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Tokyo a possible HUB for LNG spot trade

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Introduction

In a study conducted in 2015 the International Energy Agency (IEA) demonstrated that, considering average CO_2 emissions per kWh of electricity produced in OECD member countries from 2009 to 2013, natural gas emits 400g CO_2/kWh while this value is 675g CO_2/kWh for petroleum and between 875 and 1035g CO_2/kWh for coal (IEA, 2015a and Annex, Table 1.a, Power Plants Air Emissions). More globally, in the light of the recent Paris agreement in 2015 (COP21), we see a trend to replace coal by gas in the power generation business (respectively representing 40% and 23% of total consumption in 2012). As an example, Beijing's electricity is now completely produced by means of gas-fired power plants, as the last coal-fired power plant have been shut down (The Japan Times, 2017).

In addition, the needs of growing economies – especially in Asia – make clear for us that the global gas market has a bright future. Chinese, South Korean and Taiwanese gas consumption in 2030 are forecasted to reach respectively 340.7, 45.5, and 32.1 billion cubic meters (Li, 2011 and Rogers, 2016). That will represent respectively a growth of 220%, 5.5%, and 118% from 2010 level (IEA, 2016a). Natural gas will therefore continue to play an important role in the Asian energy market especially in its liquefied form (Stern, 2014). In Japan, demand will reach between 80 and 120 billion cubic meters depending on the nuclear situation, i.e. whether the share of nuclear-generated energy will be at 21% or 11% in the Japanese power mix (Rogers, 2016).

Despite the promising future of gas in Asia, there is no real index in the region reflecting the supply and demand price for natural gas/LNG. However, in the meantime gas-to-gas contracts represented about 60% of the LNG trade in Europe in 2015 (IGU, 2016) while the North American market is dominated by the gas-to-gas Henry Hub price (Reed, 2013).

Addressing this shortcoming, in May 2016 the Japanese government expressed the willingness to establish an LNG trading hub in Tokyo through a document entitled "Strategy for LNG Market Development, Creating flexible LNG Market and Developing an LNG Trading Hub in Japan" published on May 2, 2016 by the Ministry of Economy, Trade and Industry (METI, 2016).
In contrast to US and European markets, it appears to us that the financial sector is unable to provide a clear gas-to-gas price in Asia. For that reason, the subject of possible LNG HUB in Tokyo represents an interesting topic to study, as it could represent a solution to determine a gas-to-gas price in Asia. The main question here is: carefully considering three key factors such as liquidity of the market, physical issue, and current trends, could Tokyo really become the LNG HUB for spot trade in Asia?

This research paper supports the thesis that Tokyo is unlikely to become an LNG Hub for Asian spot trade due to the important constraint in terms of liquidity and the lack of a clear index representing supply and demand of LNG in the region. We think instead that hubs in Asia could be implemented in Singapore and Shanghai.

This study concentrates therefore primarily on the study of those factors which should be present if the willingness of the Japanese government and economics reality are to allow the rise of Tokyo as the LNG HUB for spot trade in Asia. To evaluate that possibility we will analyse product specificities, market structure, global trends, METI proposals and players responses. In addition we will be able to understand the possible issues preventing hub implementation.

Chapter I Specificities of LNG

LNG is a particular product. In order to understand how physical particularities could have an influence on financial transactions we will analyse LNG specificities through the four phases of its handling: liquefaction, shipping, regasification and storage.

1.1 Liquefaction

Liquefaction is a method used to transport Natural Gas (NG) through vessels. This process decreases the volume of natural gas by 600 times. Liquefied Natural Gas (LNG) is mostly composed of methane and is a cryogenic liquid at approximately -162°C. For countries which do not have any pipeline access, supply of natural gas through vessels is the only possibility to import natural gas. For instance, due to particular geographical conditions (islands, isolated countries, etc.) Japan, South-Korea, and Taiwan represented in 2016 53% of the world LNG import (IGU, 2016).

In order to be exported in liquid form, natural gas needs to be liquefied at an export terminal. The initial cost of an export terminal is important, often in the tens of billions dollars. That implies the necessity of securing sufficient cash flow to pay back the initial cost. This leads to the prevalent use of long term contracts (Corbeau, p23, 2016).

1.2 Shipping

"When vaporized, its flammability range is between approximately 5% and 15% by volume, i.e. a mixture with air within this range of concentrations is flammable" (Vanema, 2011). This particularity of LNG makes it very complicated to transport and hence implies different types of vessels. "The current LNG fleet is dominated by two main types of vessel designs, i.e. the membrane tank designs and the spherical tank designs." (Vanema, 2011). The imporance of these technical details for our study will become apparent later on when the compatibility issue between LNG terminal and vessels will be considered. In 2016, the global LNG fleet was made up of 24% Moss carrier's type (spherical tank) and 70% by Membrane carrier's type. The total fleet consisted of 478 carriers (GIIGNL, 2017).

It is important to keep in mind that during the transport phase part of the LNG will disappear by evaporation. We refer here to the Boil-Off Rate (BOR), which represents the percentage of LNG volume evaporated per day. This ratio fluctuates from 0.1% to 0.15% for ladden voyage, and 0.06% to 0.1% for ballast voyage depending on ships (Dobrota, 2013).

Compared to the oil industry, the construction cost of an LNG tanker is significantly higher than an oil tanker. Average estimation of an LNG tanker construction cost is about 1.9 billion dollars (OILGAS360, 2015) per million tons oil equivalent, when is it only 0.5 billion dollars per million tons oil equivalent for an oil tanker (Bockmann, 2013). Those costs, as well as the previously mentioned ones, clearly establish the need of large initial investments for the LNG business, again especially if compared to oil. The capital intensivity of LNG business explains the need of securing a stable cash-flow to refund the initial investment. As anticipated above, this leads to the predominance of long-term contract agreements as the standard trading format.

