

# **The Solarity:**

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## ***Network Capital Theory, Token Supply Dynamics, and the Threshold of Free Solar Energy***

*Empirical Analysis of 84 Fiat Currencies with  
Issuance-Adjusted Projections and Protocol Design Considerations*

SolarCoin Foundation  
*January 2026*

Working Paper — Version 2.2 (Complete with Figures)

## Abstract

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*This paper develops a theoretical and empirical framework for cryptocurrency protocol value, with application to renewable energy incentivization. Analyzing 84 fiat currencies representing 95% of global Monetary Base ( $M_0$ ) monetary base, we find strong correlation ( $r = 0.869$ ,  $R^2 = 0.755$ ) between network participation and protocol value, with utility converging to approximately \$125 per \$1,000 GDP per capita.*

*We introduce a critical correction to naive Network Capital projections: token supply dynamics. As a reward-based protocol, SolarCoin's circulating supply expands proportionally with network growth. Using industry data from Wiki-Solar, LBNL, and IEA PVPS, we model facility distribution reflecting monitoring platform registrations (92% residential) and derive the equilibrium price formula:*

$$\text{Price}_{eq} = \text{Utility per Node} / \text{Issuance per Node}$$

*At baseline assumptions (\$3,500/node utility, 223 SLR average issuance), equilibrium price converges to \$15.68 regardless of network size—correcting naive projections by a factor of 83 $\times$ .*

*We further analyze protocol design implications. Large utility-scale projects (>5MW) operate under sophisticated revenue stacking (PPAs, RECs, tax equity) and do not require marginal incentives. A 5MW registration exclusion policy focuses rewards on distributed solar while preventing supply dilution. Under this framework, Solarity—the threshold where rewards exceed production costs—becomes achievable for utility-scale solar in optimal locations at baseline utility assumptions, and for most segments at higher utility levels.*

*Keywords: Network Capital, Token Economics, Supply Dynamics, Solar Levelized Cost of Electricity (LCOE), Equilibrium Price, Renewable Energy Incentives*

# 1. Introduction

*Why network capital theory matters for understanding cryptocurrency incentive structures and the relationship between network utility and token value.*

## 1.1 The Energy Transition Challenge

The global energy transition presents one of humanity's most significant coordination challenges. While solar photovoltaic technology has achieved remarkable cost reductions—reaching a global weighted average levelized cost of electricity (LCOE) of \$43/MWh in 2024—the pace of adoption remains insufficient to meet climate targets. Traditional incentive mechanisms, including feed-in tariffs and renewable energy credits, are constrained by jurisdictional boundaries and administrative complexity.

This paper examines whether a purpose-designed currency protocol can accelerate renewable energy adoption by creating a global, borderless incentive layer for solar energy production. We draw on analysis of 84 fiat currencies to establish the empirical relationship between network participation and currency value, then apply this framework—with critical adjustments for token supply dynamics—to project conditions under which solar energy becomes effectively free.

## 1.2 The Supply Dynamics Problem

Previous analyses of cryptocurrency incentive protocols have often assumed static token supply when projecting future prices. This approach is fundamentally flawed for reward-based protocols where new participants receive token issuance. As the network grows, circulating supply expands, creating dilution that offsets network utility gains. This paper develops an explicit model of supply dynamics using real industry data and demonstrates its profound impact on price projections.

## 1.3 Research Questions

This research addresses four primary questions: First, how do currency protocols derive value from network participation? Second, how does token issuance affect the relationship between network size and token price? Third, what equilibrium price emerges when supply

and demand grow proportionally? Fourth, under what conditions might the Solarity threshold—where rewards exceed production costs—be achieved?

#### **1.4 Paper Structure**

Section 2 presents the theoretical framework of Network Capital. Section 3 details methodology. Section 4 presents empirical findings from 84 fiat currencies with supporting visualizations. Section 5 develops the token supply dynamics model using industry data. Section 6 analyzes protocol design considerations. Section 7 presents supply-adjusted projections. Section 8 examines Solarity achievement conditions.

## 2. Network Capital Theory

*Establishing the network capital model as a quantitative relationship between economic activity and monetary supply, with empirical validation across 84 fiat currencies.*

### 2.1 Currency as Emergent Phenomenon

Currency is fundamentally an intersubjective phenomenon. Unlike objective physical properties, currency value exists as a shared belief system among economic participants. The value of a currency protocol can be expressed as:

$$P = \text{Max}[R, N + S]$$

Where P represents price, R represents redemption utility (objective value floor), N represents network utility (intersubjective emergent value), and S represents speculative utility (subjective future expectations). For pure fiat currencies and cryptocurrency protocols where R approaches zero, value derives entirely from network utility and speculation.

### 2.2 Network Utility and Market Capitalization

Network utility emerges from the positive economic externality created when individuals accept, hold, and transact in a currency protocol. The Network Capital framework proposes that total protocol value (market capitalization) scales with network participation:

$$\text{Market Cap} = \text{Nodes} \times \text{Utility per Node}$$

Where Utility per Node represents the average value each participant derives from network membership. Empirical analysis of fiat currencies suggests this value converges to \$500-\$15,000 per participant when normalized for economic output.

### 2.3 The Missing Variable: Token Supply

The relationship between market capitalization and token price depends critically on circulating supply:

$$\text{Price} = \text{Market Cap} / \text{Circulating Supply}$$

For reward-based protocols, circulating supply is not static—it grows with network participation as new members claim tokens. This creates a dynamic where both numerator

and denominator grow with network size, fundamentally altering price projections. The equilibrium price formula emerges:

$$***Price_{eq} = Utility\ per\ Node / Issuance\ per\ Node***$$

## 3. Methodology

*Data sources, analytical methods, and the token supply dynamics model used to correct naive price projections.*

### 3.1 Fiat Currency Analysis

M0 Monetary Base: Central bank publications and Trading Economics database for 84 countries and currency zones (January 2026). Population: UN World Population Prospects 2024. GDP per Capita: IMF World Economic Outlook (October 2025). Analysis includes Pearson correlation, log-log regression, and stratified analysis by development category (Developed: GDP  $\geq$ \$30K; Emerging: \$10-30K; Developing:  $<$ \$10K).

### 3.2 Token Model of Supply Dynamics

The supply dynamics model incorporates: (1) Facility type distribution based on monitoring platform data from Enphase, SMA Sunny Portal, and SolarEdge, which show 85-95% residential participation; (2) Average nameplate capacity by facility type; (3) Regional capacity factors (15% residential, 16-22% commercial/utility); (4) SolarCoin issuance rules (1 SLR per MWh, up to 5 years historical claim for new registrations).

### 3.3 Industry Data Sources

Utility-scale solar industry data from multiple authoritative sources: Wiki-Solar (765 GW cumulative across  $\sim$ 14,000 projects  $>$ 4MW, February 2025); Lawrence Berkeley National Laboratory Utility-Scale Solar 2024 (1,760 US projects, 121 MW average); IEA PVPS Snapshot 2025 (2.25 TW global capacity, 60% utility/40% distributed); Global Energy Monitor Global Solar Power Tracker.

