Comparison of policy alternatives to reduce GHGs from potential Canadian LNG facilities

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Abstract

Canadian exports of liquified natural gas (LNG) for the purpose of converting coal-fired power generation to natural gas can reduce global greenhouse gas (GHG) emissions. However, emissions from export facilities might increase domestic emissions. As a result, LNG projects have mixed support in Canada. Many business leaders, policymakers, and First Nations leaders have discussed the idea of using carbon capture and storage (CCS) to reduce domestic emissions from LNG exports. The largest barriers to the uptake of CCS are the high costs and limited technical expertise. Government policies to encourage the uptake of CCS might help reduce costs and increase its utilization to significantly reduce domestic and global GHG emissions. In this study, we provide analysis of policies to reduce GHG emissions from LNG projects in Canada using case studies from the United States, Australia, and Canada. Grant support, regulatory requirements, research & development (R&D) funding, and carbon pricing/credits were vital policies for adopting CCS to reduce GHG emissions. These policies can all be effective to encourage CCS in Canadian LNG projects, with each policy having different costs and benefits for government and industry.

Introduction

Energy consumption is growing rapidly in developing and developed nations. Growth in energy consumption is the major cause of increasing GHG emissions that have accelerated the effects of climate change (IEA 2019a). The high demand for energy consumption is primarily met through the combustion of coal. Coal is a common energy source in developing nations due to its low cost, ease of use and storage. However, it is among the most carbon-intensive forms of energy, producing 30% more emissions than other sources (IEA, 2019a). If energy consumption is going to continue to rise without increasing GHG emissions, coal must be displaced with lower carbon-emitting forms of energy. Natural gas, which is considered a cleaner and low-carbon emitting source, could be used to displace coal-fired electricity generation to significantly reduce global emissions.

Natural gas could be the fuel that will bridge the gap in the transition toward a low-carbon future in the near term and a zero-carbon future in the long term due to its lower emissions (IPCC, 2014). Natural gas demand is forecasted to grow 2.5% per year over the next decade, mainly in the form of LNG, ranking it second in the global energy mix by the year 2040 (McGrory & Collier, 2019). Demand for natural gas is highest in Asian countries such as China, India, Japan, and South Korea due to the high number of manufacturing industries as well as new policy changes to phase out coal plants.

Proponents of Canadian LNG argue that Canada's most significant contribution to combating climate change in the near-term would be to export LNG for the purpose of coal-to-gas conversion in the aforementioned countries. While this may be true, Canada will not necessarily get credit for reducing emissions with exports of LNG under the Paris Agreement (United Nations, 2015). The emissions accounting system used by the United Nations Framework Convention on Climate Change counts emissions using a territory-based system, meaning that emissions are counted in the geographical region they are emitted (Dion, 2019). Therefore, unless the rules are altered to provide special considerations for LNG exporting countries, Canada cannot get credit for emission savings in other countries with LNG imported from Canada.

Policymakers and LNG proponents must focus instead on reducing domestic emissions associated with LNG projects to receive credit for emissions reductions under the Paris Agreement. Developing projects to capture emissions from LNG facilities like CCS technologies could be an effective solution to reducing domestic emissions for large-scale energy projects. In CCS technologies, carbon dioxide (CO_2) is usually captured from fuel combustion or industrial processes, transported via ship or pipeline, and either used as a commodity in other industries or stored in underground geological formations (IEA, 2019b). According to IEA (2019b), CCS projects are essential options for reducing GHG emissions. However, the high cost of implementation and limited technical expertise have usually prevented widespread adoption of the CCS technology. Adapting or creating policies to make CCS projects economically viable and providing proof of concept to LNG proponents might encourage its implementation in LNG facilities in Canada.

In this study, we aim to address the question of what policies Canada could adopt to develop cost-effective LNG facilities while maintaining low GHG emissions. We do so, by analyzing and comparing policies aimed at encouraging uptake of CCS as an emissions reduction strategy for LNG facilities in Canada to make it more competitive compared to other LNG exporters such as Australia and the United States. We will begin by providing background knowledge on the state of LNG in Canada. Then, we will provide a summary of the existing policy system influencing GHG emissions in Canada, using British Columbia (BC) as a case study. Next, we will provide three case studies in policy-driven CCS adoption in different projects from the United States, Australia, and Canada. Next, we will analyze the effectiveness of four policies (regulatory requirements, grant supports, carbon pricing/credits, and Research & Development (R&D) funding) that enabled CCS utilization in each of the three cases. Lastly, we will discuss the potential costs and benefits of each policy in the Canadian context, including Indigenous perspectives.