1.3 Regasification & Storage

Regasification terminals are used to transform the LNG back in its gas form. We may call them import terminal or regas terminal later in this paper.
Prior to delivery, an LNG vessel that had never been to a terminal before need to pass a Ship-Shore Compatibility Study, to ensure that the terminal can actually receive that vessel. In some cases, for example, the gangway is not adapted to the ship. Since 2007 two new types of vessels have been built, the Q-Flex and Q-Max, with a capacity of 210.000 and 266.000 m^3 respectively. The issue is that not all terminals receive Q-Flex or Q-Max due to their size. In 2016, 19% of the fleet was made up of carriers over 170.000 m^3 (GIIGNL, 2017).
Offshore terminals could be used to overcome the issue of ship compatibility, but it is still a very undeveloped type of regasification terminal, therefore we will not consider it in this study.

There are two types of storage, namely storagage of gas in gas form (NG) and in liquid form (LNG). As most of the Asian countries only use the LNG storage system, we will only refer to that type. As in vessels, LNG storages also have to cope with the Boil-Off Rate issue (evaporation). "Storage tanks are typically designed to reduce the ingress of heat from the surroundings and solar heating so that vaporization is less than 0.05 % of the total tank content per day, although this can vary from 0.02 to 0.1%"(Dobrota, 2013). This issue leads to high maintenance costs.

Chapter II LNG Market

2.1 Export countries

LNG exports worldwide increased by 15% from 223MTPA in 2010 to 258MTPA in 2016 (IGU, 2017, 2016, 2015, 2014, 2013, 2011, 2010), a modest growth with small changes during the considered period.
We did not see a complete restructuration of market players between 2010 and 2016, new players such as Angola and Papua New Guinea (PNG) are still modest, as they respectively exported in 2016 0.8MTPA and 7.4MTPA. We notice the important increase of Australian LNG export, +132% from 2010 to 2016, shifting from 19.1 to 44.3MTPA. War affected the exports of Yemen and Libya respectively diminishing from 4.3 and 0.2MTP in 2010 to 0MTPA in 2016. One interesting fact is the shift of US from "importing country" (import balance +7.9MTPA) in 2010 to "exporting country" (export balance +2.9MTPA) in 2016, and Egypt from "exporting country" (export balance +7.1MTPA) to "importing country" (import balance +6.8MTPA).
Except the mentioned changes, the nine main exporters remain Qatar, Indonesia, Malaysia, Australia, Nigeria, Trinidad, Algeria, Russia and Oman, with 85% market share all together in 2010 and 86% in 2016 (Annex, Chart 2.1.1, 2010 - 2016 LNG Exports and Market Share by Country).

Looking at future trends, U.S. is now clearly engaged in a huge LNG export expansion, using regasification terminals converted into liquefaction terminals (Annex, Map 2.1.2, US LNG Export Projects Map). When Henry Hub price raised up to 14$/MMBtu in 2000s, companies built import terminals to use oil-linked formula, cheaper at that time. Nevertheless, since Henry Hub price decreased below 5$/MMBtu it was no longer profitable to import LNG to US, and therefore they converted import terminals to export terminals, under the initiative of Cheniere Energy. The US committed with long-term contracts to export a volume of over 37MTPA in 2020 (GIIGNL, 2012, 2013, 2014, 2016, 2017). With 71MTPA export capacity operating or in construction (Annex, Table 2.1, US LNG Export Projects) the US will certainly be the second larger LNG exporter in the world by 2020. That will have an important impact on contract negotiations for at least three reasons. Firstly, the price mechanism of US exports is calculated based on Henry Hub price (further details in part 2.3), thus a gas-to-gas price not indexed on crude oil. Secondly, because the US exports do not have a destination clause (apart from EAR and ITAR lists[1]). Lastly, because with this huge volume added to the market, we are now facing a "buyers' market", where it is easy to renegotiate contracts on much better basis. From 2010 to 2016 the world demand of LNG increased by 33MTPA. Within 5 years, the US production will add 71MTPA on the market, and we will, therefore, face an oversupplied market, most likely for the next decade, especially if Japan restarts its nuclear power plants, thus decreasing its demand by 10 to 15 MTPA (Stern, 2014).

2.2 Import countries

On the import side, several changes have occurred during the past 6 years.
First of all, after the Fukushima accident, Japan increased its imports of LNG from 71MPTA in 2010 to 88MTPA in 2012, thus +24% in two years (Annex, Chart 2.2.1, 2010 - 2016 LNG Imports and Market Share by Country).
Then, we saw a clear shift from Europe to Asian in terms of market share. While in 2010 UK, Spain, France and Italy represented 23% of the worldwide imports, in 2016 this share shrank to 11% (Annex, Chart 2.2, 2010 - 2016 LNG Imports and Market Share between Europe and Asia). At the same time the share of Japan, S. Korea, Taiwan, and China increased from 56% to 62% (mainly due to Chinese demand expansion, +6% share in 6 years).
Chinese and Indian imports of LNG have experienced the fastest growth in the world, respectively increasing from 9.5 and 9.3MTPA in 2010 to 26.8 and 19.2MTPA in 2016. Both countries will represent the vast majority of the future demand growth, as in 2025 Chinese LNG demand should reach 80MTPA, and 29MTPA for Indian demand (Stern, 2014).
As previously described, US imports share shifted from 4% to 0% as it became a net exporter, and Egypt share shifted from 0% to 3%.
In terms of future prospects, we clearly see a trend in south Asian countries, with imports shares of Thailand, Malaysia, Singapore and Pakistan going from 0% in 2011 to 3,5% in 2016 (IGU, 2015).

