Abstract

This paper proposes a decentralised electrical power distribution system based on resonant magnetic coupling relay chains between household nodes. Each node combines rooftop solar generation, lithium iron phosphate (LFP) battery storage, resonant coupling coils, solid-state power electronics, and a mesh controller that negotiates load balancing with neighbouring nodes. We demonstrate that the economics of such a system — approximately $2,500 AUD per node at mass production — are favourable compared to traditional grid connection ($5,000-15,000 per lot for new subdivisions) and ongoing grid electricity costs ($1,500-2,000 AUD/year per household). We identify the critical unsolved parameter: per-hop efficiency of multi-kilowatt resonant transfer across 10-20 metre relay chains in real-world conditions. Laboratory demonstrations have achieved >90% efficiency at 2 metres with relay coils (Kurs et al., 2007; Sample et al., 2011) and 20-relay chains at 4 metres (Chen et al., 2024), but no published data exists for the suburban-scale deployment proposed here. We present a complete bill of materials, efficiency sensitivity analysis, economic comparison with grid infrastructure, safety analysis, and a pilot design for a 200-house suburb. The architecture is topologically identical to the BLE mesh communication network described in (Applebee & Combe, 2026, "*The Invisible Network*"), carrying watts instead of bytes.

Keywords: wireless power transfer, resonant magnetic coupling, relay chain, decentralised energy, mesh network, solar microgrid, LFP battery, cooperative energy

1. Introduction

1.1 The Wire as Monopoly Infrastructure

Centralised electrical grids follow the same structural pattern as the communication monopolies documented in (Applebee & Combe, 2026, "*Platform Gatekeeping*") and the AI monopolies documented in (Applebee &

Combe, 2026, "*Sovereign AI Infrastructure*"): a costly infrastructure (the wire) creates a dependency (the meter) that extracts ongoing revenue (the bill) from users who had no role in designing the system and have no alternative to using it.

The Australian electricity network has a regulated asset base exceeding $100 billion (AER, 2024). This infrastructure — poles, wires, transformers, substations — serves as the physical substrate of a metering monopoly. Electricity generated by rooftop solar is purchased from householders at approximately 5c/kWh and sold back at 25-35c/kWh, a margin of 400-600% that accrues to network operators and retailers rather than generators.

This paper asks whether the wire is necessary.

1.2 From Global to Local

Nikola Tesla proposed global wireless power transmission via Earth-ionosphere cavity resonance (Tesla, 1905). His intuition about resonance was correct — the Schumann resonance at 7.83 Hz is a confirmed global electromagnetic phenomenon (Schumann, 1952; Balser & Wagner, 1960). However, the cavity's Q factor of approximately 5-10 (Nickolaenko & Hayakawa, 2002) is insufficient for power transmission by approximately five orders of magnitude. The cavity leaks energy too rapidly for useful power accumulation at a distant receiver.

Tesla's error was not in the physics of resonance but in the scale of application. Resonant magnetic coupling is highly efficient at short range: >90% at distances comparable to coil diameter (Kurs et al., 2007). The technology that fails globally succeeds locally.

This paper proposes the local application: a mesh network of household nodes sharing power through resonant relay chains. Not one tower powering the planet — many houses powering a neighbourhood.

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2. Node Architecture

2.1 Components

Each mesh node comprises six subsystems:

SUBSYSTEM	SPECIFICATION	FUNCTION
Solar interface	Connection to existing rooftop PV (typically 6.6 kW)	DC power input
Battery	5-15 kWh LFP (lithium iron phosphate)	Energy storage
Resonant coils (×2)	Copper spiral, capacitor-tuned, transmit + receive	Wireless power transfer
Inverter/rectifier	3-5 kW bidirectional, GaN/SiC transistors	DC↔AC at resonant frequency
Mesh controller	ESP32-class MCU, power management firmware	Load balancing, credit tracking
Enclosure	IP65 weatherproof, ~600×400×300mm	Environmental protection

2.2 Bill of Materials

COMPONENT	UNIT COST (AUD, MASS PRODUCTION)	NOTES
Solar panel (400W)	$100	If not already installed
LFP battery (10 kWh)	$1,000-1,100	$80-100/kWh cells + $50 BMS
Resonant coils (×2)	$400	10-20kg copper @ $15/kg + capacitors
Power electronics	$300	Bidirectional GaN inverter/rectifier
Mesh controller	$50	ESP32 + PCB + antenna + housing

Enclosure + mounting	$100	IP65, mounting hardware, connectors
Total (DIY)	$1,950-2,050	Solar already installed
Total (with solar)	$2,050-2,150	Including one 400W panel
Total (electrician)	$2,450-2,550	Including $400 installation

2.3 Battery Chemistry Selection

LFP ($LiFePO_4$) is selected over NMC (nickel manganese cobalt) for three reasons:

1. Thermal stability: LFP thermal runaway onset >270°C vs NMC ~210°C. No oxygen release during decomposition. Critical for unattended residential installation.
2. Cycle life: 3,000-5,000 full cycles vs 1,000-2,000 for NMC. At daily cycling, LFP lasts 8-14 years before 80% capacity.
3. Cost trajectory: LFP cell prices fell below $80/kWh in 2024 (BloombergNEF, 2024) and continue declining. No cobalt dependency.