Background: LNG in Canada

Canadian LNG might play an important role in supplying natural gas to meet the high global energy demand and in reducing global GHG emissions. In Canada, there are eighteen proposed LNG export facilities (Table 1), thirteen of them which are located in the province of British

Columbia, and five on the east coast of Canada. Although most of the projects have a license to export natural gas, there is only one project in construction (LNG Canada). LNG Canada is the largest project in Canada, which is expected to export 26 million tonnes of natural gas per annum (Mtpa) (NRC, 2018).

The main exporters of LNG, based on current and proposed projects will be Canada, Australia, and the United States (Figure 1) (IGU, 2019). Canadian exporters could produce LNG at a similar or lower cost than other exporters of LNG, especially the United States, with lower associated emissions (CERI 2018; Kasumu et al., 2018). Canadian projects are expected to produce fewer associated emissions because the electricity supply used in the liquefaction process will be primarily from renewable sources like hydroelectricity. Furthermore, Canadian LNG facilities are committed to using energy-efficient technologies in the liquefaction process, which is a highly energy-consuming process, to reduce their GHG emissions (Laciak et al., 2019).

Table 1.Proposed LNG projects in Western and Eastern Canada. (Modified from NRC, 2018).

LNG Projects	**Export-Million Tons per Annum (Mtpa)**	**Location**	**Indigenous Communities**	**Current Status**
West Coast Export Facilities				
Kitimat LNG	10	Bish Cove, near Kitimat, British Columbia (BC)	Haisla Nation	Waiting for a Final Investment Decision (FID). Chevron announced its decision to sell 50% of the project at the end of 2019.
LNG Canada	26	Kitimat, BC	Haisla Nation	In construction (started in 2019). First exports are expected to be by 2025
Cedar LNG	6.4	Kitimat, BC	Indigenous-owned project (Haisla Nation)	Working on Environmental Assessment approvals
Orca LNG	24	Prince Rupert Area, BC		Export license approved in 2015.
New Times Energy	12	Prince Rupert Area (barge), BC		
Kitsault Energy	20	Kitsault		Export license approved in 2015.
Stewart LNG	30	Stewart		Export license granted in 2016.
Triton LNG	2.3	Kitimat or Prince Rupert barge facility		On Hold
Woodfibre LNG	2.1	Squamish, BC	Squamish communities	FID expected in 2020
WesPac LNG Marine Terminal	3			
Discovery LNG	20	North of Campbell River		Environmental Assessment and impact studies still to be carried out
Steelhead LNG: Kwispaa LNG	30	Barkley Sound, near Bamfield, BC	Huu-ay-aht First Nations are jointly developing the project with steelhead	It has an approved export license
Watson Island				
East Coast Export Facilities				
Goldboro LNG	10	Guysborough County, Nova Scotia	Mi'kmaq communities	Expected to initiate exports by 2023
Bear Head LNG	12	Nova Scotia		It has an approved export license
A C LNG	15	Byers Cove, Nova Scotia		Commercial operation expected by 2023
Energy Saguenay	11	Saguenay Port Authority	Innus First Nations	Approved export license
Stolt LNGaz	0.5	Bécancour Industrial Park		Environmental Assessment and impact studies still to be carried out

