ADDENDUM D

Energy & Heat: Zero to Full Competency

Why This Addendum Exists

Chapter 4 tells you what to have and do at each tier of a disruption. It does not teach you the underlying electrical and heating competency that makes those choices safe rather than dangerous. Backup power and wood heat are two of the most common sources of preventable injury and death in a power outage (carbon monoxide poisoning, electrocution, house fires); this addendum is a skill-building curriculum to close that competency gap, built from real trade programs and certifications, not just product manuals.

It's organized by skill stage, not by disaster duration, following the same structure as the other addenda. Treat the self-check at the end of each stage as the actual gate.

Four stages: Foundations (basic safe practice), Applied Practice (hands-on competence), Self-Sufficiency (independent, resilient skill), and Mastery & Teaching (able to teach others and operate at community scale). Each stage covers two sub-skill tracks that run in parallel: electrical/backup power, and heating/fuel.

Stage 1: Foundations (Awareness)

Goal: know the core safety facts well enough to not kill yourself or your household with the equipment Chapter 4 tells you to own. This stage is readable in a weekend and is non-negotiable before touching a generator or wood stove for the first time.

Electrical: Core Knowledge

The core concept at this stage is backfeeding: a generator connected to your home's wiring without a transfer switch or interlock can send power backward through the grid, which can electrocute utility line workers restoring power miles away and is illegal in most jurisdictions for exactly that reason. Understand basic load math (watts = volts × amps) well enough to know whether a generator can actually run what you're plugging into it, and know that a motor-driven appliance's starting (surge) watts, commonly 2–6x its running watts for a second or two at startup, is where an undersized generator actually fails, not the rated running wattage on the label. Understand why running a generator or any fuel-burning device indoors, in a garage even with the door open, or near an air intake is a carbon monoxide risk with no margin for error; CO is colorless, odorless, and the symptoms (headache,

dizziness) are easy to mistake for something else until it's too late. Know the basic fuel and generator-type tradeoffs before buying anything: gasoline is cheap and available but degrades within about 30 days without a stabilizer, propane has an effectively indefinite shelf life but burns roughly 20–25% more by volume, and an inverter generator's cleaner power (under 3% total harmonic distortion, versus 5%+ for a conventional unit) matters concretely for a CPAP or any other device with a precision power supply.

Heating: Core Knowledge

The core concept at this stage is combustion safety and heat-source appropriateness: not every heat source is safe indoors (unvented propane or kerosene heaters need specific ventilation and CO detection; charcoal and camp stoves are never safe indoors under any circumstances), and space heaters are a leading cause of home fires when placed near flammable material or left unattended. Understand basic insulation logic (heat loss happens fastest through air leaks and uninsulated surfaces, not just windows) since retaining heat is often cheaper and safer than generating more of it.

Stage 1 Learning Path

Resource	Cost / Format	Notes
CPSC generator and carbon monoxide safety guidance	Free, online	cpsc.gov. Already cited in Chapter 4; read the full guidance, not just the summary.
U.S. Fire Administration space heater safety guidance	Free, online	usfa.fema.gov. Covers placement, unattended-use risk, and the "3-foot rule" for anything flammable.
Basic electrical safety overview (OSHA or a utility provider's consumer guide)	Free, online	Rocky Mountain Power and other Utah utilities publish consumer electrical safety guides specifically covering backfeeding and generator interconnection.

Stage 1 Practice Exercises

- **Do the load math:** List every device you'd actually want to run on backup power during an outage, add up its running watts, add your single largest device's starting watts on top (not every device's surge together), and compare the total against your specific generator or power station's rated output before you need it for real. See the Sizing a Fuel-Powered Generator skill guide for the actual sizing math, including starting-watts margin.
- **Locate your home's main breaker and any transfer switch:** Physically find and understand how to operate your electrical panel's main breaker and, if installed, a generator transfer switch or interlock kit, before an

outage. See the Fire-Starting & Generator Safety skill guide for why backfeeding without one is illegal and deadly.

- **Walk through your CO detector coverage:** Confirm you have a working carbon monoxide detector on every level of your home, not just near obvious combustion sources.

