintenance of our electrical systems
- 2. Discuss the connection between the state's climate goals and the expanded need for lineworkers
- 3. Identify the skills, training, and experience needed to become an electrical lineworker
- 4. Discuss which aspects of a lineworker's career align with their skills, interests, and desired work environment.

Lesson Summary

Students learn about the lineworkers who keep the power on in their homes and communities and how they play an essential role in modernizing the utility grid to handle the electrification of buildings and transportation. They step into the role of lineworkers as they work together to plan to restore power to an area after a natural disaster. Scenarios include actual events that happened in Massachusetts:

- 1. 2018 Winter Storm Riley
- 2. 2021 Tornadoes in Western MA
- 3. 2022 Extreme heat wave

The career-specific lessons include:

- 11. Electricians
- 12. Engineers
- 13. Lineworkers
- 14. Managers and Analysts
- 15. Construction, Installation, and Maintenance Workers
- 16. Wind Turbine Technicians
- 17. Sales and Customer Services Workers

Technology referenced in this lesson:

- Wind
- Solar
- Battery energy storage
- Electrification

Careers referenced in this lesson: Lineworkers

Lineworkers perform crucial electrical tasks, including installing and maintaining electrical power lines. They work on both above-ground and below-ground power lines to connect or restore electricity for individuals, households, and businesses.

Agenda	Timing	PPT Slide	
Opening Activity	5 minutes	2	Pre-
Present agenda and learning objectives	5 minutes	3–5	lesso
Direct Instruction	20 minutes	6–14	
Video			
Introduce technology			
Introduce careers			
Primary Learning Activity	20 minutes	15–16	
Partner or small group work			
Reinforce what was learned			
Closing	5 minutes	17–19	
Review learning objectives			
Closing activity			
Reflection			
Extension]
Handouts			
TOTAL TIME	55 mins		

Preparation:

- Read the Student Presentation Deck (PPT).
- Watch the video(s) included in the Student Presentation Deck (most are available on the <u>MassCEC YouTube channel</u>).
- Print the worksheets and handouts before the class. **Be prepared to assist students in** reading the schematics provided for their group activity.
- Verify that the computer hosting the presentation deck is connected to the internet for video and hyperlink viewing.

• Check any links in the slide deck to ensure they work as intended, then review the content below.

Where to Learn More About the Lesson's Content

If additional preparation time is available, these resources will provide further background on the topics covered in this lesson.

- <u>Lineworkers</u>. This is a description of job duties on Indeed.
- Lineworker career paths
- <u>MA lineworker jobs</u> (LinemanCentral.com). This website shows common local employers and average salaries.
- <u>MA Building Pathways pre-apprenticeship</u>. Free Career Readiness and Occupational Skills Training. It is a pre-apprenticeship program for residents of Suffolk, Norfolk, Middlesex, or Essex counties who are at least 18 years old and have a high school diploma or equivalency. The Building Pathways Building Trades Pre-Apprenticeship Program can help students learn about the industry, practice their hands-on skills, and compete for union apprenticeship program openings.
- <u>A Climate Jobs Roadmap for MA</u> (Cornell). Grid modernization is driving a need for more lineworkers. Read more pp. 34–35. Case study IBEW 104 p. 40.

Overview and Opening Activity (10 mins)

Materials and resources:

- Slide deck
- Worksheets

Opening activity: Get the students thinking and talking right away.

Activity objective: To encourage the students to connect with the idea of how vital electricity is to modern life, helping them understand why lineworkers are essential workers.

Instructions:

- Assign each student pair or group of students a specific community role from the slide image.
- Give the students two minutes to discuss their main concerns if the power went out from the perspective of that role.
- Encourage each group to share their most significant problems with the rest of the class.

Present the agenda. Students should be gaining familiarity with the format:

• After the opening activity, they will learn new information. The main activity is intended to put them in the role of a lineworker. The closing activity helps them synthesize what they learned and helps with knowledge transfer.

Present the big question and lesson objectives:

- Start by asking students if they have ever experienced a power outage. Encourage them to share how that event impacted their daily lives (e.g., loss of Wi-Fi, heat, or lighting).
- Ask them to think about the people who restore power in these scenarios—introducing the idea that lineworkers are crucial to maintaining modern life.
- Mention that Massachusetts's climate goals will increase the electricity demand, making lineworkers even more essential.