3. Resonant Coupling Physics

3.1 Principle

Two coils tuned to the same resonant frequency exchange energy through oscillating magnetic fields. Unlike inductive coupling (which requires near-contact), resonant coupling exploits the Q factor of the coils to extend range to distances comparable to coil diameter.

Efficiency between two coupled resonators (Kurs et al., 2007):

$$\eta = \kappa^2/(\kappa^2 + \Gamma_1\Gamma_2)$$

Where κ is the coupling coefficient and Γ_1, Γ_2 are the loss rates of each resonator. High-Q coils (low Γ) at close spacing (high κ) yield high efficiency.

3.2 Relay Chains

A relay chain inserts intermediate resonant coils between transmitter and receiver. Each relay coil resonates at the system frequency and re-radiates received energy. This converts a single long-range transfer (low efficiency) into multiple short-range transfers (high efficiency per hop).

Published relay chain results:

STUDY	HOPS	DISTANCE	EFFICIENCY	POWER
Kurs et al. (2007)	1 relay	2m	90%	60W
Sample et al. (2011)	1 relay	2m	70-90%	60W
Chen et al. (2024)	20 relays	4m	High (not quantified per-hop)	Research scale
DARPA POWER (2023)	Microwave beam	8.6km	20%	800W

3.3 The Critical Unknown

No published data exists for:

- Multi-kilowatt resonant transfer across 10-20 metres with relay chains
- Relay chain performance in real-world suburban conditions (obstacles, weather, ground effects)
- Long-term reliability of outdoor resonant coils

This is the single most important measurement for the viability of the power mesh. Section 8 proposes a pilot to obtain it.

3.4 Efficiency Sensitivity Analysis

Per-hop efficiency determines system viability:

PER-HOP EFFICIENCY	3 HOPS (NEAREST NEIGHBOUR)	5 HOPS (ACROSS STREET)	10 HOPS (EDGE OF SUBURB)
95%	86%	77%	60%
90%	73%	59%	35%
85%	61%	44%	20%
80%	51%	33%	11%

Minimum viable per-hop efficiency: ~85%. Below this, losses at suburb scale exceed economic viability. Above 90%, the system is strongly competitive with wired distribution (which loses 5-8% over equivalent distances).

The mesh controller must minimise hop count — always routing power from the nearest surplus source, not the largest.

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4. Mesh Controller

4.1 Load Balancing

The mesh controller runs a continuous optimisation:

1. Sense: Monitor local generation (solar), consumption (household load), and storage (battery SOC)
2. Advertise: Broadcast surplus/deficit to neighbouring nodes via short-range radio (BLE or Wi-Fi)
3. Negotiate: Match surplus nodes to deficit nodes, minimising total hop count

4. Transfer: Activate resonant coils to transfer negotiated power
5. Settle: Record energy transferred in a local ledger, settled in tokens

4.2 Credit System

Energy credits are tracked per node:

- Generation credit: Power generated by your solar, stored or shared
- Storage credit: Power stored in your battery for later sharing
- Relay credit: Power relayed through your coils to distant nodes
- Consumption debit: Power consumed from the mesh
- (Applebee & Combe, 2026, "*The Invisible Network*") (The Invisible Network) — the data mesh whose topology this paper replicates for power
- (Applebee & Combe, 2026, "*Sovereign AI Infrastructure*") (Set It Free) — sovereign hardware that powers and is powered by the mesh
- (Applebee & Combe, 2026, "*Trust-First Governance*") (Trust-First Governance) — the token system that settles energy credits
- (Applebee & Combe, 2026, "*Cooperative Capitalism*") (Cooperative Capitalism) — the economic model for cooperative energy sharing

  This paper proves:

  - Conclusion 5 (Direct Democracy) — energy independence enables political independence
  - Conclusion 9 (Marketing To Self) — power companies sell you your own sunlight at 600% markup
  - Conclusion 15 (Justice = Economic) — the electricity bill is economic extraction

  This paper closes the escape route: "You'll always need the grid."

  See also: (Applebee & Combe, 2026, "*The Smartness Trap*") (The Smartness Trap), (Applebee & Combe, 2026, "*The Invisible Fence*") (The Invisible Fence)

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