2.3 Contract types

In this part we will describe and analyze all different forms of LNG contracts that could be signed both in Japan and worldwide.

Historically the oldest type of contract is the oil-linked contract, introduced to solve early pricing problem (Corbeau, p. 36, 2016). For Japan, one specific oil-linked contract is the JCC, standing for Japanese Crude Cocktail (IGU, 2011). It is calculated based on an average price of crude oil imported to Japan (numbers given by the METI). Oil-linked prices formula looks like:

$$P = C + \beta X + S$$

[1] Detail list on : http://www.export.pitt.edu/embargoed-and-sanctioned-countries

Where P is the LNG price ($/MMBtu), C is the base price ($/MMBtu), β is the price slope, X is the Oil Price index (JCC, brent, etc.) and S is the Shipment Charges (Flower, 2012).
In early JCC contracts, the slope was the most important element and used to be 14,85% (Corbeau, p36, 2016). Later in 1990s, in order to protect buyers from high prices and sellers from low oil prices, the S-curve system was integrated, increasing and decreasing price outside a certain range.

In North America, deregulation of gas prices started in the 1980s, moving towards a so called hub based price: the Henry Hub. Henry Hub is the price of gas given at the New York Mercantile Exchange (NYMEX) for the month of lifting. As the US is becoming an exporting country as we saw in part 2.2, this price is now used worldwide in LNG price formula (Free On Board basis). As given by Cheniere Energy Inc. it is constructed as such:

$$P = 1.15 \cdot HH + B$$

Where P is the LNG price, HH is the Henry Hub price and B is a constant different for each contract (ranging from 2.25$/MMBtu to 3.5$/MMBtu), offering an alternative to oil-linked contracts for Asian buyers.

Recently some Japanese buyers have been using JLC (Japan LNG Cocktail). JLC is an average measure based on all LNG imports in Japan (monthly price), thus now mostly reflecting oil-linked prices. Good for hedging spot in Japan, it might face difficulties to be used in neighbor countries, and it is not a measure of gas supply/demand.

A possible Asian gas-to-gas price could be the JKM price, standing for Japan Korea Marker. It is a daily price for spot value of LNG cargo for a certain delivery period. JKM is assessed by Platts "based on trades, bids and offers observed by S&P Global Platts pricing specialists. Platts LNG assessments are market-on-close (MOC) prices prevailing at 16:30 Singapore time or 08:30 GMT on a standard ship size. Market players are regularly contacted by phone, instant message, email or face to face meetings." (Platts, Platts JKM methodology)

The METI established in April 2014 a spot marker called JOE (Corbeau, p482, 2016). Nevertheless, by the end of 2015, JOE has not been used either as marker or index (Corbeau, p. 482, 2016). Therefore, we will not give more details on this price reference.
In Asia two indexes haved been launched for spot and future price of LNG.
In Japan JOE is also the name of a contract launched by TOCOM in Japan. It gives a spot and future price (delivery and non-delivery contract).

SLIng is the Singaporean spot and future price for LNG launched by SGX, it is based on assessement, similar to JKM. We will give more details on both indexes in Chapter III.

In Europe, two spot prices are available, the NBP price (in London) and the TTF price (in Amsterdam). Those price could be used for arbitrage in Asia.

2.4 Japanese market

In this part we will describe in details market players and issues in the Japanese gas sector. There are mainly three types of players: gas utilities using gas for residential, commercial, and partially industrial purposes; power companies using gas to produce electricity; and industry for their own needs.

"Power generation is the largest natural gas-consuming sector in Japan, with a share of 69.8% in 2014. In 2003, the share of power generation was 67.4%; however, in the mid 2000s, gas demand grew faster in commercial and public services than in power generation whose share in total gas consumption declined to 63.6% in 2010. In 2011, demand from power generation surged in the aftermath of the nuclear power plant shutdown and its share increased to 67%, growing steadily since." (IEA, 2016)

There are 203 city gas utilities in Japan (JGA, 2016). However, only 11 have their own re-gas terminal, namely Hokkaido Gas, City of Sendai, Tokyo Gas, Shizuoka Gas, Toho Gas, Osaka Gas, Hiroshima Gas, Shikoku Gas, Oita Gas, Saibu Gas and Nihon Gas (IEA, 2016a).

A specificity of Japan is the high number of regas terminals: 33 (22 year old on average) in total (ANNEX, Table 2.4, Regas terminals in Japan). As we specified in part 1.3, new cargos called Q-Flex and Q-Max may not be able to deliver to each regas terminal. The table below provides more details about the current situation in Japan (GIIGNL, 2016a and IEA, 2016a). Liquidity could be affected as trader might not be able to sell a Q-Flex or a Q-Max to certain regas terminals. Problems could also occur regarding the design of the vessel, i.e. whether spherical or membrane tank types.

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	Number of terminals	Regas capacity in million m^3 per year of LNG	% of total volume
Could received a Q-Flex	14	307	65.5%
Could received a Q-Max	3	54	11.5%
Could not received a Q-Flex	11	99	21%
Could not received a Q-Max	18	306	65%
Not tested for Q-Flex	8	64	13.5%
Not tested for Q-Max	12	110	23.5%
Total	33	470	100%

Source : EIA, 2016a and GIIGNL, 2016a

The Fukushima accident played an important role in the LNG business in Japan. Since the accident, most of the nuclear power plants have been shut down. As stated above, a possible restart operation that will affect the gas demand by 10 to 15 MTPA (Stern, 2014).