Key points to emphasize:

- Connect the role of lineworkers to larger climate goals: Goals to electrify our energy uses (buildings and transportation) and power them with renewable energy sources (wind and solar) will require modernizing the electrical grid.
- Point out that by the end of the lesson, they should understand the responsibilities and opportunities in a lineworker's career.

Possible discussion questions:

Why are lineworkers so crucial for climate solutions?

 Lineworkers build and maintain the infrastructure supporting renewable energy sources and electrical transportation systems. Without their work, we couldn't achieve large-scale electrification goals.

Direct Instruction (20 mins)

Provide information to help the students to achieve the learning objectives, and prepare them to actively engage with the activity.

- Use inquiry-based learning strategies to engage learners where possible.
- Highlight careers related to the technologies.
- Help the learners to relate the learning to themselves and their communities.

Lineworkers are the backbone of our electrical system.

Discussion guidance:

• Explain that lineworkers are essential workers who help maintain a critical service: electricity.

- Outline the role of lineworkers in keeping modern life running smoothly, from homes to schools to hospitals.
- Explain that they work in urban, rural, above ground, and underground environments.
- Encourage students to think about their daily reliance on electricity and what life would be like without it, connecting this to the opening activity.
- Ask students to imagine a winter storm where power lines are down. Use this to stress that lineworkers are essential first responders in many ways.
- Mention that lineworkers often work in dangerous conditions, such as making repairs and preventing further damage after a storm.

Key points to emphasize:

- Lineworkers are highly skilled in both installation and emergency repairs.
- They maintain above-ground lines (poles and wires) and underground systems (cables and conduits). Their work involves a mix of physical labor and technical expertise.

Anticipated student question: How dangerous is being a lineworker?

• Answer: It can be hazardous due to exposure to high-voltage electricity, heights, and weather, but lineworkers are trained in strict safety protocols to minimize risk.

Lineworkers are needed to upgrade power grids to support clean energy.

Discussion guidance:

- Tie the role of lineworkers to Massachusetts's climate goals: transitioning to clean energy sources and modernizing the grid for electric vehicles and buildings.
- Highlight that we need more infrastructure as we add more renewable energy, such as solar and wind. Lineworkers will be on the front lines, building and maintaining this infrastructure.
- As the climate changes, we'll experience more extreme weather, making a reliable power grid even more critical for public safety and climate resilience.
- Describe how a modern, resilient grid will help prevent outages caused by increasing storms and weather events due to climate change.

Key points to emphasize:

- Lineworkers are critical to responding to climate emergencies. Without them, public safety and infrastructure would be at much greater risk.
- They are also responsible for building the infrastructure necessary for Massachusetts to achieve its climate goals—especially for solar and wind energy.

Possible discussion or check-in questions: What is climate resilience?

• It refers to how well a community or system can withstand and recover from climaterelated impacts, such as storms or heat waves. A resilient power grid maintained by lineworkers is essential for this.

Show the video (3–5 mins) and follow it with a brief check-in to hear what students took away. *(MA-specific video coming soon)*

Lineworkers protect public safety in climate emergencies.

- Climate-related weather events are becoming more frequent and intense, increasing the need for lineworkers to respond quickly to emergencies.
- Lineworkers protect public safety by ensuring that critical infrastructures such as hospitals and emergency services have power.

Massachusetts Climate Plan

Discussion guidance:

- Ask the students whether Massachusetts can reach its climate goals without upgrading the power grid. Help them to understand that the state's success in reducing emissions depends on workers such as lineworkers building and maintaining the necessary infrastructure.
- Explain that Massachusetts aims for net-zero emissions by 2050, meaning we will use much less fossil fuel and rely more on renewable energy sources.

Key points to emphasize:

- Lineworkers are critical to achieving this goal because renewable energy (such as wind and solar) needs to be transported across the state, which requires updated power lines and infrastructure.
- Due to these changes, many new jobs will be created, offering promising career opportunities for students.

Clean Energy Transition

Discussion guidance:

- Explain that Massachusetts has ambitious climate goals, such as electrifying buildings and switching to electric vehicles (EVs), but all require a much more robust power grid.
- Point out that upgrades are needed, so more lineworkers are required.
- Discuss how Massachusetts will need almost double the number of lineworkers by 2030 to support the clean energy transition.
- Encourage the students to think of lineworkers as "climate heroes" who will help the state meet its net-zero goals by maintaining and upgrading the grid.

