Feasibility Analysis of Cryptocurrency Mining using Nuclear Surplus Electricity

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1. Introduction

• Surplus Electricity Problem

: On Korea's East Coast, power generation exceeds demand due to weak transmission infrastructure causing electricity surplus, energy waste, and economic inefficiency.

• Need for Utilization Strategies

: Legal and industrial solutions are being developed to redirect surplus electricity into productive uses, such **as hydrogen production and steel manufacturing.**

• New Opportunity: High-Power Industries

: This study explores applying surplus nuclear electricity to **high-consumption sectors like cryptocurrency mining**, enhancing energy efficiency and enabling new industrial growth.

• Boost to Local Economy

: Redirecting surplus electricity to new industries can attract investment, create jobs, and simulate economic growth in underutilized regions.

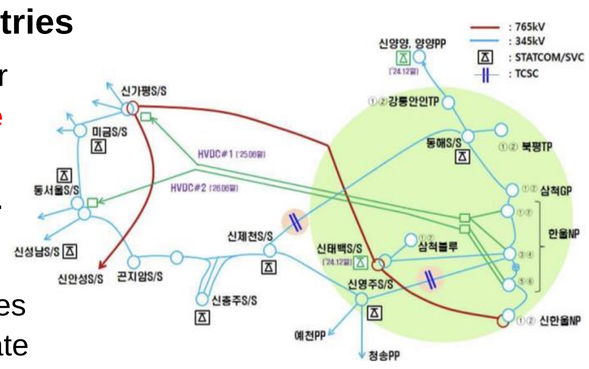

Fig 1. Transmission Infra of Korea's East Coast

2. Methods and Definitions

(1) Methodology

BCR(Benefit-Cost Ratio):
▶ calculated by comparing the total costs incurred over the entire project period with the expected benefits

▶ Profitable? When BCR > 1

$$BCR = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}$$

B_t: Benefit
C_t: Cost
r: social discount rate
t: time

Fig 2. BCR (비용편익비율)

LCOM(Levelized Cost of Mining):
▶ The cost required to mine a single unit of cryptocurrency.

▶ Profitable? LCOM < the market price

$$LCOM = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t} \Big/ \sum_{t=0}^{n} \frac{M_t}{(1+r)^t}$$

M_t: Mined (BTC, ETH)

Fig 3. LCOM (균등화채굴비용)

(2) Nuclear Surplus Electricity

▶ The portion of nuclear-generated power that exceeds actual demand due to **foreca sting errors** and **grid transmission limit**.

▶ Quantifying this surplus by allocating the East Coast's total excess electricity (6.7 GW as of April 2024) proportionally to NPPs based on their **installed capacity s hare**.

	MW	Capacity (%)	Surplus (MW)
Hanul #1	950	10.92	**360.34**
Hanul #2	950	10.92	**360.34**
Hanul #3	1000	11.49	**379.31**
Hanul #4	1000	11.49	**379.31**
Shin-Hanul #1	1400	16.09	**531.03**
Shin-Hanul #2	1400	16.09	**531.03**
East-Coast	8700	100	**3300**

3. Assumption

(1) Assumption for Economy Calculating

Item		Value
<Capital Cost>		
Loan Cost		(Initial) 50,000,000 KRW (Monthly) 5,000,000 KRW
Equipment Cost		Mining Machine Price × Number of Mining Machines
Additional Cost		20% of (Loan Cost + Equipment Cost)
<Operational and Maintenance Cost>		
Electricity	Basic	7,750 KRW/kW per month
	Usage	Generation Tariff of NPP
Water Supply	Basic	1,080 KRW per month
	Usage	1,000 KRW per ton
Maintenance Rate		2% of Capital Cost
Others		1% of Capital Cost

(2) Assumption for Cryptocurrency Scenario

Cryptocurrency Items	Ethereum (GPU) / Bitcoin (ASIC)
Operation Period	61 months (2019.02~2024.02)
Mining Machine	AMD Radeon R9 390 / Bitmain Antminer S19 Pro
Profitability	20% decrease every two years
Initial Profitability (monthly)	- Hashrate of GPU 29MH/s - Hashrate of ASIC 110TH/s
Social Discount Rate	4.5% (by Ministry of Economy and Finance)
Cost = Mining Machine Installation Cost + Electricity Bill	

4. Result of Economy Analysis

(1) Bitcoin with ASIC

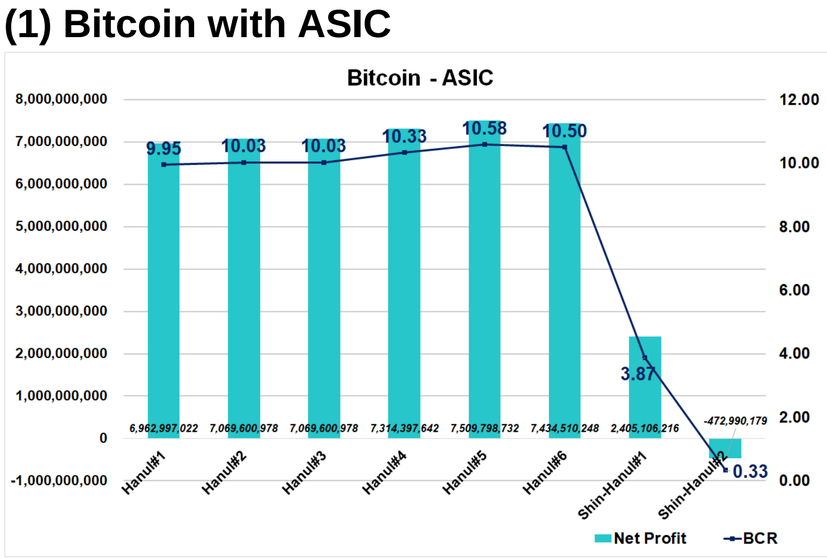

Fig 4. BCR result of scenario using ASIC to mine Bitcoin

Typical BCR
9.5~10.5
Lowest BCR
3.87 (Shin-Hanul #1)
Break-even Point
~3 days
Economic Viability
Very high