3.1 The need for an Asian Hub

The idea of an LNG hub in Tokyo strongly appears in the debate in 2011, after the Fukushima accident. Simultaneously, the oil price was reaching a peak over 110$ per barrel, and as gas was traded through oil-linked contracts it reached a peak around 22$/MMBtu in 2012 (ANNEX, Chart 3.1, 2010 - 2015 Gas Prices). It was the worst moment for Japan, as the country needed to increase LNG supply by 17MTPA in short term to offset the shutdown of nuclear power plants. That created a tremendous financial burden for the country. Therefore the Ministry of Economy, Trade and Industry (METI) thought of a new price mechanism in order to decrease the cost of LNG supply to the country. For that purpose, METI published in 2016 a document entitled "Strategy for LNG Market Development, creating flexible LNG Market and Developing an LNG Trading Hub in Japan".

As we said above, most of the LNG coming to Japan, China, Korea, Taiwan and other East Asian countries is priced in relation to oil, or, more recently, to Henry Hub price. Oil-linked price was a good mechanism when oil and gas were substitutable in power generation. Nevertheless, these days oil-fired power plants are no longer operating, thus gas could not be substituted for oil as easily as it was in the past.
Oil-linked price does not make much sense anymore and does not reflect the reality of the market; as oil prices fluctuates reflecting OPEC production target, as well as oil demand and supply. Therefore, Asian LNG buyers are unnecessarily exposed to tensions on oil market, which are not much connected to the gas market, as it could be in the past.
On another hand, Henry Hub related price formula reflects supply and demand of gas in North American market only. As a consequence, by using Henry Hub formula, Asian buyers expose themselves to North American market fundamentals (Stern, 2014).
An Asian hub would solve both oil-linked and henry hub issues by reflecting the supply and demand price of LNG in Asia. From theoretical perspective, a healthy situation is when price of a commodity reflect the demand and supply of this commodity in a specific region (Stern, 2013).

Another matter is the recent oversupply market ("buyers market"), bolstered by gas from Australia and US (ANNEX, Table 3.1, US LNG Export Projects). Looking at these circumstances, it would be good timing to establish a hub for spot trade without fearing a supply shortage on the market.

However, if we agree that a hub is needed in Asia, does that Asian hub need to be in Tokyo? Does it need to be a single hub? Virtual or physical? We will try to answer those questions in next sections.

3.2 Advocating for a Tokyo LNG Hub

The position of Japan as the world largest LNG buyer is certainly the strongest argument in favour of a Tokyo hub. With 33 LNG regas terminals, 83.3 million tons of LNG imported in 2016, and a storage capability of 12.5 million tons of LNG (IGU, 2017 and IEA, 2016a), Japan is certainly by many aspects the best candidate for an LNG hub.

In addition to market domination, Japan has proceeded to a liberalization of electricity and gas market in order to stimulate competition in the power generation sector and gas-retailing sector, with the aim of decreasing the price for final users and of increasing

the liquidity of LNG in the market. Concerning the electricity sector, since April 2016 METI has implemented a full retail competition.
Regarding the gas sector, from April 1st 2017 the Gas Retail Market will be fully liberalized. 24.7 million households and 1.2 million shops & offices will be able to choose freely their gas supplier. That represents a 20 billion dollar market. Network tariffs will be regulated. Theoretically, since April 2017 METI implemented a TPA (Third Party Access) on regas terminal and pipeline. We say here "theoretically" because in practice that will be much more complicated to implement (we will develop that issue in part 3.3).

Concerning distribution, METI determined three main targets: "Securing regional monopolies and regulated tariffs for gas pipeline service businesses. Securing a third-party access system on gas pipelines. Formulating a mechanism that the government may determine the disputes on connecting pipelines." (METI, p10, 2017)) If that is implemented, it will allow the possibility for new actors to come on the market.

Other factors in favour of an LNG hub in Tokyo could be the political stability of Japan as well as the strong wish of the Japanese government to establish such hub. For that purpose, METI launched a spot price named JOE, reported every month in METI publication (arrival based price). In June 2014 Tokyo Commodity Exchange (TOCOM) and Ginga Energy started an OTC LNG platform (confusedly named also JOE) to access: Non-deliverable Forward / Futures. In the beginning of April 2017 TOCOM announced launching the "new LNG contracts on its new OTC trading platform" (TOCOM, 2017, details in ANNEX, Table 3.2, JOE's new LNG contract). This new contract includes deliverable/non-deliverable types of contracts and, if contracts are doing well (liquid enough), TOCOM agreed with Platts that price of JOE will be reflected in JKM. The advantage of that contract is an anonymous platform to trade to put bid and offer. This methods is actually theoretically much more effective than phone calls assessment used by Platts.

At last, the paradigm shift started with imports of LNG with Henry Hub related price, offering to the Japanese companies more flexibility on the contract. This could be helpful in order to establish an LNG hub in Tokyo, because Henry Hub related contracts do not include destination clause, and buyers could easily re-sale LNG. Japanese corporations are the biggest buyers on Henry Hub related contract, with about 20-25% share in LNG export contracts from US (Stern, 2014).

3.3 Limits of a prospective Tokyo hub

At this early stage of advocating for a Tokyo LNG hub, it is important to point several issues that may prevent the hub to be established in this city
.
"Furthermore, the transparency and reasonableness in price determination will enhance the appeal of LNG as an energy source and will promote the shift to LNG and the creation of new LNG demand." (METI, p6, 2016). With this statement, it clearly appears that the idea of the METI is to find a mechanism to lower LNG price as the country is an important importer of LNG, creating a first issue: suspicion on selling side. Indeed: why would sellers trust a price emerging from a hub dedicated to lower the price of LNG? That first issue, clearly reveals the first weakness of Tokyo candidature: Japan is a heavy importer of LNG with a national production around 2 MTPA of LNG in 2015, covering less than 2% of domestic needs (IEA, 2016a). In comparison to countries hosting an LNG hub, in 2015, US produced 560 MTPA of LNG, UK produced 30 MTPA of LNG and the Netherlands produced 88 MTPA of LNG (IEA, 2016a). An important domestic production

is important for the price index to appear more neutral. On that aspect, Shanghai has an advantage on Tokyo as China produced 98 MTPA of LNG in 2015 (IEA, 2016a). Singapore does not have a domestic gas production but as LNG importations are really small, thus it still appears as neutral.

