North American "Crypto Rush" – A benchmarking study of regulatory and rate design frameworks adopted in 2017 and 2018 to cope with utilities' dilemma

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Overview

From a financial point of view, cryptocurrencies are often seen as either a revolution in the waiting or just a dream on the verge of becoming a nightmare for the growing participating investors in the last 10 years. Supporting the most common cryptocurrencies now on the market, blockchain technology is used to record all transactions in a "distributed, decentralized public ledger[1]". The so called many "blocks" will each store their part of the information about the transaction from each party separately, and then "chaining" them with a unique crypted code, referred as an "hash".

Blockchain technology is not energy intensive *per se*. The main factor of energy consumption is the way a blockchain will guarantee its security through the "consensus" mechanism. Each blockchain can use a different one. The main energy issues are related to a specific consensus called the "proof-of-work", currently used by Bitcoin and Ethereum. In this case, the validation of a block needs the approval of each node - the "miners"- of the blockchain through the resolution of a complex algorithm problem requiring important calculation or hash power. The miners get rewarded for the validation of a block. As far as the number of miners and the difficulty level increase, more hash power is needed in order to secure and validate a transaction in a blockchain[2]. The amount of energy for each transaction then becomes very high and rises with the number of miners competing in a "hash rate arms race"[3]. For Bitcoin, the hash rate has become so high that some miners have created "mining pool", concentrating tremendous hash power. With some protocols, like the one used by the most common cryptocurrency in 2018, depending on the rig technology used[4], it can consume up to 50 000 kW of electricity for the equivalent of many units of time to produce only one unit of Bitcoin. Some producers said publicly that electricity cost would represent almost 75% of their operating cost[5]. As for the fixed cost, like in any classic mining industry, those crypto miners who invest in better rig mining technologies, given the same conditions to find the same unit of value (Bitcoin or Gold in the more classic mining), will be able to move efficient. Using this classic mining analogy, some gold miners can move more dirt and find the gold faster than those who have less processing power, but they also need sufficient water flow to clean the dirt faster in their trommel. Contrary to gold miners who only use the nearby creek, crypto miners must pay for their equivalent of water, electricity price becomes important aside from the technology used.

Putting aside the financial and technological issues of producing and using cryptocurrencies in the future, many political, economic, social, environmental and legal issues have been raised in the energy sector by the sudden energy demand of this new emerging crypto mining industries. Some North American regulators, mainly those with low electricity prices, had to cope in 2017-2018 with conflicting issues around the classic monopolistic electricity distribution of this so called "public service". One of the dilemmas arousing across North America jurisdiction is the access to the public service according to the risk of an emerging industry, should utility investors be exempted from their obligation to serve? Also enlighten with crypto miners, should we create industry specific rate category? If yes, should it be cost based, market based or politically/legally engineered? These questions have been answered very rapidly earlier in the year 2018 while the real anticipated demand has not been as high as expected for now.

Methods

The purpose of this work is to sketch a general picture of the government legislation for cryptomining's energy issues in North America. A benchmarking methodology has been used in an exploratory study.

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[1] https://www.investopedia.com/terms/b/blockchain.asp
[2] Often referred as "proof of work", the Bitcoin protocol for validation is 1000 times slower than todays financial transactions
[3] *Decrypting cryptocurrencies: Technology, applications and challenges*. J.P Morgan (2018).
[4] One of the most cited study from EliteFixtures.com used AntMiner S9, Antminer S7 and Avalon 6 to mine Bitcoins but it was done in a time when the value of the Bitcoin reached unprecedent highs.
[5] Public hearings in front of the Régie de l'Énergie bu Vogogo Inc. http://publicsde.regie-energie.qc.ca/_layouts/publicsite/ProjectPhaseDetail.aspx?ProjectID=457&phase=1&Provenance=C&generate=true

First, a content analysis review of North American regulatory decisions in 2018-2019 has been completed in relation to the electric service demand for cryptocurrencies using blockchain technologies. The decisions and contexts gathered is first broadly analysed in order to assess their adequacies with common energy sector regulatory frameworks[6]: 1) the capacity to attract required capital, 2) providing reasonable rate, 3) market efficiency, 4) demand control and 5) cross-subsidization. Then, we classify each of the decisions found according to the rate design rational[7]: 1) Cost, 2) Market, and 3) Policy based. We also proceed to a quantitative and qualitative comparison that allows us to identify any global convergence in the regulatory legislations and to understand the reasons of specific differentiation. The quantitative evaluation aims to assess the financial impact of the new rates on cryptomining energy costs in terms of variation with current industrial rates and other possible augmentation.

