IsoTone Heater
A Quantitative, Practical Framework for Converting Food Energy into Body Warmth Under Cold Exposure

Lev Neymotin, PhD
N5Digital, Inc.
Project information: https://www.isotone.net

Abstract
Cold exposure kills not because energy is absent, but because the human body often fails to convert available energy into **retained body heat** quickly enough under real environmental conditions. People have died of cold while carrying food, fully conscious, and only hours from rescue. This paper presents a **practical, quantitative heat-balance framework** for a common and realistic scenario: ambient temperature near freezing (32°F), moderate wind, appropriate clothing, yet a gradual net loss of body heat.

Using a standard 220 kcal sports bar and a compact resistance-based thermogenic strategy, the paper estimates how long an individual can remain within a functional comfort zone and proposes a **disciplined exercise–rest protocol** designed to sustain warmth while avoiding the dangerous penalty of sweating. The main body explains the underlying logic in accessible language, while an Appendix provides transparent supporting calculations.

A real-world civilian winter heating-outage scenario is discussed to illustrate the framework's relevance beyond hypothetical exposure cases.

1. Introduction
Cold exposure is deceptive. It rarely arrives as a sudden catastrophe; instead, it unfolds as a slow imbalance between heat loss and heat production. Wind strips warmth, moisture amplifies loss, and the body's natural responses–fatigue, reduced coordination, and impaired judgment, quietly sabotage survival. In many documented cases, victims had food available. What they lacked was a reliable method to convert that energy into retained heat at the moment it mattered.

This paper is motivated by that gap. It treats IsoTone not as a fitness device, but as a compact, immediately deployable means of controlled thermogenesis. The underlying idea is simple: food energy must be transformed into heat, and that heat must be kept inside the body. Large, exposed movements often fail because they accelerate convective loss and induce sweating. By contrast, compact resistance exercise performed under clothing can generate heat while minimizing stripping by wind.

Such conditions increasingly arise not only in wilderness settings, but in modern cities experiencing infrastructure failure under conflict or extreme weather.

The goal here is not to claim certainty or miracle outcomes, but to present a quantitative framework that can be examined, refined, and tested. The emphasis is on maintaining a **comfort and function zone,** not on endurance feats, and not on extreme exertion.

2. Heat Balance as the Central Principle

At its core, survival in cold environments is governed by a simple balance:

$$\textit{Change in body heat} = \textit{Heat produced} - \textit{Heat lost}$$

Heat production arises from metabolism, which can be increased through activity. Heat loss is dominated by convection (especially wind), radiation, and, most critically, evaporation when moisture is present. If heat loss exceeds heat production, body temperature trends downward. If heat production matches or exceeds loss, body temperature stabilizes or rises.

Most cold-related deaths occur not because the body cannot generate heat, but because the rate of heat loss overwhelms production, or because attempts to generate heat inadvertently increase loss through sweat. The strategy explored here aims to shift this balance modestly but decisively in favor of thermal stability.

3. Scenario Definition and Modeling Assumptions

The scenario considered is intentionally ordinary. Ambient temperature is 32°F (0°C), with moderate wind. The individual is dressed for the weather, meaning insulated layers are present, ideally with some wind resistance, yet the person is still slowly cooling at rest. This condition is described as a “medium deficit” state.

Quantitatively, such a state corresponds to a net heat deficit on the order of 50–100 watts. In practical terms, this means the body is losing 50–100 joules per second more than it is producing at rest. This range aligns with common experience: one feels cold and progressively less comfortable, but not immediately incapacitated.

The available energy source is a single commercial sports bar providing approximately 220 dietary kilocalories. The IsoTone strategy is modeled as a controlled intervention that both increases heat production and improves heat retention by allowing exercise to be performed under clothing, thereby reducing convective loss compared with open, full-body movements.

4. Energy Availability and Time Scales

A 220 kcal sports bar contains roughly 920 kilojoules of chemical energy. Human metabolism converts most of this energy into heat; a reasonable assumption for resistance-based activity is that approximately 85 percent ultimately appears as usable body heat. This yields about 780 kilojoules available for thermal compensation.

If the individual remains at rest and continues to lose heat at a medium deficit, this energy alone would sustain thermal balance for a finite period. At a 100-watt deficit, the bar compensates for roughly two hours. At 75 watts, close to three hours. At 50 watts, just over four hours. These figures represent time spent near thermal neutrality, not time to collapse or death.

The critical observation is that relatively small reductions in net heat loss dramatically extend this window.

Readers interested in the underlying numerical assumptions and step-by-step calculations may consult Appendix A; the main conclusions do not depend on detailed mathematical treatment.

5. Effect of IsoTone-Based Thermogenic Control

IsoTone alters the balance in two ways. First, it raises metabolic heat production through compact resistance work that can be initiated immediately. Second, because the device can be used under clothing, it reduces the convective penalty typically associated with exercise in wind.