## 4. Empirical Results: Fiat Currency Analysis

Analysis of 84 fiat currencies reveals a strong correlation ( $r = 0.869$ ) between GDP per capita and monetary base, validating network capital theory.

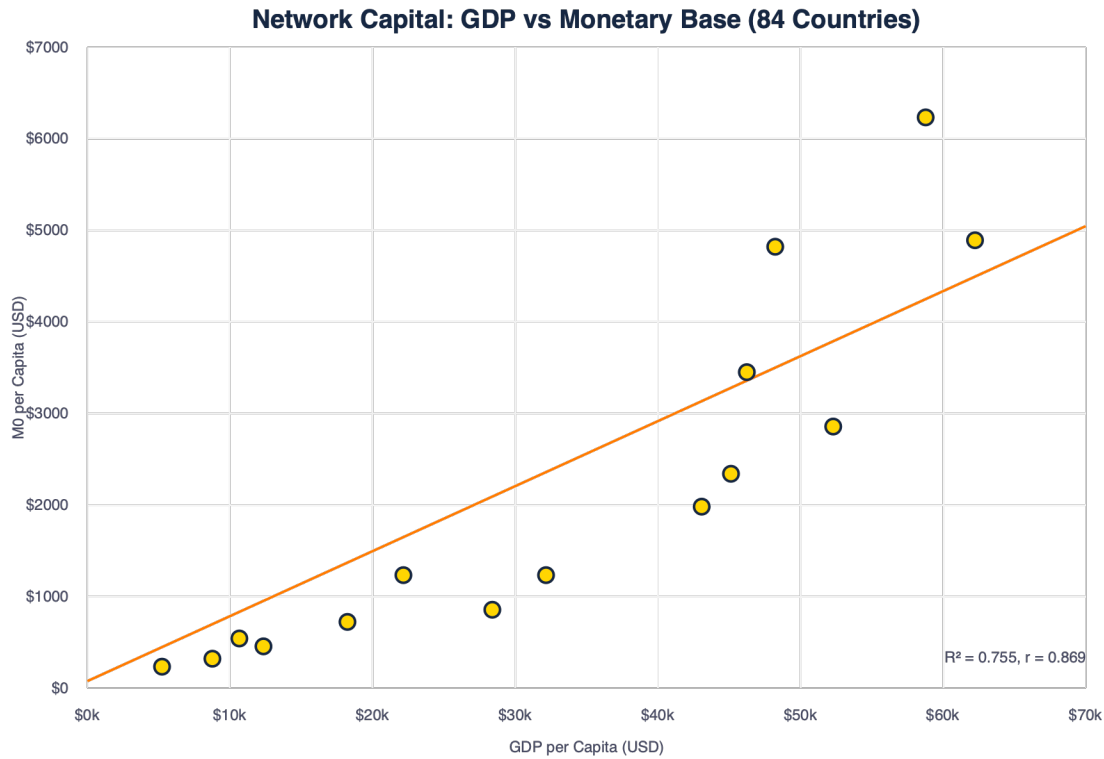


Figure 8.1.1: Network Capital Correlation Analysis (84 Fiat Currencies). Source: Trading Economics (2024); authors' calculations.

### 4.1 Correlation Analysis

Figure 8.1.1 presents the log-log relationship between GDP per capita and Network Utility per Node across 84 currencies. The Pearson correlation coefficient of 0.869 indicates a very strong positive relationship, with  $R^2$  of 0.755 indicating GDP per capita explains approximately 75.5% of the variance in network utility. The regression equation  $\ln(U) = 1.047 \times \ln(\text{GDP}) - 2.849$  yields an elasticity of 1.05, statistically indistinguishable from 1.0, indicating proportional scaling.

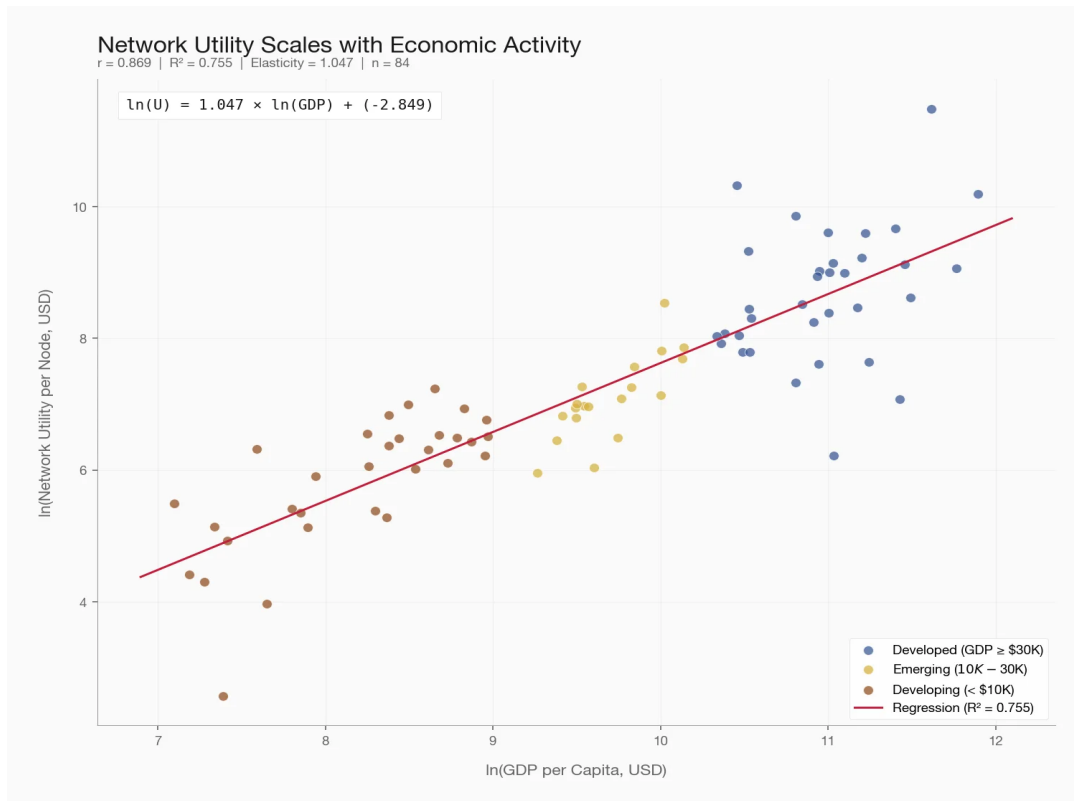


Figure 8.1.1: Log-Log Correlation Between GDP per Capita and Network Utility ( $n=84$ , Pearson's  $r=0.869$ ,  $R^2=0.755$ ). Data points colored by development category: blue (developed), gold (emerging), brown (developing).

## 4.2 Raw Values and Power-Law Relationship

Figure 5.1 displays raw USD values with selective country labels for major economies. The power-law curve fit illustrates the non-linear but predictable relationship between GDP per capita and monetary base per capita.