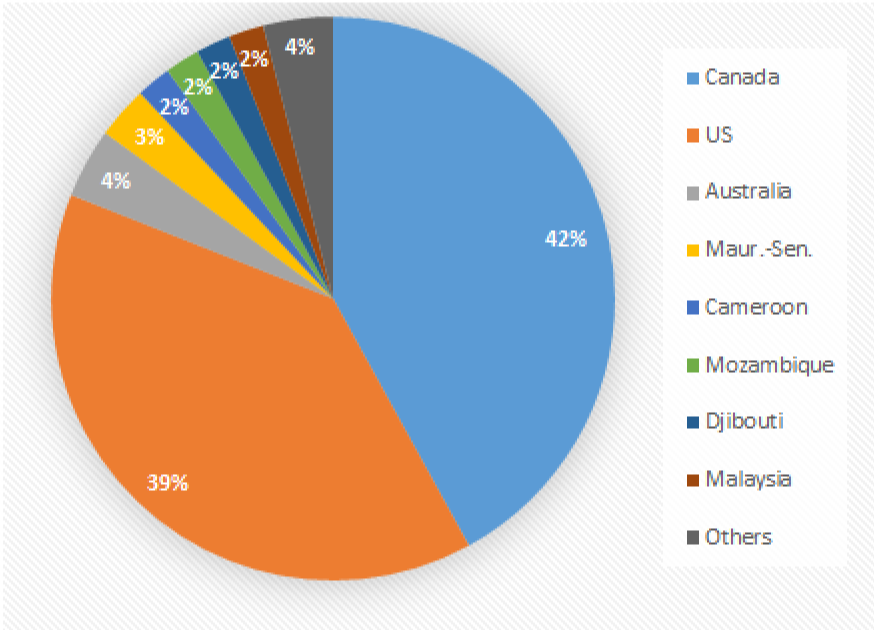

Figure 1: Under construction and total proposed LNG projects by countries as of February 2019. Projects with one or less than one percent of the total are included in others. Adapted from IGU World LNG report 2019, Data Source: IHS Markit.

Additionally, Canada has an advantage over other LNG exporters in its geographic location. Operating costs could be 8-12% lower than the United States due to fewer nautical miles to Asian markets, and a colder climate that results in higher efficiency in the liquefaction process (Grafton and Lambie, 2014). Canadian LNG projects are also unique in that many LNG companies have developed strong partnerships with Indigenous communities, which is essential for moving towards reconciliation between First Nations, industry, and the government. Despite being less carbon-intensive, more socially conscious, and more economical than other LNG export facilities, LNG Canada is still expected to produce roughly 8.6 megatonnes of carbon dioxide equivalent (Mt CO_2 e[1]) emissions per year (Heerema and Kniewasser, 2017). This will be a significant increase in GHG emissions, which is equivalent to 1.2% of Canada's total emissions or 13.8% of British Columbia’s in 2017 (ECCC, 2020).

[1] CO_2e a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. OECD, 2013.

Existing Policy System in British Columbia

Natural resources in Canada are under the jurisdiction of provincial governments, as such, LNG exports off the west coast of Canada are governed primarily by the province of British Columbia. The Greenhouse Gas Industrial Reporting and Control Act (GGIRCA) is the current legislative system regulating emissions for LNG facilities in British Columbia (SBC, 2014). The Act contains three regulations that establish requirements for emissions reporting including the Greenhouse Gas Emission Reporting Regulation, the administrative penalties (Greenhouse Gas Emission Administrative Penalties and Appeals Regulation), and the control of emissions (Greenhouse Gas Emission Control Regulation). Under GGIRCA, LNG facilities pay $30/tonne of emitted CO_2 , which incentivizes exporters of LNG to reduce their emissions.

Despite this, LNG facilities in BC will still produce large amounts of CO_2 e emissions and likely prevent the province from meeting its GHG reduction goals. The province has set the target to reduce 40% of GHG emissions by 2030 and 80% by 2050 below 2007 levels under the Climate Change Accountability Act (CCAA) (SBC, 2007). If the LNG industry develops in the west coast of Canada without more aggressive policies to encourage significant emissions reduction through CCS uptake, these goals will become even further out of reach.

Policies to incentivize CCS could assist the province in developing a strong LNG export industry and reduce GHG emissions. The Gorgon LNG facility in Australia, the Petra Nova CCS project in the United States, and the Weyburn/Boundary Dam project in Saskatchewan provide examples of policy options that were used to incentivize CCS in large scale energy projects. These case studies will be used to analyze the effectiveness of different policy options and their applicability for reducing GHGs in Canada's LNG industry.

Case Studies in Reducing GHG Emissions with CCS

1. Gorgon LNG – Australia

The Gorgon CO_2 injection project is the world's largest commercial-scale carbon dioxide (CO_2) sequestration facility. Gorgon LNG is a joint venture of oil majors including Chevron Australia, ExxonMobil, Shell, Tokyo Gas, and a few other smaller corporations. The LNG plant has an annual production capacity of 15.6 million tonnes of LNG. The estimated cost of adding CCS into the Gorgon LNG project was approximately AU$2 billion (Chevron, 2019).