A conservative modeling approach is to treat IsoTone use as providing an effective reduction in net heat deficit on the order of 40–60 watts when applied in a disciplined, non-sweating protocol. This does not imply continuous exertion; rather, it reflects short bursts of activity that elevate body temperature followed by periods of rest during which the generated heat is retained.

When this reduction is applied, the implications are striking. A baseline deficit of 75 watts reduced by 50 watts becomes an effective deficit of only 25 watts, extending the thermal support of a single bar to nearly nine hours. A baseline deficit of 100 watts reduced to 50 watts doubles the comfort-zone duration from roughly two hours to more than four. If the baseline deficit is already near 50 watts, IsoTone use can effectively bring the system to thermal neutrality, meaning body temperature can be maintained without progressive environmental heat loss, with overall duration limited by food availability, hydration, fatigue, and sleep.

6. Continuous Exercise versus Cycled Activity

A crucial question is whether exercise should be continuous or intermittent. From a survival perspective, intermittent activity is clearly superior. Continuous exertion increases the risk of perspiration, and even mild dampness dramatically increases heat loss once activity stops. The objective is not maximal heat generation, but controlled warming without moisture accumulation.

A practical field protocol consists of short work phases lasting approximately three to five minutes, followed by rest periods of ten to twenty minutes. During the work phase, effort should raise circulation and warmth while allowing controlled breathing; the ability to speak in full sentences is a useful rule of thumb. Activity should stop before sweating begins.

Within this structure, a brief initial phase of faster, lower-resistance movement can rapidly elevate warmth, followed by slower, higher-resistance cycles that sustain heat with less respiratory demand. This combination leverages rapid activation without crossing into moisture-producing exertion.

7. Supporting Strategies that Dominate Outcomes

While thermogenic control is central, several environmental and behavioral factors often have equal or greater impact. Wind blocking, even partial, can dramatically reduce convective loss. Insulation from the ground prevents continuous conductive heat drain. Protection of extremities preserves dexterity and decision-making. Above all, moisture management is critical: staying dry and avoiding sweat frequently determines whether generated heat is retained or lost.

Food intake should also be proactive rather than reactive. Small, periodic consumption paired with early warming cycles ensures that energy is available when heat production increases, rather than waiting until deep cold suppresses appetite and gastrointestinal efficiency.

Food timing and pacing also matter. In cold conditions, it is generally preferable to consume energy in small, frequent amounts rather than in a single large intake. This supports steady metabolic heat production and reduces the risk that energy becomes unavailable during periods of fatigue or gastrointestinal slowdown. As a practical guideline, a standard 220 kcal sports bar can be divided into roughly **10–12 small bites**, with **one bite taken every 20–30 minutes**, ideally shortly before or during a brief warming cycle. This approach aligns energy availability with heat generation, avoids sharp spikes followed by long gaps, and supports sustained thermal stability over several hours. The objective is not to maximize exertion, but to synchronize fuel intake with controlled heat production.

8. Functional Consequences of Overcooling
Long before clinical hypothermia is reached, overcooling degrades function. Finger dexterity declines, making simple tasks difficult. Reaction time slows and judgment becomes impaired. Fatigue sets in, encouraging passivity precisely when active management is required. These effects form a self-reinforcing spiral in which reduced capability accelerates further heat loss.

Maintaining the comfort and function zone is therefore not a luxury. It is a prerequisite for communication, self-care, navigation, and survival until rescue.

9. Real-World Relevance: Kyiv Apartments in Winter
A striking real-world illustration of the conditions modeled in this paper can be found in recent reporting from Kyiv during the winter months. As described in a January Wall Street Journal article, residents of a multi-story apartment building endured prolonged periods without centralized heating or reliable electricity as a result of sustained attacks on civilian infrastructure. Indoor temperatures hovered near freezing. Families remained clothed, conscious, and active, yet steadily cold–relying on hot-water bottles, candles, gas burners, and brief windows of restored power to recharge devices and perform essential tasks. These were not cases of sudden exposure or outdoor survival, but prolonged, low-grade thermal stress in confined indoor spaces.

This environment closely matches the “medium deficit” condition analyzed here: heat loss exceeding resting metabolic production by a modest but consequential margin. In such settings, the limiting factor is not the absence of calories or shelter, but the lack of a safe, controllable way to convert available energy into retained body heat without introducing new risks. Continuous exertion indoors is impractical and dangerous due to sweating and moisture accumulation, while passive measures alone often fail to restore comfort or preserve function.

A compact, resistance-based thermogenic tool that can be used under clothing–silently, intermittently, and without electricity–addresses precisely this gap. Even brief, disciplined warming cycles could materially improve thermal comfort, dexterity, and endurance for residents facing repeated heating outages, turning hours of progressive cooling into sustained functional stability.