In that way, we expect to process an objective analysis of the different regulatory legislations for cryptomining's energy issues. Eventually, it should lead to a critical framework of the cryptomining legislations in North America in order to reveal both their inconsistencies and their better assets.

Preliminary results

Globally, the North American benchmark analysis showed that there is an absence of common methodology to really understand the real amount of electricity needed to produce different cryptocurrencies, making it difficult for utilities to analyse the potential demand and integrate it into their future supply plan, and invest accordingly. The absence of consensus about the future demand for crypto miners and the absence of a method for the assessment of their specific risk, were the main motivation for most regulators to treat this new industry differently.

Few jurisdictions have already processed a regulatory decision as Table 1 shows. Two of them will be in application on April 1st 2019. Some of them are still undetermined by a moratorium forbidding any cryptomining activities. The most advanced jurisdictions in crypto energy regulation are those who have faced the most important risk on their retail loads and costs. Because of a large and brutal cryptomining energy demand, local Public Utility District (PUD) feared an increase of the electricity prices for their traditional customers, and, most important, for the power infrastructure sustainability. The cities mainly concerned are: Chelan, Grant and Benton for Washington State, followed by NYMPA from New York. In fact, Washington state, thanks to hydroelectricity, has the cheapest US industrial retail price of electricity: 4,71 cents/kWh[8] versus 6,91 cents/kWh average in the US[9]. Cryptomining investors, in their quest for cheap energy, massively rushed to Washington State.

Table 1: Summary of the jurisdictions concerned by cryptomining regulation in North America

Approved public regulation	
Chelan (Washington)	New utility rates, effective April 1st 2019.
Grant (Washington)	New utility rates, effective April 1st 2019
Benton (Washington)	Usage of existing rate
New York (New York)	Creation of a rate rider for high intensity load
Moratorium – Public regulation in process – Not determined	
Plattsburgh (New York)	Moratorium on cryptocurrencies electricity usage
Franklin (Washington)	Moratorium on cryptocurrencies electricity usage
Medicine Hat (Alberta)	Shared 10 years upfront investment risk with crypto miners

[6] Tomain, J. P. & Cudahy, R.D (2011). Energy Law in a nutshell, 2nd edition
[7] Conkling, R. L. (2011). Energy Pricing : Economic and Principles.
[8] Energy information administration: www.eia.gov/electricity/data/browser
[9] Statista: statista.com/statistics/190680/us-industrial-consumer-price-estimates-for-retail-electricity-since-1970/

Through the analyse of the regulatory decisions that occurred, two types of jurisdictions have been identified: 1) first one, like Chelan and Grant, who have decided to create specific category and tariff for cryptomining customers; 2) the others, like Benton and New York, who slightly adapt this new sector to the current industrial rates.

Chelan and Grant

Despite their differences, Chelan and Grant PUD have reacted relatively in a same way against cryptomining issues. Two converging actions can be define:

- Creation of a new category of energy customers specifically dedicated to cryptocurrencies and blockchain producers, or, broadly, for intensive energy activities relative to data sector.
- For this new category, an increase of energy and demand charge rates.

However, these two actions have been processed in different ways.

According to Chelan's PUD, cryptomining service inquiries would have doubled the current retail load, as detailed in its public report[10]. In reaction of that massive demand, it has been decided that cryptomining load would be supply with **market energy**. The market-based energy solution enables to[11]:

- Protect the load service and rates stability for current customers.
- Assess the volatility and unpredictability of cryptomining operations.
- Ensure the financial stability of District's Finance by recovering all the costs spent to serve these clients. .

Table 2 shows the two different rates for cryptominers and industrial large power customers at Chelan.