- Mention specific projects, such as wind farms or solar energy storage, directly tied to lineworkers' work, which students have already discussed in previous lessons.
- Explain that wages vary, but the median in Massachusetts is about \$48 per hour. There are also many opportunities for overtime, especially during emergencies.
- Many lineworker roles and projects are subject to prevailing wage laws; these jobs will have a higher base or starting pay rate than shown here.
- Point out that wages may increase as demand for lineworkers increases, or organizations may offer increased benefits to attract and retain talent.

Key points to emphasize:

- Lineworkers will be critical to ensuring the distribution of renewable energy sources, such as wind and solar, throughout the state.
- Expanding the electrical grid is not just about adding more power—it's also about making it more resilient and able to handle climate emergencies.

Possible discussion or check-in question:

What exactly does "electrification" mean?

• Electrification means using electricity to power things traditionally using fossil fuels, such as cars (electric vehicles) and buildings (electric heating).

The Path to Becoming a Lineworker

Discussion guidance:

- Start by asking the students to list which skills they think would be necessary for a job as a lineworker.
- Explain that this career doesn't require a traditional college degree but does require specialized training and physical fitness.
- Outline the job requirements. Lineworkers often work in challenging conditions, including during storms and emergencies.
 - Technical proficiency: mastering electrical systems and telecommunication cables, understanding blueprints, schematics, and manuals. And lots of math!
 - Physical stamina: the ability to perform strenuous tasks such as repeatedly climbing and lifting heavy objects
 - Problem-solving: troubleshooting and repairing defects in the power line system
 - Safety awareness: strict adherence to safety protocols and practices in high-risk situations; maintaining composure under pressure
 - A willingness to work irregular hours and in various weather conditions
 - An ability to relay complicated technical information clearly and succinctly
- discuss local apprenticeship programs and training schools in MA.

- Most lineworkers receive three to four years of technical and on-the-job training after high school.
- Lineworkers usually start as apprentices or ground workers, where they get hands-on experience and can learn from seasoned professionals before advancing to specialized roles, such as journeyman or lineworker, which require additional years of experience and expertise.

Key points to emphasize:

- Lineworkers need strong problem-solving abilities because they often deal with unexpected challenges like storm damage.
- They must also be comfortable working safely at heights, in harsh conditions, and with high-voltage equipment.

Anticipated student question: Can anyone become a lineworker?

• Answer: Many people can, but it requires physical ability, technical skills, and safety training. Apprenticeships are often the best way to enter the field.

Lineworker Career Paths

Discussion guidance:

- Ask students what they envision when they think about their future careers. Connect this to how linework can lead to a fulfilling, stable career without a traditional college degree.
- Mention that many lineworkers advance into more specialized roles, such as substation technicians or engineers, after gaining experience.
- Explain that there are several possible careers involved in the work you're discussing today, including
 - Lineworkers or line repairers
 - Underground construction workers
 - Substation technicians
 - Electrical systems planners
 - Engineers for distribution and transmission
 - Project managers.

Key points to emphasize:

- Linework offers opportunities for growth and specialization.
- Massachusetts has several apprenticeship programs that provide hands-on training and a clear career path for young workers.

Primary Learning Activity (20 mins)

Materials:

• Worksheets

Activity objective: to engage students in understanding the critical role of lineworkers during climate-related emergencies, highlighting their essential role in maintaining public safety and contributing to climate resilience.

Time suggestions:

- 1. Set up and explanation: two minutes. Divide the class into three groups and assign each to a scenario. Provide the handouts for each scenario.
- 2. Group planning: seven minutes. Each group will take on the role of lineworkers tasked with responding to their climate event. Their task is to develop a quick action plan, deciding which areas to prioritize and what safety concerns could affect their repairs.
- 3. Group presentations: two minutes each (six minutes total). Each group will present its plan to the class, explaining its strategy, the risks involved, and how its response helps ensure public safety.
- 4. Debrief discussion: five minutes. Class-wide discussion about how lineworkers' quick and effective response to emergencies ties into climate resilience and clean energy infrastructure. Summarize what the class learned to reinforce key points.

Instructions:

- Divide the class into three groups and assign each to a scenario. Depending on the class size, you may have more than three groups, with more than one group working on each scenario.
- Assign the students to the role of lineworkers tasked with responding to an actual climate event from the past few years in Massachusetts. They must
 - Analyze the scenario and the town's electricity grid schematic provided on their worksheet for their assigned scenario (Winter Storm Riley, Tornados, or Extreme Heat Wave)
 - Develop their quick action response plan, deciding which areas to prioritize and what safety concerns could affect their repairs
 - Present their plan to the class, explaining its strategy, the risks involved, and how its response helps ensure public safety.
- Following the students' presentations, initiate a class-wide discussion about how lineworkers' quick and effective response to emergencies ties into climate resilience and clean energy infrastructure.