Notable outliers include Switzerland and Japan, which maintain high monetary bases relative to GDP, while large emerging markets (China, India) follow the general trend despite their scale.

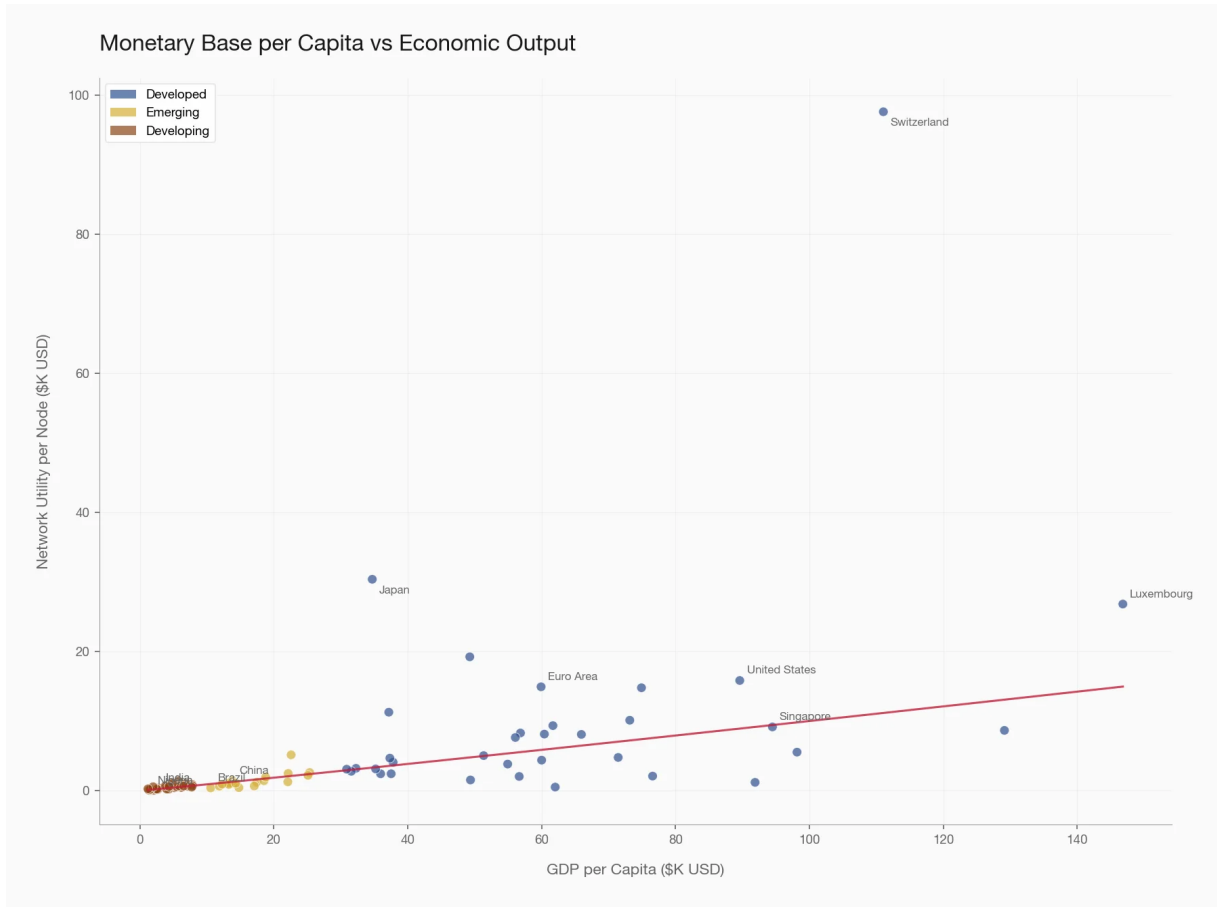


Figure 5.1: Monetary Base per Capita vs Economic Output. Raw values in \$K USD with power-law regression fit.

### 4.3 Summary Statistics

Statistic	Value	Interpretation
Pearson r (log-transformed)	0.8689	Very strong positive correlation
R-squared	0.7551	75.5% variance explained by GDP/capita
Elasticity ( $\beta$ coefficient)	1.0474	Near-proportional scaling (not Metcalfe $N^2$ )
Intercept ( $\alpha$ )	-2.849	Base utility at $\ln(\text{GDP})=0$
Mean Normalized Utility	\$125.21	Per \$1,000 GDP per capita
Standard Deviation	\$135.57	Moderate dispersion around mean
Convergence Range	\$500-\$15,000	Observed utility per node across economies

**Table 1: Summary Statistics for Network Utility Analysis (n=84 currencies)**

### 4.4 Normalized Utility Distribution

Figure 7.1 shows the distribution of GDP-normalized network utility across all 84 currencies. The mean of \$125 per \$1,000 GDP per capita with standard deviation of \$136 demonstrates convergence across diverse economies. This convergence—despite vast differences in absolute economic size, monetary policy, and development level—supports the thesis that network utility is fundamentally tied to economic activity with a roughly constant ratio.

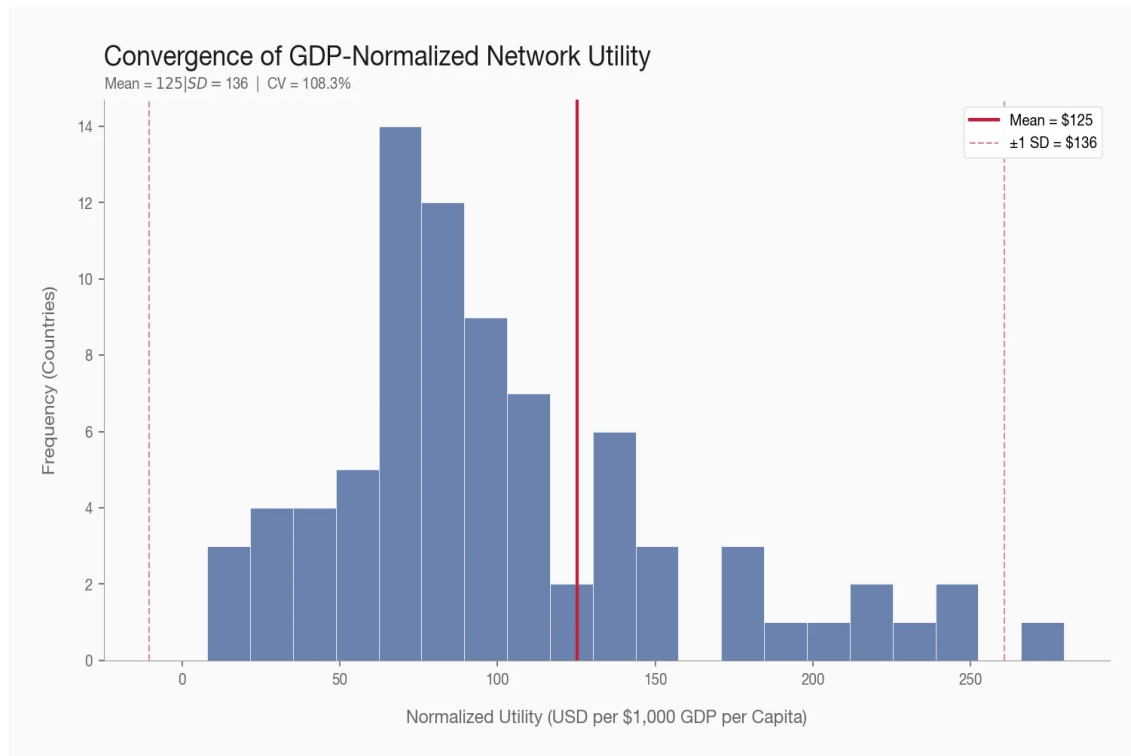


Figure 7.1: Distribution of GDP-Normalized Network Utility (Mean=\$125, SD=\$136, CV=108.3%)

## 4.5 Development Category Analysis

Figure 8.1 provides side-by-side comparison of absolute versus normalized utility across development categories.