Table 2: Cryptomining and large power rates, Chelan County (from PUD of Chelan County)

	Cryptomining Rates	**Schedule 35 "High density load" Rates**
Basic Charge	**Per month per meter**	**Per month per meter**
Up to 300 kW	$130	$130
300 kW to < 1 MW	$560	$560
1 MW to < 3 MW	$860	$860
Monthly Demand Charge, Residential	$5.50 per kW of Demand (effective prior to 4/1/2020) $15 per kW of Demand (effective 4/1/2020)	-
Monthly Demand Charge, Non-Residential	$5.50 per kW of Demand	$5.50 per kW of Demand
Energy charge total billed	5.33 cents per kWh	2.70 cents per kWh
Consists of :		
Market energy	3.02 cents per kWh	-
Other :	2.31 cents per kWh	-
Upfront Capital Charge	**Per kW of new or expendant Electric Service Under this schedule**	**Per kW of new or expendant Electric Service Under this schedule**

Through this table, one can see that, for cryptomining clients, the "energy charge" rises by +97% in comparison with Schedule 35. In fact, electricity no longer provided by Chelan's PUD local production but by the wholesale energy market. Note that 5.33 cents/kWh is an approximation: it will probably vary because of market volatility.

[10] *Draft – Cryptocurrency Staff Report*, Chelan's PUD, November 2018.
[11] *Ibid.*

However, the demand charge ($/kW) is unchanged for cryptominers, except for residential demand[12]. The rate structure also includes a "cost recovery" portion through the "upfront capital charge" in order to recover all incremental cost needed to serve cryptominers not covered by rates. In this way, Chelan's PUD minimizes the financial impact of the cryptomining industry.

Chelan's PUD rate structure fulfils some basic point of regulatory frameworks: as a public service, it allows and controls the supply of a new energy demand while protecting current customers from any undue rates increase, especially the industrial and residential sectors. Chelan's PUD tackles the risk inherent to cryptocurrencies operations by displacing responsibility to wholesale energy market and cryptocurrencies operators. This solution enables also Chelan's PUD to recover all additional cost of maintenance and construction (like grid connection) specifically needed for cryptocurrency customers. At the end, the costs should be totally supported by cryptomining firms. Moreover, no cross-subsidization is planned for this sector meaning that no subsidies will reduce the electricity cost for cryptominers.

On the other hand, Grant's PUD regulatory system for cryptomining issues came with the 2 000 MW new service inquiries, of which 75% from cryptominers[13]. It is merely based on the creation of a new category ("evolving industry") and on a progressive increase of energy and demand rates. The "evolving industry" category refers to all activities with high legal and commercial risk and high power concentration[14].

This 3-years plan, from 2019 to 2021, allows Grant's PUD to control the volume of energy demand on a long-term period and determine the financial viability of cryptomining activities on his site. As it is explicitly revealed on Tables 3-4-5, this category faces a drastic augmentation of its rates, particularly the demand charge portion ($/kW) that increases by +428% through the period in comparison with industrial Rate 15 (Table 5).

Table 3: "Evolving Industry" rates - Grant PUD.

< 200 kW	**Evolving industry rates**		
	April 1, 2019	**April 1, 2020**	**April 1, 2021**
Basic Charge	$ 5.00 per day	$ 7.50 per day	$ 10.00 per day
Energy Charge	$ 0.05448 per kWh	$ 0.08165 per kWh	$ 0.12209 per kWh
Minimum Charge	$ 5.00 per day	$ 7.50 per day	$ 10.00 per day
> 200 kW			
	April 1, 2019	**April 1, 2020**	**April 1, 2021**
Basic Charge	$ 500 per month	$ 750 per month	$ 1000 per month
Energy Charge	$ 0.02219 per kWh	$ 0.02465 per kWh	$ 0.03518 per kWh
Demand Charge	$ 8.00 per kW	$ 19 per kW	$ 30.00 per kW
Minimum Charge	The Minimum shall be computed as Demand Charge times 75% of the Customer's Maximum Billing Demand during the most recent 12-month period.		

Table 4: Schedule 15 rates for "Large industrial service" – Grant PUD.