Information about Schematics (provided on student worksheets)

Each scenario is accompanied by an illustration of the town's electrical grid, including the central power station, several electrical junctions, and the critical locations affected by the climate emergency.

To restore power to locations in town, students must restore power to any **semi-operational** or **non-operational** junctions connecting buildings to the power station. Electricity runs through power lines and junctions. Once you restore power to a junction point, it will distribute power through all connected lines until they reach a building or another junction point. The key below will help you.

Red power lines and buildings are currently without power. **Red** junctions are non-operational and require significant maintenance to restore function.

Gold power lines and buildings with fluctuating, limited, or unstable power. Gold junctions are semi-operational and require minor maintenance to restore function.

Green power lines and buildings are fully powered. Green junctions are fully operational and can distribute power without any maintenance.

Teams can only reach junctions by traveling on roads shown as gray lines on their schematics. Due to the emergency, some roads may be blocked by hazards, such as fallen trees or traffic disruptions. Teams must communicate with local authorities to coordinate clearing hazards to access junctions requiring maintenance.

Safety, weather, and hazards are all factors that should be considered when putting together the best way to restore power to the community.

Debrief discussion:

- Ensure each group includes how their team's response contributed to public safety. This discussion will help connect the dots between climate events, lineworkers, and climate resilience.
- Start by revisiting the Big Question from the beginning of the lesson: "How do lineworkers and other electric utility workers contribute to climate solutions?"
- Discuss why their role is critical in ensuring the safety and well-being of communities.
 - Students should reflect on the immediate and future safety and well-being of individuals and communities.
 - They should observe that electricity powers everything from heat, water, locks, transportation, and communications to food safety and access.
- Consider how the ability to restore power during emergencies contributes to broader climate resilience goals, such as clean energy access and reliable infrastructure.

- As we transition to an electrified grid, more services will be connected to the grid and will, therefore, depend on our ability to restore electrical power quickly and safely.
- Ask students to reflect on what they've learned and how their understanding of the role of lineworkers has changed. Encourage a few students to share their thoughts.

Guiding question for closing the discussion:

Why do you think lineworkers are crucial to achieving climate goals?

• Encourage students to connect lineworkers' skills and responsibilities to the large-scale transition to renewable energy and electrification.

Summarize key takeaways:

- 1. The essential role of lineworkers: Lineworkers are indispensable to keeping the electrical grid functioning. Their role is crucial in ensuring the transition to renewable energy sources, critical to fighting climate change.
- 2. The connection between lineworkers and climate resilience: Lineworkers support daily electricity needs and are on the front lines of climate resilience. They keep critical infrastructure operational during storms and emergencies caused by climate change.
- 3. Career opportunities in the energy sector: A career as a lineworker offers a path to stable employment without needing a traditional college degree. It also provides opportunities for further specialization and growth.

Guiding students toward further reflection:

 Highlight that many roles (including lineworkers) will be crucial as we work toward climate solutions. There are opportunities for various skills and interests, from technical to managerial and hands-on to strategic.

Differentiations and Adaptations: Learning Activity

For students who focus better on role-playing, assign emergency response roles.

Adaptation: Assign specific roles within each group, such as "crew chief," "safety officer," and "grid specialist." Provide role-specific prompts or questions (e.g., the crew chief prioritizes repairs, the safety officer identifies hazards, and the grid specialist ensures their plan aligns with the schematic). Each role contributes to the overall strategy during the presentation. **Goal**: To break down the task into smaller, role-specific responsibilities, making it easier for students with different strengths to contribute meaningfully.

For students who prefer hands-on activities, use a physical model.

Adaptation: Create a simple physical model of the town's grid using materials such as a printed map, yarn for power lines, and small markers for substations and critical facilities (e.g., hospitals or fire stations). Students can move markers or place "damage" indicators on the model to visualize their response plans.

Goal: To engage tactile students by turning the activity into a tangible, interactive exercise that supports visual and spatial understanding.

For students who struggle with group dynamics, incorporate individual reflection time.

Adaptation: Before the group discussions, give the students 5–10 minutes to review their scenario and worksheet prompts independently, jotting down their initial thoughts. During the group discussion, each student shares their ideas to build the plan collaboratively.
Goal: To ensure students who feel overwhelmed in group settings have time to process the task independently and contribute confidently.