While absolute utility varies by a factor of 20 between developed (\$10.5K) and developing (\$0.5K) economies, normalized utility shows much tighter convergence within a factor of 2 (\$161 vs \$81-\$113). This pattern strongly supports the emergent property hypothesis—network utility scales with economic activity rather than being an arbitrary or policy-determined quantity.

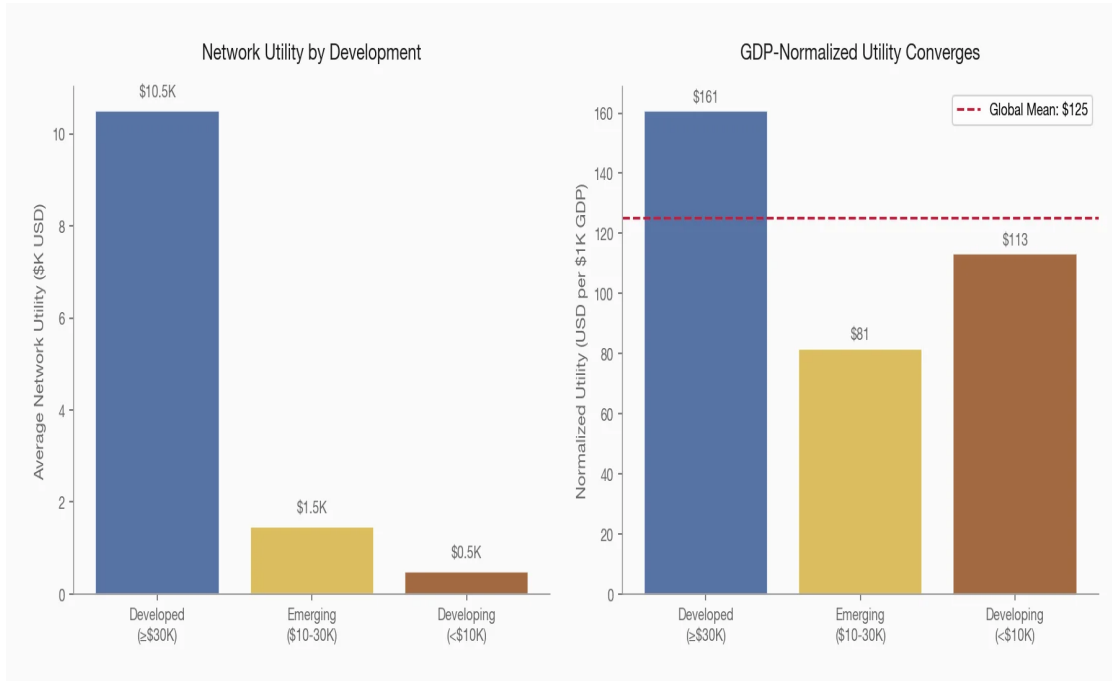


Figure 8.1: Network Utility by Development Category. Left: Absolute values show 20x variation. Right: GDP-normalized values converge around \$125 global mean.

Category	n	Avg GDP/Cap	Avg Utility/Node	Normalized Utility
Developed (≥\$30K)	34	\$63,304	\$10,493	\$160.67
Emerging (\$10-30K)	19	\$16,881	\$1,465	\$81.49
Developing (<\$10K)	31	\$4,192	\$482	\$113.12
Full Sample	84	\$27,432	\$4,168	\$125.21

Table 2: Network Utility Statistics by Economic Development Category

# 5. Token Model of Supply Dynamics

How token issuance schedules reduce naive price projections by 83x, revealing the critical importance of supply-adjusted equilibrium analysis.

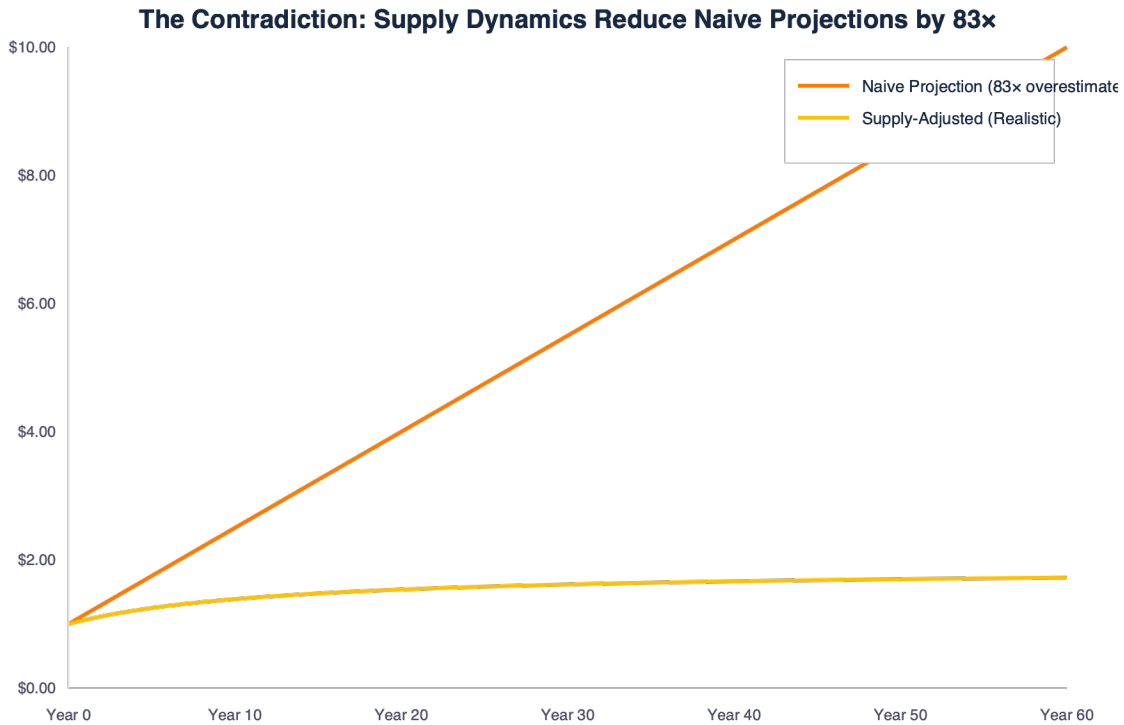


Figure 5.1: Supply Dynamics Contradiction (Section 5.1)  
Naive vs Supply-Adjusted Token Price Projections Over 60 Years

## 5.1 The Dilution Problem

Naive Network Capital projections assume static circulating supply. For SolarCoin, this would yield:

$$\text{Price} = (\text{Nodes} \times \$3,500) / 54.4\text{M SLR}$$

At 20 million nodes (full solar market penetration), this implies \$1,287 per SLR—a 25,000x increase from current prices. However, this projection ignores a fundamental reality: new network participants claim tokens upon registration, expanding circulating supply proportionally with network growth.