> 15 MW	**Large industrial service rates**
Basic Charge	$ 1000 per month
Energy Charge	$ 0.02552 per kWh for the first 10,950,000 kWh $ 0.02909 per kWh for 10,950,001 to 21,900,000 kWh $ 0.03044 per kWh greater than 21,900,000 kWh
Demand Charge	$ 5.68 per kW
Minimum	The Minimum shall be computed as Demand Charge times 75% of the Customer's Maximum Billing Demand during the most recent 12-month period.

[12] For this case, "demand charge" rate rises because further infrastructure cost would be necessary to adapt residential grid to higher level of power and energy consumption.

[13] http://www.ifiberone.com/columbia_basin/cryptocurrency-businesses-suing-grant-pud/article_a9740000-1541-11e9-bf85-fb3997ef4956.html

[14] *Rate Schedule 17 – Evolving industry service*, Grant County, Public Utility District.

Table 5: Relative variations of « Evolving industry » rates in comparison with Rate 15.

	April 1, 2019	April 1, 2020	April 1, 2021
Energy Charge ($/kWh)	- 27 %	- 19 %	+ 16 %
Demand Charge ($/kW)	+ 40 %	+ 234 %	+ 428 %

From this basic quantitative analysis, one can wonder about the "reasonability" of Grant's rates level for cryptomining operations. In fact, Grant's rates don't seem to be based on any evaluation of global costs entail by cryptomining demand but more on the perception of unpredictability.

Obviously, Grant's PUD intention is, first and foremost, to protect at any prices the current strategic sectors and to limit local energy demand of high-risk and unregulated activities like cryptomining. The new rate pretends to price the unpredictability of this new industry that can be assessed through three risks: regulatory, business and power concentration[15]. In this framework, the most sustainable firms can accept these restrictive rates. Grant's PUD also affirms that this new rate will ease cross-subsidization for "core residential, irrigation and commercial customer"[16]. In response to this decision, Grant's cryptomining firms have protested to this legislation. Indeed, nine of them have sued Grant PUD for inappropriate electricity costs[17].

Benton and New York

Benton and New York are two cities that just adapt their current rates to cryptomining category.

Benton's city has developed a cautious approach about cryptocurrency regulation. First and foremost, cryptomining is included in large category of new industry, called « Electric intensive load » (EIL), for whom high power concentration is a predominant input:

« *Server farms, an aggregation of microprocessor-based computing equipment within a home, garage or business, or special purpose data centers* »[18].

A wide range of activities, such as cryptomining and data centers, is concerned by this category. Thus Benton's PUD doesn't create any specific rate structure for cryptomining activities. For instance, for a power demand charge within 3.5 and 10 MW, the Schedule 34 applies to cryptomining companies (see Table 6). For further demand charge, the Schedule 80 is applied and rates are negotiated individually. Nevertheless, PUD mentions that EIL clients would not be accepted for "Large customer credit policy".

Table 6: Schedule 34 - Benton PUD

3.5 MW < Puissance < 10 MW	Schedule 34
Daily System charge	$7.54 per day
Monthly energy charge	$0.0384 per kWh
Monthly demand charge	$8.53 per kilowatt billing demand per billing period
Minimum monthly Bill	Shall be the daily system charge before any applicable adjustments.
Billing Demand	The billing demand shall be the measured demand for the month, and will adjusted for power factor if the average power factor is less than 95%.

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15 *Cryptocurrency businesses suing Grant PUD.*
16 https://bitcoinexchangeguide.com/washington-state-utility-grant-pud-sued-by-9-crypto-mining-firms-over-higher-electricity-costs/
17 *Ibid.*
18 www.bentonpud.org/Services/Energy/Electricity-Intensive-Load

New York Municipal Power Agency (NYMPA), which gathers 36 power authorities, has decided to adapt his "High density load" tariff to cryptomining companies known as "Rider A" tariff. It allows cryptomining service under an "individual service agreement" if only existing customers costs are protected[19].