A second issue, which could prevent Tokyo from becoming a hub, is the lack of liquidity on LNG market. Indeed, in order to ensure a good price mechanism, the amount of transactions should increase to assure liquidity on the market. This is very important because if the liquidity is not good enough then it could imply shortages as well as a very high volatility of prices.
Liquidity is indeed the core problem; regarding the possible LNG hub in Tokyo, we found several issues impacting liquidity on the market. Some of those issues are purely related to Japan and some to the nature of LNG. Nevertheless, both will be obstacles to the development of an LNG hub in Tokyo.
We will first assess those issues of liquidity purely related to Japan. The most important issue is the structure of contract in Japan, since Japanese corporations are used to buy on long-term contract basis, and in so doing they diminish the opportunities for spot and short-term transactions.
To have a better understanding of that issue we computed all the existing long-term contracts (more than 4 years) signed by Japanese companies (as given in GIIGNL reports). We also forecast a possible LNG demand in Japan based on low and high nuclear scenario (as given in Stern, 2014 and IEA, 2016b). On "LNG 2017 - 2030 supply contracted by Japanese companies before 2017 and contestable demand forecast 2017 – 2030" (ANNEX, Chart 3.3, Future room for spot transaction in Japan) we can see the future quantity already contracted by Japanese corporation until 2030, at the same time we can see demand forecast, thus the possible room left for spot trade. What we see is that Japan already secured more than 67% of the Japanese demand in the low nuclear case in 2025 and 90% in 2021.

If the Japanese does not sign any new contract by 2025 and if nuclear power plant does not restart (which is not the official position from Japanese government) the room for LNG spot trade will be 25 million tons in 2025. That will represent about 0.6 cargoes per day (based on 150.000 m^3 average cargoes). So "if the minimum trade was one whole cargo this is likely to be a barrier to developing liquidity" (Stern, p42, 2014). In addition to that, we strongly doubt that Japanese companies would not renew or sign new long-term contracts. In fact, since oil is very cheap in these days and the market oversupplied, Japanese corporations tend to renegotiate oil-linked contracts on better terms, decreasing the slope from 14-15% to 11-12%, taking off the destination clause, increasing the quantity not covered by "take or pay" in the contract, and shifting from 20-year contracts to 10-year contracts. By doing so, they increase flexibility and decrease price without taking any risks on supply security. Consequently, we do not even forecast a spot trade of 0.6 cargoes per day in 2030.

The supply target for 2025 for the biggest player in Japan (JERA) is 25% gas to gas price in Asia (JKM, JLC, JOE, etc.), 25% henry hub, NBP or TTF related and 50% oil-linked, from our understanding that percentage of spot is relatively high compared to this other Japanese corporations involved in the LNG business. Therefore, the average target for Japanese companies might be around 15% to 20% of spot trade in 2030, representing between 10.5 and 14MTPA of LNG (based on a 70MTPA demand which is the level of 2010) and 0.21 to 0.35 cargoes per day.
Another problem for the Tokyo hub is that pipeline connections inside Japan are very underdeveloped (ANNEX, Map 3.3.1, Japan pipeline map). Due to the fact that storage facilities are coupled with regas terminals, a lack of pipeline connections between them will make impossible to re-allocate LNG stored in other areas of Japan. Instead of

building two new terminals (Soma, Toyama Shinkou) and planning a third one (Wakayama), increasing pipeline connections should be the priority. In addition to that, three major companies hold 50% of the pipeline network, limiting competition on the network side. Low flexibility in stock allocations and few market players will for sure negatively affect the liquidity.

Concerning the regas terminal side, TPA (Third Party Access) is an important factor in increasing liquidity on the market, by increasing the number of players. In Japan, since April 2017 regas terminals' operators have to announce unused capacities of their terminals and let other companies use them. In reality, most of the company owning regas terminals are reluctant to open them to others (due to the initial investment, the loss in flexibility, the relatively high rate of utilization, etc.) and therefore TPA in Japan need to be studied after one or two years of experience. Since it is really recent we cannot conclude whether it does not work, or the opposite. Since nuclear power plants have been shut down, gas suppliers need to adjust to electricity peak management, and therefore regas terminals as well as storage capacity are partially used to adjust to electricity demand, leaving little room for implementing a TPA. Nevertheless, if restarting nuclear power plants will make TPA easier to be implemented, in the same time, as it will decrease gas demand, it will negatively affect the liquidity on gas market. We conclude here that restarting nuclear power plants will have both a positive and a negative effect on the gas market liquidity. The price, and the modality for the use of regas terminals also do not appear as perfectly clear, and increased our suspicions about the reality of future TPA in Japan.

TPA implemented in Japan

	Yes	No	Negotiates TPA	No information
Regas Terminals	17 (52%)	6 (18%)	9 (27%)	1 (3%)
Terminal send-out in million cm per year of LNG	266,3 (57%)	15,3 (3%)	182,5 (39%)	5,5 (1%)

Source: GIIGNL, 2017

The figures in the table above may suggest that TPA is doing well in Japan, but in reality the 17 regas terminals where TPA have been implemented only concerns truck loading, unlike Europe, where it concerns bunkering, cool-down services, reloading, transhipment and truck loading. Unless nuclear clearly restarts, regas terminals will very busy and operate with full capacity, living no space for TPA in other activities than truck loading. For that reason we conclude that so far there is no real TPA in Japan, and we are very sceptical about further TPA development in Japan.