> **Self-Check: Ready for Stage 2?**
>
> You should be able to explain what backfeeding is and why it's dangerous, do basic watt/amp/volt load math for your own equipment, and state which heat sources are never safe indoors without hesitation.

Stage 2: Applied Practice (Competent)

Goal: move from knowing the safety rules to having actually operated the equipment correctly under real conditions. Expect this stage to take a season or two, gated by weather (you genuinely need a cold day to test heating capacity) more than effort.

Electrical: Applied Practice

- **Run a real generator test under load:** Start your generator, connect it through a proper transfer switch or interlock (never a direct backfeed), and run your actual planned Tier 1 load list for at least a few hours; confirm what it can and can't handle. See the Fire-Starting & Generator Safety skill guide for the backfeeding and carbon-monoxide risks to check before that first real run.
- **Practice safe extension cord and connection use:** Learn to identify a generator-rated (not just any) heavy-gauge outdoor extension cord, and practice safe cable routing that doesn't create a trip or water-exposure hazard.
- **Build and test a small solar setup:** Assemble a portable solar panel plus power station or battery bank, and actually charge and run a real device from it, including on a cloudy day, to understand real-world output versus rated output.

Heating: Applied Practice

- **Operate your wood stove or heater through a full burn cycle:** If your household has a wood stove, practice a full cycle (building the fire, managing airflow/damper, safely reloading, and a clean shutdown) under normal conditions before you need it in an emergency.

- **Practice CO and fire-safety response:** Physically test your CO detectors (most have a test button) and walk through your household's actual fire-extinguisher location and use, since a heating-related fire is a real and specific risk this addendum is meant to reduce.
- **Insulate one real weak point:** Identify and actually fix one real heat-loss point in your home (weatherstripping a door, sealing an attic hatch) rather than just reading about insulation theory. The Staying Warm Without Power skill guide covers the rest of the heat-retention hierarchy beyond your primary heat source.

Stage 2 Learning Path

Resource	Cost / Format	Notes
Generator interlock kit or manual transfer switch	$50–$500 depending on setup	The single highest-leverage safety purchase in this stage; consult a licensed electrician for installation if wiring into your panel directly.
A basic multimeter	$20–$50	Lets you actually verify voltage/continuity rather than guessing; a genuinely useful, low-cost tool for this entire track.
Working CO and smoke detectors on every level	$20–$60 each	Test and replace batteries on the same schedule as your other emergency equipment checks.

Self-Check: Ready for Stage 3?

You should have physically run your generator through a full load test using a proper transfer method, operated your primary heat source through at least one complete cycle, and fixed at least one real insulation weak point in your home. Owning the equipment without having run it under real conditions is still Stage 1 competency.

Stage 3: Self-Sufficiency (Proficient)

Goal: genuine independence from grid power for extended stretches, the actual skill level Chapter 4's Tier 2 and Tier 3 assume a household has. This stage involves real coursework, not just more careful DIY practice.

Electrical: Self-Sufficiency

- **Take an entry-level electrical or electronics course:** Bridgerland Technical College (Brigham City) offers both a full Electrical Apprenticeship track and a shorter Electronics Technology program; Davis Technical College

(Kaysville) offers a comparable maintenance-and-construction electrical program. Either is a genuine, structured entry point well beyond DIY YouTube-level knowledge, and both are open-entry (you can start most months).

- **Design a real off-grid or hybrid solar system for your home:** Move beyond the Stage 2 portable setup to actually sizing a system against your household's real Tier 2/3 power needs, using NABCEP's associate-level training material as a reference even if you don't sit the full exam. The real formula: panel wattage = daily Wh needed ÷ (your worst month's peak sun hours × 0.75) × 1.1–1.2 for margin. Size against your worst month, not the annual average; Salt Lake City averages 5.1 peak sun hours a day across the year, but that swings from roughly 8.3 in June to about 1.8 in December, a system sized off the annual figure does almost nothing in the exact winter outage this addendum is built around. Battery capacity = daily load × days of autonomy ÷ usable depth of discharge, and depth of discharge depends on chemistry: roughly 85% for lithium ($LiFePO_4$), only about 50% for lead-acid or AGM, meaning a lead-acid bank needs nearly double the rated capacity for the same usable power. The Sizing a Solar Array & Battery System skill guide walks through this exact calculation with your own numbers.