Basically, the terms and conditions for applying to "Rider A" tariff are[20]:

- Maximum demand exceeding 300 kW
- Load density exceeding 250 kWh per square foot per year
- No economic development assistance

In addition, "Rider A" tariff includes a "power purchase adjustment clause" (PPAC) that "will recover the incremental purchased power cost incurred by the utility needed to serve such customers"[21]. Like the "upfront capital charge" of Chelan's PUD, this additional clause ensures the risk of increasing costs for current customer and provides financial stability for the NYMPA. Thus, the cryptomining companies will have to support any price augmentation their service may occur.

As we can see, NYMPA first imposes restrictive energy conditions for cryptomining firms in order to limit and control the public energy demand. Then, in order to cope the risks for the utility authority, the financial responsibility is put on cryptomining firms for any incremental purchased power costs, through a specific clause in the rate structure.

Discussions and classification

As we can see, massive cryptomining service inquiries generate important risks for local jurisdiction. The cryptomining industry suffers from a high unpredictability, low economic and social benefits and high issues on power infrastructure. As NYMPA argues, cryptomining industry has been "increasing costs for all NYMPA members and their ratepayers while providing no corresponding benefit to the community."[22] Obviously, referring on public reports, all service inquiries for cryptocurrency load couldn't have been satisfied without jeopardize current customers service. As Chelan's PUD assumes: "the use and cost of District generated was unreasonable and unsustainable".

So, in that situation, local PUDs have to solve a serious dilemma: 1) hosting cryptomining investments, 2) avoiding any risks for current customers and power facilities, 3) limiting power service to the most secure crypto companies. In order to cope with these issues, utility authorities have chosen three main regulatory decisions:

- Supply cryptomining demand with wholesale market energy.
- Restrictive rates structure to control service demand for cryptomining through drastic augmentation of energy prices.
- Forecast, through a specific clause, the recovery of all further incremental costs needed to serve this new category.

At this point of the study, we can say that Chelan, Benton and NYMPA decisions avoid heavy rates discrimination for cryptominers compared with industrial rates: no global tariffs increase, aside from indirect variations from market energy. Chelan and NYMPA's decision to supply through energy market justifies their intention to externalize the risk of supply disruption in case of drastic demand situations, while hosting cryptomining investments. It must be mentioned that the market pricing decision incurs less stability for cryptominers than "production cost pricing", as Chelan's PUD admits[23]. This solution respects a core concept of market theory that is to involve the private responsibility of economic actors.

[19] Public service commission: "*PSC Approves New Cryptocurrency Electricity Rates for Upstate Utility"*.
[20] https://www.transmissionhub.com/articles/2018/03/new-york-psc-heavy-electricity-using-cryptocurrency-companies-can-be-charged-higher-rates-by-upstate-municipal-power-authorities.html
[21] *Ibid.*
[22] https://www.crowdfundinsider.com/2019/01/142829-usa-states-different-approaches-to-cryptocurrency-industry/
[23] *Draft – Cryptocurrency Staff Report*, Chelan's PUD, November 2018

Nonetheless, in order to preserve utility's financial stability, cryptominers are totally responsible for all additional costs engaged to serve them. But no evaluation of these additional costs can be done at this point of the process. Narrowing any financial forecast for cryptominers, this could be a major issue by the time, in the case of bad economic conditions, and adds more uncertainty.

Furthermore, no financial support or economic development assistance, like cross-subsidization, are expected for this specific category since cryptomining doesn't stand for a strategic customer sector. On the contrary, like Grant case, benefits from cryptomining rates could be transferred to other customer category.

Grant attitude to drastically increase energy rates can be explain by his decision to provide cryptomining demand with District generated energy. Because district energy offer is limited, energy prices logically rise. It is a way to safely select the most secure investors: those who can rationally accept very restrictive rates environment must have the most favourable financial conditions. However, this can induce heavy distortions for crypto companies and unsustainable economic conditions in a long-term period.

The cases of Benton and New York seem to be the most "fair" and "wise" regulatory decisions since no rates increase are legally decreed, aside from incremental costs clause (New York). However, Benton original rates (Table 6) are relatively high in comparison with Chelan or Grant rates. So, without any specific decisions on cryptomining regulation Benton rates could not be as suitable as other jurisdictions, even after the application of the new rates structure. Consequently, non-regulatory action is not necessarily the most reasonable choice.