## 5.2 Global Utility-Scale Solar Industry Data

Understanding the facility landscape is essential for modeling issuance. Table 3 presents estimated global utility-scale project counts by size bucket, derived from Wiki-Solar (765 GW across ~14,000 projects), LBNL data (121 MW US average 2024), and regional analyses. Projects follow a log-normal distribution with growth rates increasing for larger projects.

Size Bucket	Est. Projects	Capacity (GW)	Avg Size	CAGR	Economics
4-10 MW	4,958	35	7 MW	15%	Net metering, community
10-25 MW	3,542	60	17 MW	18%	Corporate PPA
25-50 MW	2,550	89	35 MW	22%	Corporate PPA
50-100 MW	1,700	119	70 MW	28%	Utility PPA
100-250 MW	992	149	150 MW	35%	Large PPA, tax equity
250-500 MW	354	124	350 MW	40%	Large PPA, RECs
>500 MW	71	57	800 MW	45%	Large PPA, RECs
TOTAL	14,167	633	45 MW avg	—	—

**Table 3: Global Utility-Scale Projects by Size (2024). Sources: Wiki-Solar, LBNL, IEA PVPS, Global Energy Monitor**

### 5.3 SolarCoin Registration Model

SolarCoin registrations come primarily through monitoring platforms (Enphase, SMA Sunny Portal, SolarEdge), which are 85-95% residential. Large utility projects (>5MW) rarely participate—they operate under different economics with dedicated monitoring infrastructure and sophisticated revenue stacking that doesn't require marginal incentives.

Facility Type	Share	Avg kW	CF	Annual SLR	Initial (5yr)
Residential	92%	8	15%	10.5	53
Small Commercial	7%	35	16%	49.1	245
Community Solar (<5MW)	1%	2,000	18%	3,154	15,768
WEIGHTED AVERAGE	100%	29.8	—	44.6	223

**Table 4: SolarCoin Facility Distribution Model (Based on Monitoring Platform Pipeline)**

### 5.4 Equilibrium Price Derivation

As the network grows, both market capitalization and circulating supply expand. The dynamics can be expressed as:

$$\begin{aligned}
 \text{Total Supply} &= \text{Base Supply} + (\text{New Nodes} \times \text{Issuance per Node}) \\
 \text{Market Cap} &= \text{Total Nodes} \times \text{Utility per Node} \\
 \text{Price} &= \text{Market Cap} / \text{Total Supply}
 \end{aligned}$$

At scale, as the number of nodes approaches infinity, this simplifies to:

$$\text{Price}_{eq} = \text{Utility per Node} / \text{Issuance per Node}$$

This equilibrium is independent of network size. At baseline assumptions:

$$\text{Price}_{eq} = \$3,500 / 223 \text{ SLR} = \$15.68$$

The equilibrium represents the fundamental ratio between the value each participant brings to the network and the tokens they receive for joining.

## 6. Protocol Design: Large Facility Considerations

*Why facilities larger than 5 MW should be excluded from SolarCoin registration to prevent supply dilution and preserve incentive effectiveness.*

### 6.1 Economic Rationale for 5MW Exclusion

Facilities larger than 5MW operate under fundamentally different economics that do not require marginal incentive programs:

**Power Purchase Agreements (PPAs):** Long-term contracts at \$30-50/MWh provide revenue certainty for 15-25 years.

**Investment Tax Credit (ITC):** 30%+ federal credit significantly reduces capital costs.

**Renewable Energy Certificates (RECs):** Additional revenue stream of \$5-40/MWh depending on market.

**Tax Equity Financing:** Sophisticated structures that monetize tax benefits through partnership flip arrangements.

These projects are already economically viable through revenue stacking. A marginal incentive of \$15-40/MWh from SolarCoin would represent only 5-15% of their total revenue—insufficient to influence investment decisions but sufficient to cause substantial supply dilution.

### 6.2 Supply Dilution Risk

Without facility size limits, a single 100MW project registering would claim approximately 109,500 SLR initially ( $100,000 \text{ kW} \times 0.25 \text{ CF} \times 8,760 \text{ hours} / 1,000 \times 5 \text{ years}$ ). This exceeds what 2,000 residential installations would claim collectively. The asymmetry creates perverse incentives for mega-projects to register primarily for token acquisition rather than genuine participation in the solar incentive ecosystem.

### **6.3 Recommended Policy**

Exclude facilities >5MW from SolarCoin registration. This policy: (1) Prevents supply dilution from mega-projects that don't need incentives; (2) Focuses rewards on distributed solar where marginal incentives influence adoption decisions; (3) Aligns with monitoring platform registration reality (already <5% large utility); (4) Maintains equilibrium price stability for genuine participants.

# 7. Supply-Adjusted Network Projections

Forward-looking scenarios incorporating realistic token issuance growth provide a more accurate framework than naive network capital extrapolation.