(2) Ethereum with GPU

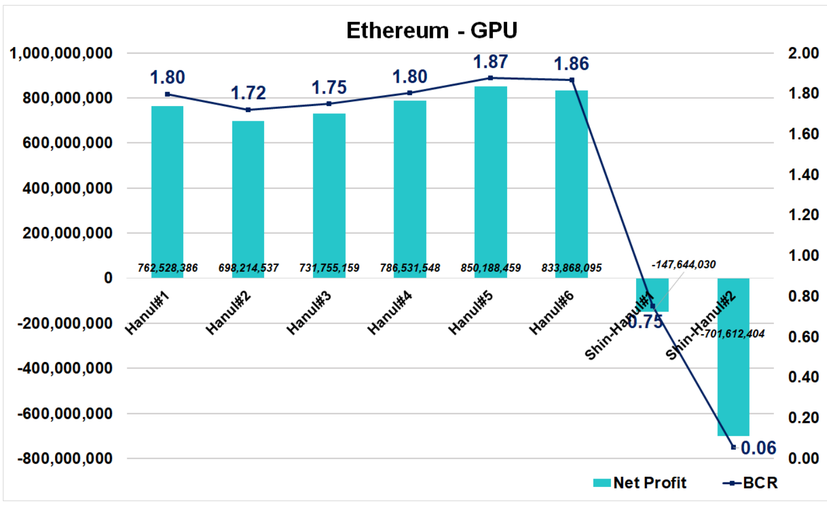

Fig 5. BCR result of scenario using GPU to mine Ethereum

Typical BCR
1.7~1.9
Lowest BCR
< 1.0 (Shin-Hanul #1/2)
Break-even Point
~30 months
Economic Viability
Moderate to Low

BCR		Net Profit (KRW)	
Bitcoin	**Ethereum**	**Bitcoin**	**Ethereum**
63.52	**2.80**	**3.2E+11**	**6.37E+09**

(3) LCOM (Bitcoin)

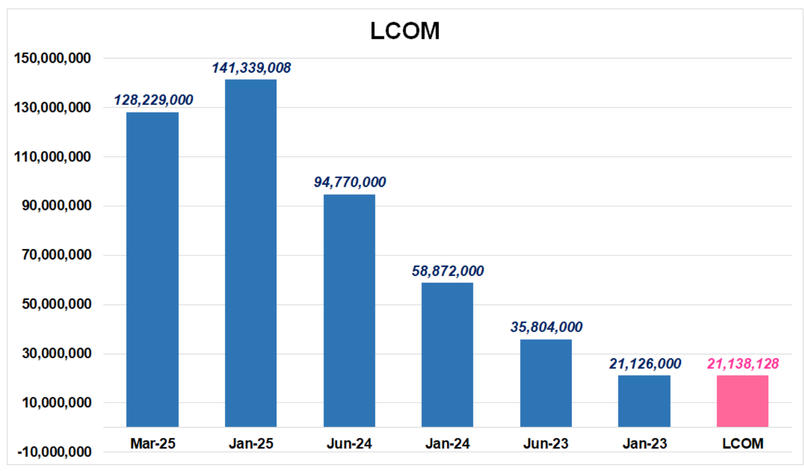

Fig 6. Comparison of LCOM and Market Price of Bitcoin

LCOM (1 BTC)
21,138,128 KRW
Market Price (2025.03)
128,229,000 KRW
Cost Coverage Ratio
~600%
Revenue per Unit Cost
+107,090,872 KRW

(4) Sensitivity Analysis (Shin-Hanul #2)

• Type of GPU

GPU	BCR
GeForce RTX 3090	**1.285**
Radeon RX 570 8GB	**2.979**
Radeon RX 5600 XT	**3.511**

• Type of ASIC

ASIC	BCR
Bitmain Antminer S9	**24.426**
Canaan AvalonMiner 12	**48.274**
Whatsminer M30S++	**70.206**

• Number of GPU

GPU	BCR
21	**1.012**
122	**2.314**
490	**1.001**

• Number of ASIC

ASIC	BCR
14	**1.011**
100	**17.807**
500	**110.036**

5. Conclusion

Bitcoin mining with ASICs demonstrates clear economic feasibility, with BCR > 10 and a break-even point of just 3 days under current market conditions.

This strategy not only improves the **operational efficiency of nuclear power plants**, but also promotes **regional industrial growth** by introd ucing new energy-intensive businesses.

Further research is needed on **policy frameworks, environmental impact**, and **expanding applications** beyond cryptocurrency mining.