Key Points and Closing Activity (5 mins)

Materials:

- Presentation/slide deck, slides
- Reflection journal or worksheets

Summarize key points:

- **Essential role of lineworkers:** Lineworkers are indispensable to keeping the electrical grid functioning. Their role is crucial in ensuring the successful transition to renewable energy sources, critical to fighting climate change.
- The connection between lineworkers and climate resilience: Lineworkers support daily electricity needs and are on the front lines of climate resilience. They keep critical infrastructure operational during storms and emergencies caused by climate change.
- **Career opportunities in the energy sector:** A career as a lineworker offers a path to stable employment without needing a traditional college degree. It also provides opportunities for further specialization and growth.

Guiding students toward further reflection:

 Highlight that many roles (including lineworkers) will be crucial as we work toward climate solutions. There are opportunities for various skills and interests, from technical to managerial and hands-on to strategic.

Activity objective: To encourage students to reflect on the key takeaways and identify areas of curiosity for further exploration.

Ask students to take one minute to think about the lesson and answer these questions:

- Why are lineworkers critical to Massachusetts achieving its climate goals?
- How do lineworkers contribute to climate resiliency?
- What is one unique aspect of working as a lineworker?

Discussion notes:

- Go around the room, asking students to share their answers.
- Encourage brief discussions or clarifications if students' questions are particularly thought-provoking.

Instructional steps:

- 1. Review the learning objectives so that learners can summarize what they have learned.
- 2. Present the closing activity.
- 3. Allow time for students to reflect in their career journals.

Extensions: If learners are loving this topic and want more . . .

Local Training and Apprenticeship Opportunities

Middlesex Community College https://www.middlesex.mass.edu/advising/downloads/maps/2017-2018/eutc.pdf

Create a Day-in-the-Life Project

Prompt: Research a lineworker's daily responsibilities, tools, and safety procedures. Create a visual or multimedia project (e.g., a slideshow, poster, or video) illustrating a typical day and highlighting challenges such as working in extreme weather conditions or repairing high-voltage lines.

Goal: To encourage students to explore the technical and human aspects of lineworker careers, fostering an appreciation for their critical role in maintaining the electric grid.

Design a Disaster Preparedness Plan for Lineworkers

Prompt: Imagine you are tasked with creating a preparedness plan for a team of lineworkers responding to extreme weather events such as hurricanes or heat waves. Outline key steps, such as training, tools, safety protocols, and communication strategies. Present your plan in a report or diagram.

Goal: To help students think critically about the planning and organization behind emergency response, emphasizing problem-solving and safety.

Explore Emerging Technologies in Utility Work

Prompt: Research new technologies that assist lineworkers, such as drones for line inspections, smart grid technology, or augmented reality (AR) repair tools. Write a summary about how one of these technologies could improve efficiency and safety in the field.

Goal: To introduce the students to the evolving nature of utility work, highlighting how innovation supports traditional careers.

Handouts: Group Activity

Critical Response: Lineworkers in Emergencies

Instructions

Your team represents a group of lineworkers responding to a climate emergency. Review the details of your assigned event to understand the challenges your team faces. Then, examine the schematic provided for your town's power grid. Identify the areas affected by downed power lines and damaged infrastructure.

How to Use Your Schematic Drawing

Each scenario is accompanied by an illustration of the town's electrical grid, including the main power station, several electrical junctions, and the important locations affected by the climate emergency.

To restore power to locations in town, you must restore power to any semi-operational or nonoperational junctions connecting buildings to the power station. Electricity runs through power lines and junctions. Once you restore power to a junction point, it will distribute power through all connected lines until they reach a building or another junction point. The key below will help you.

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Green power lines and buildings are fully powered. Green junctions are fully operational and can distribute power without any maintenance.

You can only reach junctions by traveling on roads shown as gray lines. Some roads may be blocked by hazards due to the emergency, such as fallen trees or traffic disruptions. Your team will need to communicate with local authorities to coordinate clearing hazards so you can access junctions requiring maintenance.

Safety, weather, and hazards are all factors that should be considered when putting together the best way to restore power to the community.

Response Plan Prompts

Priorities: Which area(s) of the grid will you restore first and why?

Safety concerns: What safety hazards does your team face?

Steps to restore power: Outline the key tasks your team will complete to repair the grid and bring power back online for your town.