From this analysis, the rates structures designed here are likely to create a situation where cryptomining firms will be among the largest rates fees contributors. That means larger ROE for cryptomining firms. But one can wonder about the coherence between rates fees and revenues expectations. Furthermore, apparent reasonable and convenient rates do not cancel risks for cryptomining firms; rather, they can lead to more uncertainty through market volatility. Indeed, if energy consumption of cryptomining operations is an issue for local Districts, we can wonder how energy market will react to a massive and brutal power demand.

Rates structures classification

From this content analysis, we can elaborate a brief classification of the regulatory decisions according to rate design theory. It is not objective but it pinpoints the core differences between jurisdiction's decisions and enables to assess rates decisions in a rational way.

As it was mentioned in the previous methods part, Conkling developed three approaches in order to analyse rate structures:

- Cost-based: analysing the cost, the investment level to design rates
- Market-based: analysing the value, ROE expectations.
- Policy-based: industrial, social and political arbitration

Most of legal decisions studied here are policy-based, meaning that cryptocurrency industry is not considered as a strategic industrial sector in terms of social, commercial and economic benefits. Because of its financial and energy issues, its regulation appeals political arbitration between current customers, energy availability and cryptocurrency demand control.

Neither jurisdictions use a market nor cost based approach. The rates structure is not designed according to the coherence between revenues expectations and structural costs of cryptocurrency firms. The objective for PUD is not to maintain the American competitiveness of electricity rates for the cryptomining industry but rather to minimize local risk and protect current customers by ensuring recovery costs. Consequently, new rates could imply serious distortion by requiring higher ROE for cryptomining actors they could not be able to reach regarding cryptocurrency market situations. A cost and market analysis could have been useful to verify the reasonability of crypto rates, especially for Grant.

Table 7: Classification of the jurisdictions according to rate design theory

Jurisdiction	Cost based	Market based	Policy based
Chelan	X	X	√
Grant	X	X	√
Benton	X	X	√
New York	X	X	√

This classification doesn't want to prove the inadmissibility of cryptocurrencies rates but it can eventually explain some shortcomings, and thus the possible improvements. A strict policy-based reflexion can lead to some incoherence in rates design. More attention on cost and market matters will certainly reveal the political intention to integrate cryptocurrencies and blockchain operations in an industrial strategic arbitration.

Aside from the perspectives analysis, rates structures have to fulfil some basic functions according to rates design theory. These core principles can be described as follows[24]:

- Attract capital: host new investments.
- Reasonable rate: ensure the customer's capacity to pay.
- Market efficiency: equitable ROE considering risks and concurrence.
- Demand control: clear price signals for customers.
- Cross-subsidization: financial transfer between customer categories.

Applying these principles to our study, we can sketch the following classification as presented in Table 7.

Table 8: Summary of the rates theory functions assessed by the regulatory decisions

Jurisdiction	Attract capital	Reasonable rate	Market efficiency	Demand control	Cross-subsidization
Chelan	√	√/X	X	√/X	X
Grant	X/√	X	X	√/X	√
Benton	√	√/X	X	√/X	X
New York	√	√/X	X	√/X	X

√: Fulfils the function
X: does not fulfil the function
X/√: likely not to fulfil
√/X: likely to fulfil

Attract capital

All jurisdictions demonstrate their capacity to attract new cryptocurrency capital. However, their capacity to keep it after the regulatory decisions stays undetermined and must be the subject of further studies. Except for Grant, cryptomining legislations create favourable conditions to attract and maintain crypto investments even if the new rates cause more restrictive conditions and higher uncertainty. The trial opposing crypto business and PUD officials underlines the matter of Grant to attract cryptocurrency investments.

[24] Sylvain Audette, *Demande de fixation de tarifs et conditions de service pour l'usage cryptographique appliqué aux chaînes de blocs*, 2018.

Reasonable rate

The reasonability of rate is difficult to assess. For Chelan, Benton and New York, we can say that the reasonability of rates is ensured since they are very closed from current industrial rates. However, Table 6 shows that the policy-based approach could be limit to "reasonability", since costs and market situations have not been considered. The reasonable criterion is ensured *a priori*, but some issues could narrow this estimation. This explains the "√/X" rating assigned to Chelan, Benton and NYMPA.