**Equilibrium Price Sensitivity: Utility per Node Variance**

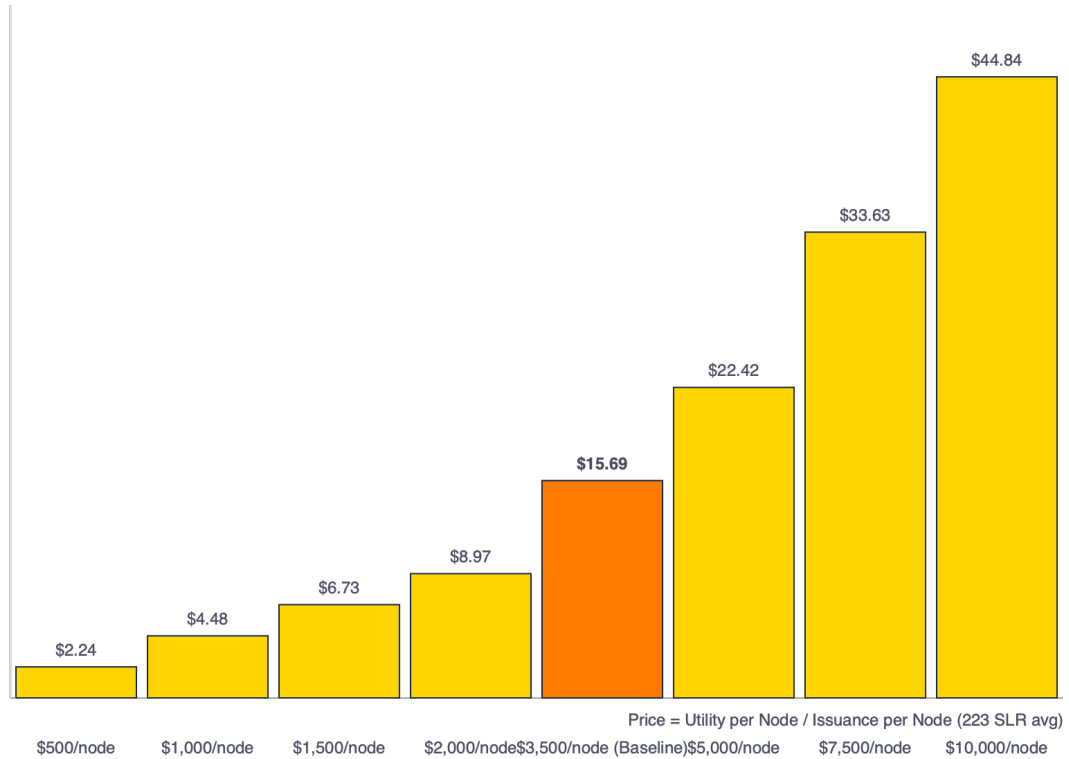


Figure 7.1: Equilibrium Price Sensitivity (Section 7.1)  
Price Scale Across Utility-Per-Node Scenarios

## 7.1 Baseline Projections at \$3,500/Node Utility

Table 5 presents network growth projections using the residential-heavy facility model (223 SLR weighted average issuance). Price converges toward equilibrium of \$15.68 regardless of network size, in stark contrast to naive static-supply projections.

Scenario	Nodes	New Issuance	Total Supply	Market Cap	Price	Naive Price
Current	30,910	0 M	54.4 M	\$0.11 B	\$1.99	\$1.99
0.5% Penetration	100,000	15.4 M	69.8 M	\$0.35 B	\$5.01	\$6.43
1% Penetration	200,000	37.7 M	92.1 M	\$0.70 B	\$7.60	\$12.87
5% Penetration	1,000,000	216.3 M	270.7 M	\$3.50 B	\$12.93	\$64.34
10% Penetration	2,000,000	439.5 M	493.9 M	\$7.00 B	\$14.17	\$128.68
25% Penetration	5,000,000	1,109 M	1,164 M	\$17.50 B	\$15.04	\$321.69
100% Penetration	20,000,000	4,457 M	4,512 M	\$70.00 B	\$15.52	\$1,286.76

**Table 5: Supply-Adjusted vs Naive Network Projections at \$3,500 Utility per Node**

The correction factor grows with network size: at 1% penetration, adjusted price is 41% lower than naive; at full penetration, adjusted price is 99% lower (83× overstatement by naive model).

## 7.2 Equilibrium Price Sensitivity

The equilibrium price is directly proportional to the assumed utility per node. Table 6 presents sensitivity across the observed fiat currency range (\$500-\$15,000).

Utility per Node	Equilibrium Price	% of \$43 LCOE	Solarity Status
\$500 (Conservative)	\$2.24	5%	Minimal offset
\$3,500 (Baseline)	\$15.68	36%	Significant offset
\$7,500 (Optimistic)	\$33.60	78%	Near-Solarity
\$15,000 (Maximum)	\$67.20	156%	Full Solarity

**Table 6: Equilibrium Price Sensitivity to Utility per Node Assumption**

### 7.3 SolarCoin Position on Empirical Curve

Figure 5 overlays SolarCoin's current and projected positions onto the empirical fiat currency data. The current utility per node of approximately \$87 (market cap \$2.7M / 30,910 nodes) is marked below the regression line, indicating pre-critical mass status. Projected values at various penetration levels (1% at \$500-\$3,500/node, full penetration at \$15,000/node) show convergence toward the empirical regression line, supporting Network Capital price predictions.

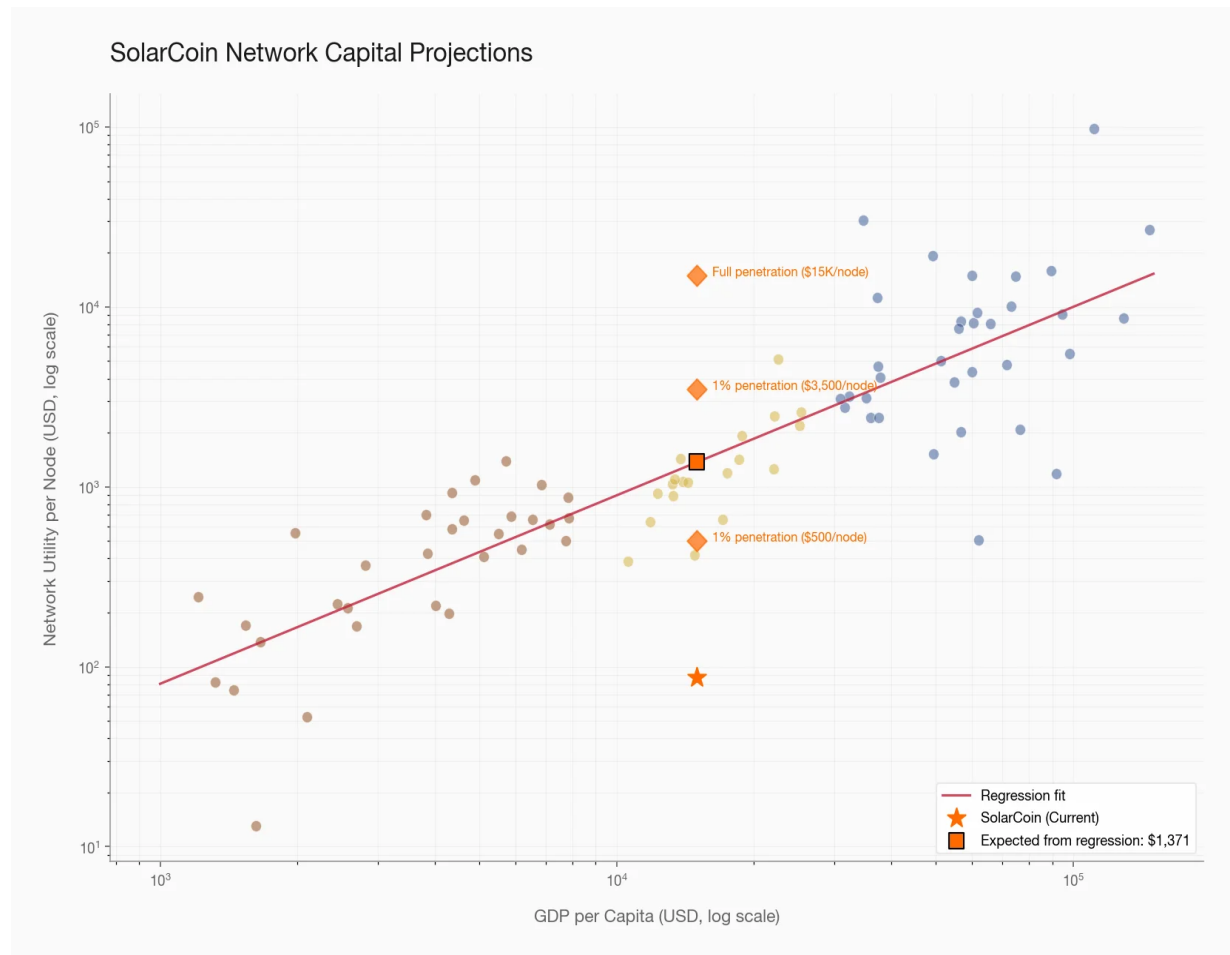


Figure 5: SolarCoin Network Capital Projections Overlaid on Empirical Currency Data. Star marks current position; diamonds show projections at various utility assumptions.