Winter Storm Riley

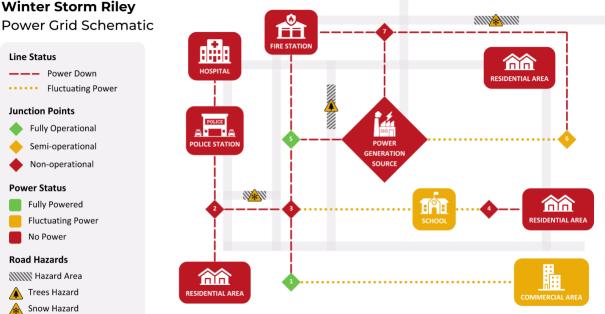
Scenario: In March 2018, Winter Storm Riley—a powerful nor'easter—brought heavy snowfall, strong winds, and flooding to Massachusetts. The storm caused widespread power outages as trees and utility poles were brought down by the intense winds and heavy, wet snow. Lineworkers were called upon to restore power to more than 450,000 homes and businesses across the state.

Your team of lineworkers is at the forefront of this emergency response. Your role is crucial in restoring power to the affected areas, particularly the rural regions where access is challenging due to blocked roads and heavy snow accumulation. Hospitals and emergency services in several towns rely on your expertise to restore power quickly despite the hazardous conditions and dropping temperatures.

Your Mission: As lineworkers, your task is to restore power to critical facilities and the community while ensuring the safety of your team and working efficiently under hazardous conditions.

Key Challenges:

- Prioritize which areas to restore first.
- Safely access areas blocked by fallen trees and heavy snow.
- Follow safety protocols to prevent accidents.
- Coordinate with local authorities and keep the public informed about the restoration progress.



Winter Storm Riley

Tornado Outbreak

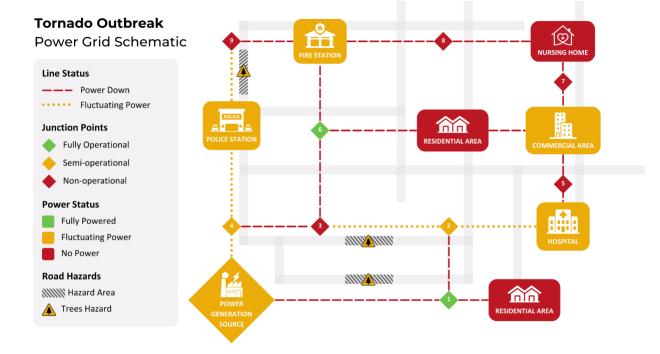
Scenario: In July 2021, a series of tornadoes struck Western Massachusetts, causing severe damage to homes, businesses, and power infrastructure. Trees and power lines were downed, leaving thousands without electricity. The tornadoes damaged several substations, adding further complexity to the restoration efforts. Your crucial role as lineworkers across the state, deployed to repair the extensive damage to above-ground and underground electrical systems, is invaluable.

Your team faces a critical mission—repairing the damage in one of the hardest-hit areas. Substations in the region have been severely damaged, and many residents are without power, including a nursing home that urgently needs electricity for medical equipment. However, strong thunderstorms are still forecast, posing additional risks.

Your mission: As lineworkers, your task is to restore power to critical facilities and the community while ensuring the safety of your team and working efficiently under hazardous conditions.

Key challenges:

- Prioritize which areas to restore first.
- Safely access areas blocked by fallen trees and hazards.
- Follow safety protocols to prevent accidents.
- Coordinate with local authorities and keep the public informed about the restoration progress.



Extreme Heat Wave

Scenario: In August 2022, Massachusetts experienced an extended heat wave with record-breaking temperatures exceeding 100°F in some areas. The increased demand for air conditioning and cooling systems led to a surge in power consumption, overloading the electrical grid and causing rolling blackouts. Several power lines overheated, leading to widespread outages in both urban and rural areas. Your crucial role as lineworkers was dispatched to repair the affected lines and prevent further outages as demand increased, demonstrating the vital importance of your work.

Your team is deployed to an area where the power grid has been significantly affected. The heat is dangerous for the public and your crew, and there are concerns about heat-related illnesses. The potential impact of this heat wave on the community is significant. Critical infrastructure has lost power, including a local water treatment plant, and its operations must be restored to ensure the community has access to clean water.

Your mission: As lineworkers, your task is to restore power to critical facilities and the community while ensuring the safety of your team and working efficiently under hazardous conditions.

Key challenges:

- Prioritize which areas to restore first.
- Safely access areas blocked by fire hazards and traffic disruptions.
- Follow safety protocols to prevent accidents.
- Coordinate with local authorities and keep the public informed.