- **Understand your utility's actual restoration priorities and programs:** Know how your specific utility (Rocky Mountain Power or your municipal provider) prioritizes outage restoration and whether they offer a medical-equipment priority program, cross-referencing Chapter 8's guidance for any household member on powered medical equipment.

- **Build genuinely off-grid generation and storage capacity:** Beyond a grid-tied or portable solar setup, two options extend real self-sufficiency further: human-powered generation for charging small devices when the sun isn't cooperating, and a Stirling engine, which can turn stored heat (including waste heat from a wood stove) back into usable electricity. See the Pedal Power: Bicycle Generators and Stirling Engines skill guides for what each can and can't realistically supply.

Heating: Self-Sufficiency

- **Understand wood-burning science, not just operation:** Learn the actual physics and chemistry behind efficient, low-creosote wood burning (moisture content, air supply, burn temperature) that a CSIA-certified sweep would know, even before pursuing certification yourself. The Building a Rocket Mass Heater skill guide applies that same combustion science to a genuinely different, far more fuel-efficient design.

- **Build a real wood fuel supply chain:** If using wood heat as a real Tier 2/3 plan, understand seasoning time (properly seasoned wood typically needs 6–12+ months of covered, ventilated drying) and build a rotating supply rather than assuming green wood will burn safely and efficiently.

- **Get a professional chimney inspection:** Have your chimney or flue professionally inspected before relying on wood heat for a real Tier 2/3 scenario; creosote buildup is a genuine, common house fire cause and isn't something to assess yourself without training.

- **Build supplemental, non-electric heat and hot water capacity:** Two real, situational options extend heating self-sufficiency beyond a single wood stove: a compost heat mound that generates usable heat from decomposing organic matter over months, and a solar water heater that cuts the energy load of heating water at all. See the Building a Jean Pain Compost Heat Mound and DIY Solar Water Heater skill guides for what each actually requires and delivers.

Stage 3 Learning Path

Resource	Cost / Format	Notes
Bridgerland Technical College Electronics Technology / Electrical Apprenticeship	Program fees vary; open-entry most months	btech.edu. Brigham City campus; a genuine structured entry point into electrical competency.
Davis Technical College electrical program	Program fees vary	davistech.edu. Kaysville campus; covers electrical theory, blueprint reading, code, and safety.
NABCEP PV Associate exam prep material	Free/low-cost study guides available; exam fee if pursued	nabcep.org. The entry-level credential in the NABCEP solar certification track; useful reference material even without sitting the exam.
A local CSIA-certified chimney sweep	Inspection cost varies, typically $150–$300	csia.org has a certified-sweep locator; get a real professional inspection before depending on wood heat.

Northern Utah Note

Utah’s technical college system (Bridgerland, Davis Tech, Salt Lake Community College, and others) is a genuinely strong, low-cost regional resource for real trade competency, deliberately structured to be more accessible than a 4-year degree. Most programs are open-entry, meaning you don’t have to wait for a fall semester to start.

Self-Check: Ready for Stage 4?

You should have completed or be actively enrolled in real electrical coursework beyond DIY level, have a properly sized off-grid or hybrid solar system designed (even if not fully built), and have had your primary heat source’s venting professionally inspected. This is the stage where your household’s Tier 3 energy independence is real, not aspirational.

Stage 4: Mastery & Teaching (Expert)

Goal: professional-level credentials, the ability to teach others safely, and the capacity to help design or maintain shared energy systems at community scale. This is the stage Chapter 4's Tier 4 (linked household energy systems) actually depends on.