### 7.4 Annual Inflation Dynamics

Beyond initial claims, ongoing production generates continuous token issuance. At the weighted average of 44.6 SLR/node/year and initial claims of 223 SLR/node, the implied annual inflation rate is approximately 20% of supply at steady state. This ongoing dilution

must be offset by demand growth, ecosystem development, or token burns for long-term price stability.

# 8. The Solarity: Threshold of Free Solar Energy

*Defining the threshold where SolarCoin rewards exceed the levelized cost of solar electricity—the point at which solar energy becomes effectively free.*

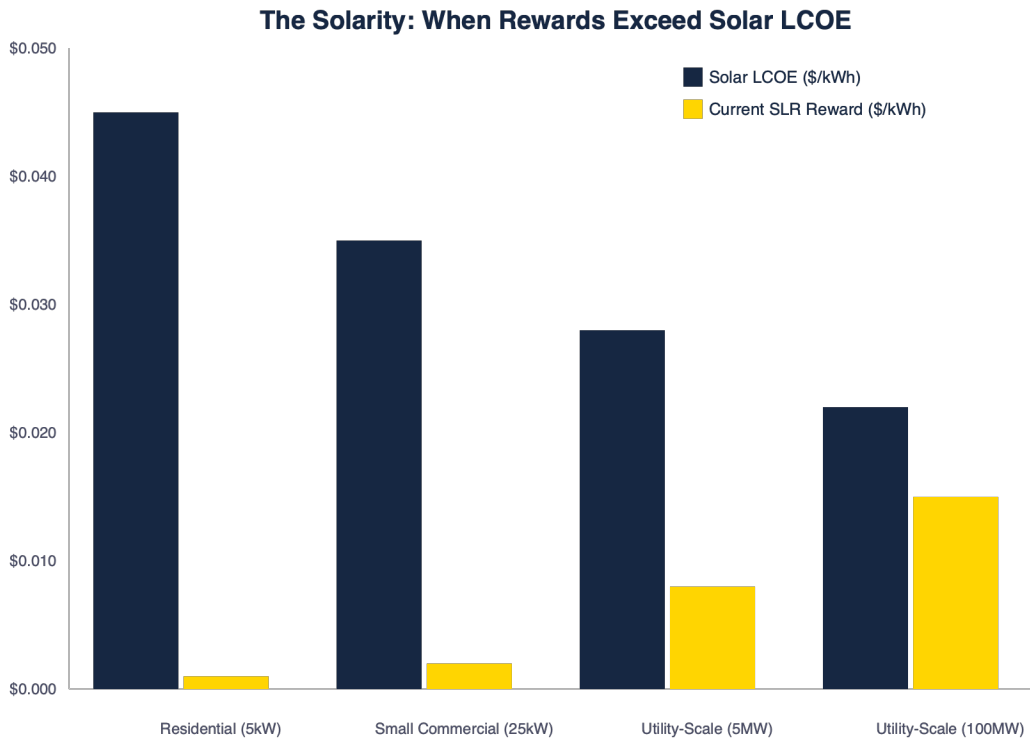


Figure 8.1: The Solarity - When SolarCoin Rewards Exceed Solar Levelized Cost of Electricity (LCOE)

## 8.1 Definition

The Solarity is the threshold at which SolarCoin rewards for solar electricity generation equal or exceed the levelized cost of producing that electricity. At this point, protocol-based incentives fully offset production costs, rendering solar energy effectively free from the producer's perspective:

$$\text{Solarity Condition: Price}_{SLR} \geq \text{Levelized Cost of Electricity (LCOE)} \text{ (\$/MWh)}$$

Since SolarCoin issues 1 token per MWh of verified production, and Levelized Cost of Electricity (LCOE) is expressed in \$/MWh, the comparison is direct: a SolarCoin price of \$43 would fully offset the global average utility-scale Levelized Cost of Electricity (LCOE) of \$43/MWh.

## 8.2 Solarity Achievement Analysis

Table 7 presents comprehensive Solarity analysis across solar market segments under different utility-per-node assumptions.

Solar Segment	LCOE	@\$3.5K/node	@\$7.5K/node	@\$15K/node	Achievement
Best Utility (MENA/Chile)	\$12	\$15.68 (131%)	\$33.60 (280%)	\$67.20 (560%)	✓ @\$3.5K
China/India Utility	\$35	\$15.68 (45%)	\$33.60 (96%)	\$67.20 (192%)	✓ @\$15K
Global Avg Utility	\$43	\$15.68 (36%)	\$33.60 (78%)	\$67.20 (156%)	✓ @\$15K
US Utility-Scale	\$58	\$15.68 (27%)	\$33.60 (58%)	\$67.20 (116%)	✓ @\$15K
Commercial Rooftop	\$50	\$15.68 (31%)	\$33.60 (67%)	\$67.20 (134%)	✓ @\$15K
Residential (Good)	\$60	\$15.68 (26%)	\$33.60 (56%)	\$67.20 (112%)	✓ @\$15K
Residential (Average)	\$85	\$15.68 (18%)	\$33.60 (40%)	\$67.20 (79%)	79% max

**Table 7: Solarity Achievement by Solar Segment and Network Utility Assumption**

## 8.3 Key Findings

Solarity is achievable under supply-adjusted analysis, but conditions vary significantly by segment:

**Best utility-scale (MENA, Chile at \$12/MWh Levelized Cost of Electricity (LCOE)):** Solarity achieved even at baseline \$3,500/node utility assumption. These regions represent approximately 50 GW of installed capacity.

**Global average utility (\$43/MWh):** Requires \$15,000/node utility—the upper end of observed fiat currency range. Achievable but requires strong ecosystem development.

**Residential average (\$85/MWh):** Maximum 79% cost offset even at highest utility assumptions. Full Solarity would require utility levels exceeding observed fiat ranges.

The analysis reveals that protocol utility—not merely network size—determines Solarity achievability. Network growth is necessary but not sufficient.