Policymakers in Australia utilized a combination of regulatory requirements and grant support to encourage uptake of CCS at the Gorgon LNG facility. Incorporating CCS to capture fugitive emissions was part of the regulatory requirements from the Australian regulators to approve this LNG project (Zapantis et al., 2019). The Australian government, in the form of grant support, committed AU$60 million to the CO_2 Injection Project through the Low Emissions Technology Demonstration Fund (LETDF) (MIT, 2016). The purpose of the grant is to make an investment in CCS and similar projects attractive to the private sector investors, reducing the cost of project financing and building confidence in the use of the technology (i.e. CCS). According to MIT (2016), the success of CCS at the Gorgon facility was a combination of two main factors, strong government regulations with government support through grant funding.

Over the lifespan of the Gorgon LNG project, about 40 years starting 2016, the CCS plant is expected to sequester 120 million tonnes of CO_2, or roughly 4 million tonnes per year (Chevron, 2019). The estimated reduction of GHG emissions directly associated with the CCS project is about 40 percent. As a result, coupled with the LNG plant energy-efficient design, Gorgon LNG project is expected to have the lowest GHG emissions intensity in Australia (Chevron, 2019). Likewise, it serves as an early reward for investments that can lead to the creation of knowledge useful for future energy-related projects.

2. Petra Nova - United States

The Petra Nova project was the first industrial-scale CCS facility in the United States, which began operations in 2017. Petra Nova is a coal-fired power plant in Texas, with 240 MW of generating capacity. Petra Nova is a small part of the multi-unit W.A Parish power plant with a total capacity of 3.6 gigawatts. The CCS facility extracts 5,000 tonnes of CO_2e per day, and between 1.4-1.6 million tonnes of CO_2e per year with 90% efficiency. The CCS unit on Petra Nova reduces the total emissions from W.A Parish by 11% (Folger, 2018).

The main policies implemented by the US Department of Energy (DOE) to encourage the uptake of CCS in the Petra Nova coal facility included carbon credits, grant support, and R&D funding. The DOE provided US$160 million (19% of total project cost) in grant support for the construction of the facility and US$30 million in R&D funding. According to the DOE, the purpose of the project was to provide evidence that CCS technologies can be done economically at scale, especially when there are nearby oil fields available for enhanced oil recovery (EOR) (NETL, 2018). Additionally, the US government provides a tax credit for sequestered carbon that pays out $50 per tonne of sequestered CO_2. The tax credit is viewed by CCS proponents as a significant step in incentivizing large-scale CCS and improving its economic viability.

3. Boundary Dam/Weyburn – Canada

The Boundary Dam CCS project is a large-scale demonstration project by SaskPower to capture and store up to 1 million tonnes of CO_2 per year. CO_2 is sourced from the coal-fired electric power station in Estevan, Southeastern Saskatchewan. The Boundary Dam CCS plant supplies CO_2 via a 66 km pipeline to the Weyburn and Midale oil field for commercial EOR operation. Thus, the captured CO_2 becomes a commodity and generates revenue that helps to offset capture costs.

Boundary Dam provides evidence of the effectiveness of CCS as an emissions reduction tool in the Canadian energy sector. The CCS project is capable of a 90% emission reduction from the post-combustion CO_2 generated from the power plant. This results in 10 times less emission compared to a typical coal-fired power plant without CCS. Capturing of CO_2 began in 2014 and within 5 years of operation, it has captured 2.5 million tonnes of CO_2, which is equivalent to taking over 600 thousand cars off the road in terms of emission (SaskPower, 2019). Weyburn field has a potential of storing 20 million tons of CO_2 and the estimated cost of storage is less than $20/tonne of CO_2 (Preston et al., 2005), this shows the economic feasibility of pursuing CCS to mitigate GHG emissions.

The Canadian and Saskatchewan governments used grant support, R&D funding, and carbon taxes to incentivize CCS uptake at Boundary Dam. The project was a CA$1.35 billion government-industry partnership, where the federal government provided CA$240 million of funding support to foster R&D in CCS. Additionally, the project is subject to the federal carbon pricing system, under which the Boundary Dam facility would avoid paying CA$30/tonne for the CO_2 it captures and stores.