Concerning gas market liberalization, it is true that consumers will have the choice of their gas supplier from April 2017; however legal unbundling in the gas pipeline service sector (targeting three largest companies) will be implemented from April 2022.
For the electricity sector, legal unbundling between the transmission sector and the distribution sector will start in April 2020. Therefore, full competition will start in 2020 in the electricity sector and 2022 in the gas sector. In addition, the slowly decreasing demand in Japan would also affect liquidity as well as a possible restart of nuclear power plants.

Liquidity could be disturbed by the nature of the product itself. As we developed it in Chapter I, liquefaction terminals require important investments, thus a stable cash flow granted by contracts. Long-term contracts are also important for sellers, decreasing room for spot contracts.

As we described in part 2.4, the problem of regas terminal accessibility from certain ships (Q-Flex and Q-Max) could as well decrease the liquidity on market, so that transactions may aborted due to ship compatibility problems. In order to assure liquidity on the market, storage is an important factor. Japan does have an important storage capacity (12.5MT) nevertheless, storage is coupled with regas terminal and the storage is made in liquid form, implying important maintenance cost. That may limit the numbers of storage facilities or their size, and hence the liquidity on the market.
Apart from the liquidity issue, we will raise several other issues that could prevent the hub to be in Tokyo. The high level of corporate taxes in Japan (around 31%) is clearly not helping financial companies trading LNG to establish their offices in Tokyo. Neither Vitol nor Gunvor have an office in Tokyo, and Glencore, Trafigura only have a small office. This situation does not compare to Singapore, where corporate taxes are much lower (i.e. 17%, with possible discounts): currently there are about 30 companies trading LNG in Singapore, while there are only Japanese Shousha (商社) in Tokyo.

A well-accepted and used index is also needed to establish a hub. On that issue, the EIA wrote: "In September 2014, Japan launched an LNG futures contract on the Japan over-the-counter exchange (JOE), settled against Rim Intelligence Co.'s Daily Pricing Index. However, only one trade has been made on JOE since its inception. The country's lack of pipeline connectivity with other markets, low volumes of flexible LNG, and lack of LNG price transparency and liquidity have contributed to limited spot LNG trading activity on JOE." (EIA, [Online], 2015).

To be precise, from September 2014 to March 2017, only one spot transaction took place on JOE. In April 2017 TOCOM launched a new version of JOE in partnership whit Platts. But the main issue remains: "how attract sellers on that platform?", so far there are no registered sellers (by sellers we would refer to gas producing companies) yet on the JOE platform. The JOE advantage (probably the only one) is the anonymity offered to buyers and sellers.

Having said that, we collected (in interviews and conversations with industrial players) the opinion that Tokyo might become a virtual hub, trading vessels prior to them reaching Japan, due to the high cost necessary to implement a physical hub. We do think that this strategy will ever succeed for two main reasons: the limited number of vessels in general, in particular vessels with no destination clause, and the lack of strong financial companies in Tokyo, which are needed to increase liquidity leading to a price index. What Singapore could achieve in this field may not be relevant for Tokyo, and we do think that if Japanese companies want to buy or sell vessels the price negotiation will be based on JKM or another sufficiently liquid Singaporean index.

3.4 Shanghai or Singapore Hub

Unlike the EU, there is no regional coordinator in Asia to set up laws and regulations in order establish a LNG hub. European regulators implemented third-party access to the gas transmission and distribution assets and pushed to unbundle vertically integrated companies. In addition to that, European Commission declared that destination restrictions and full-supply long-term contracts violated EU competition law (Kirkness, 2016). That gave much more flexibility for European contractor and therefore leaded to the establishment of hubs. The path to the establishment of a regional hub in Asia will be much more complicated without coordinating role.
We did not consider South Korea as a possible competitor to Tokyo for an LNG hub as the country has never expressed any willingness to establish it and also because of the monopoly of KOGAS on gas import (Platts, 2016).