Grant's PUD decision to drastically increase rates can be explained by his intention to take advantage of the cryptomining industry to finance strategic industrial sector such as irrigation. Comparing it with the other jurisdictions, it might have been figured out from its own perception of risk inherent to crypto operations. The legal procedure sued by cryptomining firms against Grant's PUD might underline the lack of coherence behind this decision and a strong feeling of injustice from a market point of view. As it was precise previously, this decision can also be understand as a way to control and limit amount of inquiries for cryptomining service. The lack of "reasonability" of Grant's rate can also be assessed through the benchmarking methodology, which reveals that other counties from the same state were able to solve cryptomining issues without skyrocketing rates level.

Market efficiency

As the previous content analysis reveals, neither rate structure are based on market efficiency. The ROE of cryptominers doesn't seem to have leaded the reflexion of utility authorities, neither the coherence between electricity costs and revenues depending on cryptocurrency market environment. Because cryptocurrencies are high speculative with low economic and social benefits, rates structure have been designed first and foremost to ensure a *status quo* on utility's situation and no to guarantee the sustainability of this market or the comparative advantage of American electricity prices for cryptomining industry. For these reasons, we can assume that any jurisdiction fulfils market efficiency functions.

Demand control

There is a strong uncertainty concerning demand control principle, particularly the incremental purchased power cost adopted by each jurisdiction. Indeed, there is confusion about the level of such costs because of their unpredictability. By the time, incremental costs level can be an important issue, especially in a bad economic situation, and could affect the financial stability and the ability to of cryptomining firms. Nonetheless, at this point of the process nothing indicates it will play an important role. In a precautionary approach, the "√/X" rating reports the demand of clear information concerning this clause.

Québec's cryptomining regulatory decision

The 29th of April 2019, "La Régie de l'énergie" of Québec approved the final decision for the regulation of cryptomining industry after more than a year of intense negotiations. Let resume the content of this decision[25]:

- Creation of a new category for customers using electricity for blockchain cryptomining operations.
- Creation of a "300 MW energy bloc" for cryptomining purposes in addition of current contracts.
- No specific rates for this category: current rates "tarifs M et LG" for large industrial activities will be applied to cryptomining operators, with a maximum of 300 hours of service interruption during critical situations (mainly in winter).
- Cryptominers are financially responsible for any additional costs (e.g. grid connection).

The tariffs M and LG are presented below:

[25] Régie de l'énergie: http://publicsde.regie-energie.qc.ca/projets/457/DocPrj/R-4045-2018-A-0104-Dec-Piece-2019_04_29.pdf

Table 9 : Tariffs M and LG of Hydro-Québec

Tariff M[26]	**Costs (in $CA)**
Energy demand: < 210 000 kWh > 210 000 kWh	 5,03 cents / kWh 3,73 cents / kWh
Power demand	14,58 $ / kW
Tariff LG[27]	
Energy demand	3,46 cents / kWh
Power demand	13,26 $ / kW

These core decisions, according to "La Régie de l'énergie", will be enough to mitigate the risks around the increase of rates for the other customers and the sustainability of energy facilities.

Thus, in order to reach the "300 MW energy bloc", new cryptominers will have to pass through a two steps selection procedure[28]:

1) First step. Crypto companies must fulfil minimum requirements to be selected. Here the main decisions (see note 26 for further information):

- Electricity consumption must be dedicated to cryptomining blockchain operations
- Power demand between 50 kW and 50 MW
- The period of application must be at least 5 years. The guarantees correspond to one-year electricity consumption at 1cents/kWh, ending after the fifth year of service.