Analysis and Comparison of Policy Options

In this section, we analyze and compare the policies utilized by the Australian, Canadian, and United States governments to encourage CCS technologies in large scale energy projects. Four primary policy options were pursued by the three governments: 1. regulatory requirements, 2. grant support, 3. carbon pricing/credits, and 4. research and development (Figure 2).

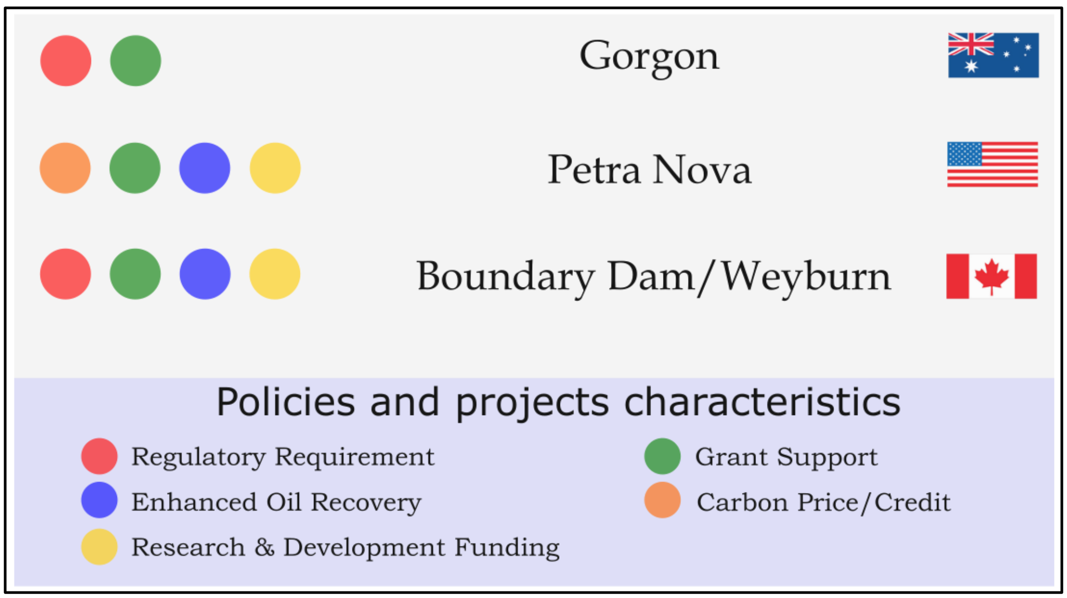

Figure 2: Policies and project characteristics of three CCS case studies in Australia, the United States, and Canada. Adapted from Zapantis et al., 2019.

1. Regulatory Requirements

Regulatory requirements were utilized at the Gorgon LNG facility in Australia and Boundary Dam in Canada. Regulatory requirements, like mandating CCS in LNG plants, can be an effective measure for ensuring compliance from industries to reduce GHG emissions. However, CCS may not be favored by investors due to the additional cost of implementation. Therefore, CCS projects could raise costs for exporters of LNG, which might prevent some facilities from being economically viable. It may be more effective to couple regulatory requirements with other cost-reducing policies to ensure that LNG projects are still profitable, in addition to having lower GHG emissions.

2. Grant Support

Grant support was the most common policy in the three case studies. All three governments utilized some form of direct grant support to encourage GHG reducing technologies (Figure 2). While the degree of funding given by the levels of government differed, all governments provided direct funding to the industry to help reduce the upfront cost of installing CCS. Grant support as a policy strategy has the advantage of directly lowering costs for industry, which is often cited as the largest barrier to the widespread adoption of CCS as an emissions reduction strategy (Abdulbaqi et al., 2018). Therefore, grant support could be an effective policy solution for providing evidence that CCS can be implemented economically in LNG facilities. However, it may not be the most effective policy solution in the long term. If the government of Canada or the government of British Columbia were to provide grant support at the same level of funding as Petra Nova (19% of project cost) for CCS on all LNG facilities, they would be handing out billions to industry. Therefore, grant support may be more effective to provide proof of concept to industry, after which grant support should not be pursued as a viable long-term policy strategy.