Teaching & Certification

- **Pursue a Utah electrician license:** Utah's DOPL licenses electricians at several levels: a Residential Journeyman Electrician (2-year, 288-classroom-hour apprenticeship plus 4,000 supervised hours, or 8,000 hours without formal classroom education) or a full Journeyman Electrician (4-year, 576-classroom-hour apprenticeship plus 8,000 supervised hours, or 16,000 hours without formal education), each followed by written and practical exams. This is a serious, multi-year commitment, appropriate if energy work is becoming a real vocation, not just a prep skill.
- **Pursue NABCEP PV Installation Professional certification:** The full credential requires at least 10 hours of OSHA Outreach Training and 58+ hours of advanced PV training beyond the associate level; this is the recognized professional standard for solar installation and design.
- **Pursue CSIA Certified Chimney Sweep certification:** A nationally recognized credential covering chimney physics, fire codes, and solid-fuel appliance installation, with required recertification every three years; appropriate if wood heat is a serious, ongoing part of your household's or community's energy plan.

Community-Scale Practice

- **Design for a shared or microgrid system, not just one household:** Take what you've built at Stage 3 and scope what it would take to link multiple households' solar/battery systems or share a wood fuel supply chain, per Chapter 4's Tier 4 goal; the coordination and safety questions (shared transfer switching, fair fuel allocation) are genuinely different from single-household design.
- **Build the skills roster described in Chapter 4's Tier 4:** Chapter 4 calls for shared energy infrastructure and a skills roster; Stage 4 is where you're the person capable of safely inspecting, repairing, or teaching from that roster.
- **Teach generator and wood-stove safety specifically:** These are the two most common sources of Chapter 4-relevant injury; a short, repeatable safety walkthrough (backfeeding, CO risk, safe wood-stove operation) taught to neighbors prevents more harm than almost any other single teaching investment in this addendum.

Stage 4 Learning Path

Resource	Cost / Format	Notes
Utah DOPL Residential or full Journeyman Electrician licensing	Multi-year program; exam fees apply	commerce.utah.gov/dopl/electrical. Recognized Utah apprentice program list available from DOPL directly.
NABCEP PV Installation Professional certification	58+ hours advanced training plus exam fee	nabcep.org. The full professional solar credential.
CSIA Certified Chimney Sweep	Coursework plus two exams; recertify every 3 years	csia.org. The recognized professional wood-heat safety credential.

Self-Check: Have You Actually Arrived?

The real test of Stage 4 isn't the credential; it's whether you've safely walked at least one other household through generator or wood-stove setup and they've since operated it correctly without you present. If you're pursuing a full professional license, treat that as a genuine bonus toward Stage 4, not a requirement most households need to clear.

A Suggested Learning Sequence

The two tracks (electrical, heating) don't have to move at the same pace. As a rough guide, not a requirement:

- **Weeks 1–2:** Stage 1 across both tracks: read the core safety references, do the load math, confirm CO detector coverage.
- **A season or two:** Stage 2: run a full generator load test with a proper transfer method, complete a full wood-stove burn cycle, fix one real insulation weak point.
- **6–18 months:** Stage 3: begin an electrical/electronics course, design a properly sized off-grid solar system, get a professional chimney inspection.
- **Ongoing:** Stage 4: pursue a professional electrical or solar credential if energy work is becoming a real vocation, and start teaching generator/wood-stove safety to specific neighbors.

At a Glance: Energy & Heat Deep Dive

A single-page reference for planning purposes. This does not replace the detailed guidance above; use it to see how the four stages scale, and cross-reference against Chapter 4's tiers, which describe what a household needs to have and do rather than how skilled it needs to be.

Stage	Focus	Key Milestone	Primary Resource
Stage 1: Foundations	Core electrical and combustion safety, no hands-on requirement yet	Can explain backfeeding risk and CO danger from memory	CPSC guidance, USFA space heater guidance
Stage 2: Applied Practice	Hands-on equipment operation and low-stakes repetition	Ran a full generator load test and a full wood-stove burn cycle	Transfer switch/interlock kit, multimeter
Stage 3: Self-Sufficiency	Structured coursework and properly sized systems	Enrolled in electrical coursework; off-grid solar system designed; chimney professionally inspected	Bridgerland/Davis Technical College
Stage 4: Mastery & Teaching	Professional credentials, community-scale design	Has taught safe generator/wood-stove operation to another household	Utah DOPL electrician license, NABCEP, CSIA