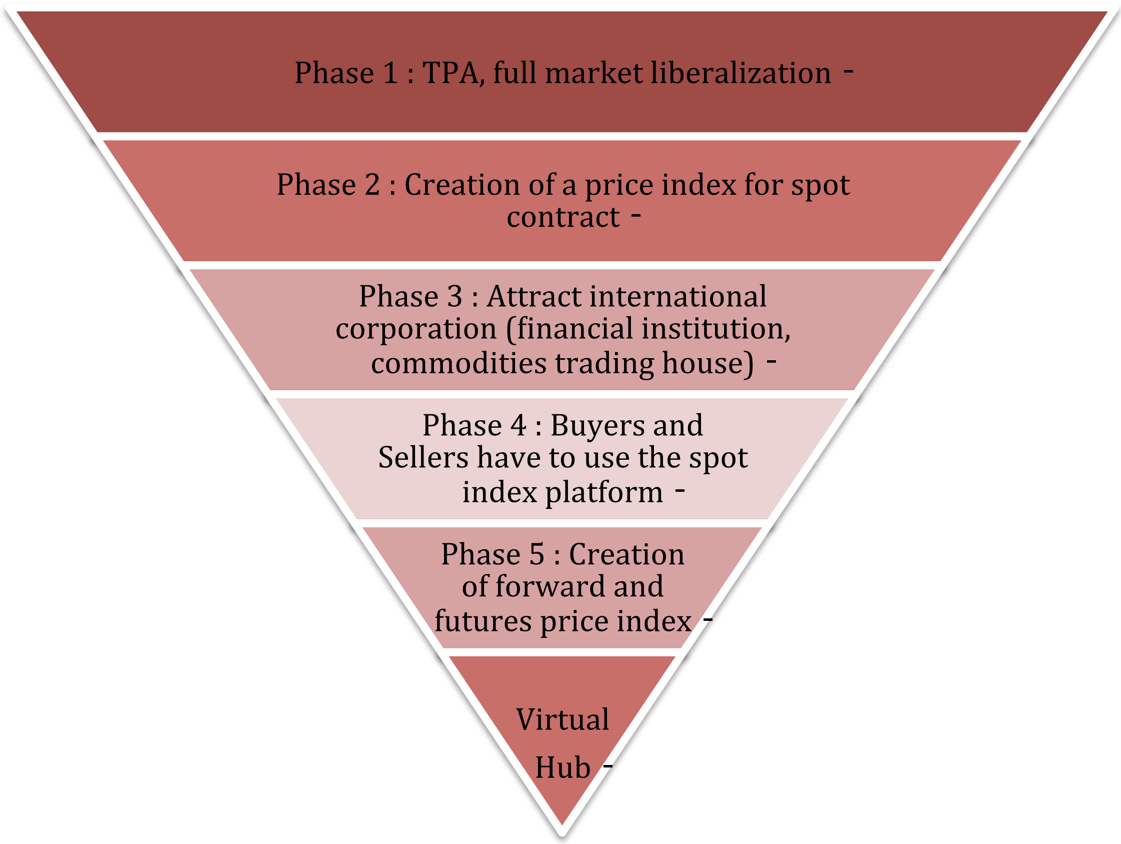
In addition to Japan, China and Singapore expressed the wish to establish an LNG trading hub. We will see which advantages both could have on Tokyo's candidacy.

A Singapore LNG hub could be a solution due to its geographic location; indeed most of the LNG coming to Japan, Korea, Taiwan, and China arrives from the Middle East.
"In 2015 and 2016, Singapore has emerged as a reloading facility in Asia as the country develops the infrastructures and trading capabilities needed to support its ambitions to become a major LNG trading hub in the region." (IEA, p57, 2016b).
Reflecting IEA's expectations for Singapore, we seen it as a front-runner compared to Tokyo and Shanghai. Mainly because Singapore is at advantage on several points: TPA has been well implemented, (unlike Japan and China); TPA concerns cool-down services, reloading, storage and truck loading (pilot facility).
Low corporate taxes attracting financial companies have also played an important role in the appeal of the city-state. The JKM index is doing well so far (especially JKM swaps), and Platts might be able to use its *Ewindow* platform to establish a price discovery based on direct bid and offer, rather than phone calls price assessment (this system could be improved by assuring anonymity on the *Ewindow* platform). In parallel, in 2015 Singapore launched its own spot index for LNG (FOB Singapore SLIng). This SLIng index is directly competing with the Japanese JOE, even though assessment methods are different. SLInG methodology is closer to JKM Platts (phone call assessments) while JOE price discovery follows direct bids/offers mechanism. As the liquidity is still very low on the market, SLInG methodology might be more accurate as a first step, most likely this will lead to bids/offers price mechanism system when the liquidity will increase. Furthermore it is interesting to notice that Singapore launched two types of SLInG index: one Singapore SLInG, and one North Asia SLInG focused on Japan, Korea, Taiwan and China (EMC, 2016), demonstrating a willingness to establish not only price for South East Asian players.
The small quantity of storage facility and demand in Singapore make a physical hub impossible to implement. Nevertheless, a virtual LNG hub in Singapore for South East Asia (and possibly for North Asia as well) could be totally feasible as the city-state is politically stable, geographically well-positioned, attracts numerous financial companies (with interesting taxes rates), and appears neutral between sellers and buyers. It may simply repeat a previously successful path towards oil indexation, which made now Singapore the leading oil pricing spot in Asia. In that case perhaps JKM index will reflect North East Asian prices for LNG while SLIng will be used for South East Asia.

North East Asia has different fundamentals than South East Asia, consumption peaks are different as the climate is different and thus demand peaks do not occur at the same time. For that reason it appears important to consider the existence of at least two hubs in Asia (i.e. one for North East Asia and one for South East Asia).

A Shanghai LNG hub could be a solution, as Chinese LNG demand is growing very quickly (+182% in the last 6 years). In addition, China signed a contract with Russia for the delivery of up to 46MTPA starting in 2018 until 2048. Shanghai will be connected directly with the pipeline from Russia most likely in the 2020s, ensuring a good liquidity on the market, so that in a situation of shipping shortage, ships could be loaded at Shanghai and sent to Japan, Korea, Taiwan or other south Asian countries. The only issue with this would be the floor price paid by China for Russian gas, estimated in the 9-11$/MMBtu range, which is much higher than the actual market price (around 6$/MMBtu). The pipeline from Russia could be a solution if prices rise above a certain level (RT, 2015). Another issue, as pointed out by IEA, is the lack of handoff from Chinese government on business. For example, China's five biggest crude oil companies are state-owned (Sinopec, CNPC, CNOOC, Sinochem Group, Shaanxi Yanchang Petroleum). Shanghai will also experience the same problems as Japan to establish a physical hub concerning TPA, market liberalization and so on. Nevertheless, Shanghai could become a physical hub as the China will soon become the first importer of LNG in the world, with very diverse supply sources. A very recent agreement between US and China comfort us with the idea that China LNG demand is going to growth rapidly, and within few years China gas supply will be from Russian pipelines, US LNG, Australian LNG and Qatar LNG (Worldoil, 2017).
Establishing a physical hub in Shanghai will for sure take a long time but in a broader perspective it appears to us that Shanghai could overcome problems such as the government massive involvement in the economy, infrastructure issues, and market liberalization. As this paper is about a possible Tokyo hub we will not dwell much more on Shanghai, for more details the reader may refer to the paper entitled "Developing a natural gas trading hub in China" (Zhu, 2016).