3. Carbon Pricing/Credits

Carbon pricing or tax credits were available to industry in both the Petra Nova and Boundary Dam/Weyburn case study. Placing a price on carbon emissions provides an incentive for large-scale energy facilities to internalize the social costs of polluting; similarly, placing an incentive to reduce emissions through carbon capture with tax credits and carbon credits encourages the uptake of CCS (Zhang et al., 2020). In Boundary Dam, carbon pricing encouraged the adoption of CCS to reduce CO_2e emissions. In Petra Nova, the federal tax credit for sequestered CO_2 was a critical component of the economic viability of the project (Folger, 2018). The OECD (2003) report noted that for a carbon price to be effective in reducing GHG emissions and maintaining incentives to the industry, the rates should be set as high as possible but with some adaptations that allow companies to stay competitive. The IEA (2019b) suggested that although a tax and carbon price are measures that could secure long-term investments, it might be necessary to include additional policies to secure CCS project funding.

4. Research and Development Funding

Petra Nova and Boundary Dam both received R&D funding. R&D funding played a critical role in reducing the cost of CCS at Petra Nova. Government investment through R&D aimed at lowering the cost of CCS technology can be an effective policy for encouraging CCS in the energy sector. On the other hand, private investment in CCS related R&D is limited because of the unequal distribution of costs and benefits. A private company that invests in R&D bears all the cost of making CCS less expensive. However, they do not receive all the benefits as the technology becomes less expensive for competitors. The unequal distribution of gains and losses inhibits private investment in R&D; and therefore, carves out a role for public investment. Government investment in R&D ensures that all companies benefit equally from lower CCS costs.

Discussion

Canada's LNG industry must demonstrate high environmental and social commitments as well as relatively low economic costs to be competitive in the global LNG market. Establishing policies to reduce GHG emissions without significantly increasing costs could help develop the LNG industry in Canada. The three case studies of CCS projects provide evidence of the effectiveness of four policy alternatives to reduce GHG emissions in the energy sector. These policies could be implemented in the LNG industry in Canada to achieve similar results. On the global stage, Canada is already among the leading countries in terms of GHG emission reduction through CCS technologies and could further improve its emissions reductions in the natural gas sector. LNG operators will likely commit to projects that guarantee profitability in a short period and projects that have a clear set of rules from the government side. Support from the provincial and federal governments will be vital to reduce costs and encourage stakeholders to invest in the development of LNG projects.

LNG projects provide the opportunity to create partnerships between Indigenous communities, the LNG industry, and the government that could bring economic development. Indigenous communities can benefit from job creation opportunities as well as from social benefits that might include road and facilities construction. Canadian LNG projects can be used to advance the reconciliation path between government and Indigenous communities. Additionally, remote Indigenous communities that are heavily dependent on diesel can be encouraged to transition to a cheaper and cleaner LNG fuel.

Policy formulation and implementation must consider the impacts on both the environment and industry. Regulators should control the price of achieving interim emission goals and avoid driving carbon-intensive industries out of business or increasing prices to consumers. Policy analysis implies that using only one policy is not the best solution to reduce emissions and may have negative impacts on the energy industry or the government. For example, regulatory requirements are not as effective as a standalone policy because they significantly raise costs to the LNG industry. However, regulatory requirements can be effective when combined with other policies, like grant support, to lower the costs of CCS technologies for GHG emission reduction. Adopting a suite of policies and regulations could be more effective than individual policies in the long term.

Conclusion

LNG exports present an economic growth opportunity for Canada with a potential contribution to global GHG emissions reduction. However, emissions from LNG facilities must be mitigated with appropriate sets of technologies and policies. Policy incentivizing uptake of CCS in western Canadian LNG facilities could encourage the growth of the industry without leading to significant increases in emissions. The existing policy system utilizes a carbon price that has proved insufficient for encouraging the widespread adoption of CCS. The uptake of CCS may be better encouraged by utilizing a mix of regulatory requirements, grant support, carbon pricing/credits, and funding for research and development. These policies have varying costs and benefits but have all proven effective in encouraging the adoption of CCS in the three large scale energy projects analyzed in this study. The adoption of this suite of policies could assist

Canadian governments in developing a successful LNG industry that does not prevent them from meeting their emissions reduction objectives.

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