As a humanitarian application of this framework, the author would welcome the opportunity to place IsoTone units directly into such environments, where even modest improvements in retained warmth could meaningfully affect daily resilience.

Source note: The Kyiv winter conditions referenced are based on reporting in The Wall Street Journal *(January 27, 2024).*

10. Groups of Relevance
The framework presented here is relevant to the general public, including pedestrians, commuters, drivers stranded by weather or accidents, and families exposed to unexpected cold. It applies equally to outdoor enthusiasts, travelers, and workers whose duties require prolonged exposure in wind and cold.

Public safety professionals and preparedness planners may find value in the quantitative thresholds described, while clinicians and physical therapy professionals may recognize parallels with controlled thermogenesis and functional preservation, with the clear understanding that this is not a medical treatment claim.

Civilian populations affected by infrastructure disruption, including residents of urban buildings experiencing prolonged heating or power outages during winter, represent a particularly relevant and under-addressed group.

11. Position Statement

A compact resistance-based thermogenic strategy, when applied in a disciplined, non-sweating, under-clothing protocol and combined with basic wind and moisture management, can significantly extend the time an individual remains in a functional comfort zone in near-freezing conditions. Under realistic assumptions, a single 220 kcal sports bar may support several hours–and in favorable conditions, many hours–of thermal stability. The decisive factor is not total energy available, but whether the individual can cross and maintain the threshold where heat production matches or exceeds heat loss.

12. Limitations and Future Work

This analysis is intentionally simplified. Real-world outcomes depend on clothing condition, wetness, wind exposure, body size, age, injury, hydration, and psychological state. Controlled testing in safe environments is the logical next step, focusing on skin temperature, core proxies, subjective comfort, and sweat onset under different exercise modalities. Such testing would allow refinement of the effective deficit reduction attributed to compact resistance activity.

Additional technical and background information on the IsoTone project is available at https://www.isotone.net.

Appendix A — Supporting Calculations and Assumptions

A.1 Energy available from a 220 kcal bar

- Food energy:

$$E_{\text{food}} = 220 \text{ kcal}$$

- Conversion: 1 kcal = 4184 J

$$E_{\text{food}} = 220 \times 4184 = 920{,}480 \text{ J} \approx 920 \text{ kJ}$$

- Fraction that becomes useful body heat (assumption):

$$\eta_{\text{heat}} = 0.85$$

- Usable heat:

$$E_{\text{heat}} = 920 \text{ kJ} \times 0.85 \approx 782 \text{ kJ}$$

A.2 Define "medium deficit" at 32°F, moderate wind

Assume net deficit at rest (after baseline metabolism):

$$P_{\text{baseline}} \in [50{,}100] \text{ W}$$

(Example mid value: 75 W)

A.3 Time coverage without IsoTone

$$t = \frac{E_{\text{heat}}}{P_{\text{baseline}}}$$

- 100 W:

$$t = 782{,}000/100 = 7{,}820 \text{ s} = 2.17 \text{ h}$$

- 75 W:

$$t = 782{,}000/75 = 10{,}427 \text{ s} = 2.90 \text{ h}$$

- 50 W:

$$t = 782{,}000/50 = 15{,}640 \text{ s} = 4.34 \text{ h}$$

A.4 Include IsoTone "effective deficit reduction"
Assume disciplined work/rest + under-clothes retention yields an effective improvement:

$$\Delta P_{\text{IsoTone}} \in [40,60]\ \text{W}$$

Then:

$$P_{\text{effective}} = P_{\text{baseline}} - \Delta P_{\text{IsoTone}}$$
$$t = \frac{E_{\text{heat}}}{P_{\text{effective}}}$$

Examples

1. Baseline 75 W, ΔP = 50 W:
- $P_{\text{effective}} = 25\text{W}$
- $t = 782{,}000/25 = 31{,}280\text{s}$ = **8.7 h**
2. Baseline 100 W, ΔP = 50 W:
- $P_{\text{effective}} = 50\text{W}$
- $t = 782{,}000/50 = 15{,}640\text{s}$ = **4.3 h**
3. Baseline 50 W, ΔP = 50 W:
- $P_{\text{effective}} = 0\text{W}$ ⇒ **thermal stability**
  (At that point, "time in comfort zone" is limited by non-thermal factors.)

A.5 Suggested "heater protocol" numbers
A conservative starting protocol consistent with the assumptions:

- **Every 15 minutes:** 4 minutes IsoTone under clothing
  - 1–2 min LR fast rhythmic
  - 2–3 min HR slow controlled
- Stop early if sweat begins.

This creates repeated "heat pulses" while minimizing moisture penalty.