## 9. Discussion

*Theoretical contributions, the equilibrium price insight, protocol design implications, and limitations of the analysis.*

### 9.1 Theoretical Contributions

This paper makes three primary contributions to the literature on cryptocurrency protocol valuation and renewable energy incentives:

**Empirical Validation:** We validate Network Capital theory across 84 fiat currencies, demonstrating strong correlation ( $r=0.869$ ) between economic activity and network utility with near-proportional scaling (elasticity=1.05).

**Model of Supply Dynamics:** We develop an explicit token supply dynamics model using real industry data that corrects naive price projections by up to 83×.

**Equilibrium Price Formula:** We derive the equilibrium price formula showing that for reward-based protocols, price converges to  $\text{Utility/Node} \div \text{Issuance/Node}$  regardless of network size.

### 9.2 The Equilibrium Price Insight

The most significant finding is that SolarCoin's price is bounded by an equilibrium determined by protocol design, not network size. The formula  $\text{Price}_{eq} = \text{Utility/Node} \div \text{Issuance/Node}$  reveals that increasing the equilibrium price requires either: (1) Increasing utility per node through ecosystem development, liquidity provision, or additional use cases; or (2) Decreasing issuance per node through protocol changes such as lower reward rates or facility size caps.

### 9.3 Protocol Design Implications

For renewable energy incentive protocols, this analysis suggests careful attention to issuance mechanics. Lower issuance rates per MWh would increase equilibrium prices but reduce participant rewards per unit of production. The optimal balance depends on whether the goal is maximizing per-unit incentive value or maximizing total network adoption. Large facility exclusion (>5MW) provides structural protection against supply dilution while focusing incentives where they matter most.

## **9.4 Limitations**

Several limitations merit acknowledgment. The facility distribution model is based on monitoring platform data that may not perfectly represent future SolarCoin registrations. The 5-year historical claim assumption represents maximum rather than average initial issuance. The utility-per-node assumptions are drawn from fiat currency analogies that may not fully translate to purpose-built incentive protocols. Additionally, the model assumes all claimed tokens enter active circulation, whereas some may be lost, burned, or permanently held.

## 10. Conclusion

*Synthesis of findings and their implications for cryptocurrency protocol design, renewable energy finance, and network economics.*

This paper demonstrates that token supply dynamics fundamentally constrain price projections for reward-based cryptocurrency protocols. Naive Network Capital projections assuming static supply overstate potential prices by up to 83×. The corrected model reveals an equilibrium price determined by the ratio of network utility to issuance:

$$\text{Price}_{eq} = \text{Utility per Node} / \text{Issuance per Node}$$

For SolarCoin with residential-heavy registration (223 SLR average initial issuance), equilibrium price ranges from \$2.24 (at \$500/node utility) to \$67.20 (at \$15,000/node utility). At the baseline \$3,500/node assumption, equilibrium of \$15.68 provides meaningful but partial Levelized Cost of Electricity (LCOE) offset—36% of global average.

The Solarity—the threshold of free solar energy—remains achievable under specific conditions. For utility-scale solar in optimal locations (MENA, Chile) with Levelized Cost of Electricity (LCOE) of \$12-15/MWh, Solarity is achieved at baseline utility assumptions. For broader market segments, Solarity requires utility-per-node values at the upper end of observed fiat currency ranges (\$7,500-\$15,000), implying the need for ecosystem development, additional use cases, or protocol modifications.

The fundamental insight is that for reward-based protocols, network size is necessary but not sufficient for price appreciation. Protocol design—particularly the relationship between utility generated and tokens distributed—determines the equilibrium around which prices converge. This has profound implications for the design of incentive mechanisms across renewable energy and other positive externality domains.

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# Appendix A: Token Supply Dynamics

## Methodology

### A.1 Facility Type Classification

Facility types classified by nameplate capacity: Residential (<15 kW), Small Commercial (15-75 kW), Medium Commercial (75-500 kW), Community Solar (500 kW - 5 MW). Distribution shares estimated from SMA Sunny Portal, Enphase Enlighten, and SolarEdge monitoring platform registration data, which consistently show 85-92% residential participation.

### A.2 Capacity Factor Assumptions

Capacity factors by segment based on NREL and LBNL data: Residential 15% (reflecting typical orientation, shading, and system losses); Small Commercial 16%; Medium Commercial 17% (better orientation and maintenance); Community Solar 18% (optimized ground-mount). The residential factor of 15% yields 1.31 MWh/kW/year, consistent with the SolarCoin operational standard of approximately 1.31 MWh production per kW nameplate.

### A.3 Issuance Rules

Per SolarCoin protocol rules: 1 SLR is issued per MWh of verified solar production. New facilities may claim up to 5 years of historical production upon registration. The model assumes maximum historical claim for conservative (maximum dilution) projections. Actual average claims may be lower if facilities register promptly after installation.

### A.4 Equilibrium Derivation

*Total Supply at N nodes:  $S(N) = S_0 + (N - N_0) \times I$ , where  $S_0$  = initial supply (54.4M),  $N_0$  = initial nodes (30,910),  $I$  = issuance per new node (223 SLR).*

*Market Cap at N nodes:  $M(N) = N \times U$ , where  $U$  = utility per node.*

*Price at N nodes:  $P(N) = M(N) / S(N) = (N \times U) / [S_0 + (N - N_0) \times I]$*

*As  $N \rightarrow \infty$ :  $P_{eq} = \lim(N \rightarrow \infty) P(N) = U / I = \text{Utility per Node} / \text{Issuance per Node}$*

# Appendix B: Industry Data Sources

## B.1 Wiki-Solar

Wiki-Solar maintains the world's most comprehensive database of utility-scale solar projects (>4 MW). February 2025 release reports 765 GW cumulative capacity across 33 leading countries, representing 93% of global utility-scale solar. The top 27 developers hold 146.7 GW across 2,738 operating plants, yielding an average project size of 54 MW.

## B.2 Lawrence Berkeley National Laboratory

LBNL's Utility-Scale Solar 2024 Edition provides detailed analysis of 1,760 US projects exceeding 5 MW<sub>AC</sub> through 2024. Key findings include 121 MW average project size for 2024 installations, median capacity factor of 24% (AC basis), and Levelized Cost of Electricity (LCOE) averaging \$46/MWh pre-incentive.

## B.3 IEA PVPS

IEA PVPS Snapshot 2025 reports global cumulative PV capacity of 2.25 TW, with 2024 additions of 554-602 GW. The utility/distributed split is approximately 60%/40%. China alone represents nearly 50% of cumulative global capacity.

## B.4 Regional Average Project Sizes

Average project sizes vary significantly by region (Wiki-Solar 2024 analysis): Saudi Arabia (ACWA) averages 330 MW for mega-projects in the NEOM and Red Sea regions; China and India typically develop 100 MW projects; US average reached 121 MW in 2024; European developers average 20-30 MW due to land constraints and permitting complexity.

## B.5 Growth Rate Data

Utility-scale solar grew 32% year-over-year in 2024 (Wiki-Solar). IEA forecasts approximately 20% CAGR through 2030. Larger projects are growing faster: >500 MW projects show 45% CAGR versus 15% for 4-10 MW projects, driven by economies of scale and increasing developer sophistication.