2) Second step. The selected applicants then will be ranked beside economic and environmental criteria as next table presents:

Table 10 : Criteria with their weighting for step 2 of Québec selection procedure

Criteria of selection	**Weighting**
Economic development criteria: - Number of direct employments in Québec / MW - Total payroll of direct employments in Québec / MW - Investments in Québec / MW	 30 30 30
Environmental criterion: - Energy efficiency: electricity efficiency / total electricity consumption*	 10
Total	**100**

[26] http://www.hydroquebec.com/affaires/espace-clients/tarifs/tarif-m-general-clientele-moyenne-puissance.html
[27] http://www.hydroquebec.com/affaires/espace-clients/tarifs/tarif-lg-general-clientele-grande-puissance.html
[28] Régie de l'énergie: http://publicsde.regie-energie.qc.ca/projets/457/DocPrj/R-4045-2018-A-0103-Dec-Dec-2019_04_29.pdf

** Electricity efficiency through heat recovery: minimum threshold: 7.5%*

Since Québec case is quite different from previous jurisdictions because its energy production has great surplus, we can say that the regulatory decision allows to:

- Avoid heavy discrimination for cryptominers through high rates increase since the service is ensured through surplus electricity.
- Secure traditional customers from any undue increase rates that could affect their ability to pay.
- Ensure the sustainability of energy facilities and long-term financial planning by recovering all additional costs and managing the risk of non-payment fees.

This new decision is a decisive political action. In fact, first of all, it allows Québec to be one of the most competitive areas for cryptomining operations in the world. Thus, as classic industrial rates are applied to cryptominers, Québec demonstrates its intention to considerer cryptomining as a common industry, at least from a "rate" point of view; it also takes the risk to welcome and develop cryptomining investments and operations and control the long-term viability of this new industry.

Like some US jurisdictions (like Chelan, Benton, and New York), Québec's regulatory decision respects core principles of rate design. This allows us to add Québec to Table 8, obtaining the following classification:

Tableau 11 General classification of US States and Québec beside rate design theory

Jurisdiction	Attract capital	Reasonable rate	Market efficiency	Demand control	Cross-subsidization
Chelan	√	√/X	X	√/X	X
Grant	X/√	X	X	√/X	√
Benton	√	√/X	X/√	√/X	X
New York	√	√/X	X	√/X	X
Québec	√	√	X/√	√	√

Conclusion

Since the future of this industry is unclear, jurisdictions don't see cryptomining as a strategic sector, but speculative and disruptive. In a situation of limited energy availability, choices have to be made for the access of a "common good" as public energy, in terms of security and economic benefits (employment, investments) particularly when the facilities sustainability is involved.

Massive service inquiries for cryptomining demand have frightened utility authorities because it endangered current ratepayers service and facilities sustainability. So, utility authorities have externalized risks by putting full financial responsibility on cryptominers and on wholesale energy market. Their intention is also to limit energy service to the most secure investors to assess their financial sustainability over time.

These solutions enable to temporarily protect current utmost sectors such as strategic industries and residential. But they have some shortcomings in particular the lack of coherence between costs/revenues of crypto firms and rates structure, the volatility of market energy and the uncertainty of incremental costs clause. The sustainability of these solutions is not totally ensured. Using regulatory framework and rate design rationales could lead to some improvements in crypto rates issues avoiding arbitrary decisions or any discrimination within industrial sectors. More legal regulation and economic integration will certainly give more confidence and visibility on cryptocurrency business for utility administration. However some key issues have to be solved by the cryptocurrency actors such as energy consumption and financial volatility in order to increase confidence of decision-makers.

Québec decision is a decisive action for cryptomining regulation. By reducing the severity first conditions, it reveals its intention to be a welcoming area for cryptomining operations, and to consider this new industry as equal to other industrial activities, at least in terms of rates conditions. However, this specific decision is possible thanks to large surplus of Québec hydroelectric energy production. In fact, part of this surplus will feed the 300 MW-bloc for cryptomining industry.

This “crypto episode” should warn politicians and regulators because it reveals a dilemma that could arise from any emerging industries such as data centers, artificial intelligence and electric transportation, which are going to take utmost importance in future economy. Indeed, new electric demand might come from unknown industries in a context of profound mutation of modern economies. We should study how to cope with this, not losing track of what is the role of a “public” utilities, the Bitcoin could then be seen a heads up for what’s to come. The key issue here is to find good balance between the protection of traditional customers and the great development of emerging industries. Thus, it can be the opportunity to enhance energy grid in a more flexible way that could reconcile utilities officials and cryptominers.

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