<u>Example of a simple path to establish an LNG virtual trading hub:</u>



Source: Author

3.5 Possible solutions for a Tokyo Hub

In this section, we will propose additional measures in order to establish an LNG trading hub in Tokyo. Prior to any movement to establish a hub in Tokyo, Japan should give market visibility with a clear schedule regarding nuclear power plants, as that will have an important impact on the LNG business.

The first step to implement a physical hub will be a totally competitive wholesale gas market (including legal unbundling in the gas pipeline service). At the same time, a real and effective third party access to pipelines, regas terminals and storage facilities, with price transparency and law enforcement, should be put in place.

Japan is moving in the right way concerning above mentioned points, but we regret that the legal unbundling of the gas pipeline service will only start from April 2022. That first step should increase the number of market players on mid and downstream side.

Japan should also improve domestic pipeline connections in order to connect all storage facilities to the pipeline network. Building a pipeline connecting Russian production from Sakhalin to Tokyo (ANNEX, Map 3.5, Sakhalin gas pipeline map) could be also a good solution to increase liquidity on the market. Technical feasibility is not a problem, but that will imply the solution of political issues pending between Russia and Japan. The good point with that part is that the government would have much more leverage to initiate a pipeline project with Russia.

The second step will be to attract international LNG players to trade, based on a transparent and liquid spot index. To achieve that target, we strongly recommend to Tokyo to implement fiscal incentives for LNG players wishing to establish there headquarters in the city. Corporate tax rate is indeed about 31%, much higher than in Singapore (17%) or Shanghai's (25%). A good incentive could be for example a 5-year corporate tax exemption. Currently, tax exemptions in Japan are, "10% tax credit for the promotion of income growth where a company raises wages by at least 5%" or "A tax credit for job creation (i.e. where a corporation hires new employees)" (Deloitte, p4, 2017). In contrast, an approved global trading company in Singapore is granted concessionary tax rates of 5%-10% for 5-10 years. Shipping industry could also benefit of concessionary tax rates of 10% for several years.

The last step is, after having a liquid enough spot index, the creation of a derivative market in order to hedge physical transaction. As state above, it implies the implementation of incentives to attract financial companies to establish trading desks in Tokyo.

Technical solutions could be found to overcome physical issues. To solve the problem of ship compatibility, Japan could privilege FLNG (floating regas terminal), and instead of storing gas in a liquid form it stored it in a gas form like in Europe.

A path to a virtual hub in Tokyo is as we just envisage is however very unlikely to materialise. Nevertheless a possible solution could be -as the trading platform JOE exists- to send a clear signal to the market that "Japanese companies (*Shousha (商社)*, utilities, etc.), agreed to only use JOE platform in order to buy spot cargoes". If they adhere to that principle, sellers (such as Qatargas, Chevron, etc.) will be forced to join the platform and price could be assessed almost on daily basis (if you consider the hypothesis of spot demand of 0.3 to 0.6 cargoes per day). If that mechanism is working well, Korean, Chinese, Taiwanese companies could be interested to put a bid on JOE too, leading to improvement in liquidity. Through this scenario JOE index could become a reference spot index for North East Asia. In addition to that, tax incentives will be very much needed. This scenario could lead to implement Tokyo as virtual hub, but it appears highly improbable.

Possible solution to implement a virtual hub in Tokyo:

Source: Author

Conclusion

It appears clear to us that the Japanese government has the willingness to establish an LNG hub in Tokyo for spot trade. Nevertheless, whether Tokyo will have the capacity to implement a hub and it is likely to become true in the next decade are the two is a major question.

Despite all issues previously mentioned, Tokyo has the capacity to become a physical hub for LNG spot trade, but to achieve it, important infrastructure investments (pipeline, storage, etc.) and important changes in contract supply structure from Japanese companies (shifting clearly to spot deal instead of long-term contract and becoming much less risk averse) will have to take place. The engendered cost might well be higher than the benefits of having a hub in Tokyo. Cost–benefit analysis of implementing a physical hub in Tokyo needs therefore to be carefully studied. It does not appear clear for us that the cost–benefit analysis will be favourable towards implementing a physical hub for LNG in Tokyo.

Furthermore as many players understood that a physical hub might be too complicated, the idea of a virtual hub has been considered.
Tokyo as a virtual hub based on JOE index is something hard to believe, as during the last three years only one deal has been using the JOE price. Sellers are reluctant to join the platform, and international companies in the LNG business clearly prefer to use Platts JKM instead. Unless radical changes as expressed in section 4.5 (i.e. Japanese companies taking the risk of buying only JOE spot and futures price in order to make it liquid enough) we consider that a virtual hub cannot be implemented.

To sum up, considering: the physicals complexities of LNG, the insignificant gas production in Japan, the lack of infrastructure, a price index (JOE) leading to only one deal in the last three years, the clear risk aversion of Japanese companies, mistrust from sellers, the absence of pipeline connection with gas fields, the relatively high corporate tax, the decreasing consumption in the next 20 years, and the unclear future for nuclear power plants, we think that Tokyo will neither become a physical nor a virtual hub for LNG spot trade in North East Asia. In the best scenario, we think that Tokyo could have a specific spot price used only by Japanese companies, but that will be a very illiquid index.

It has been proved that hub location in Asia will have very limited impact on prices (Xunpeng, 2016) and we could argue that, if a hub is truly needed in Asia and as the location will not matter much, it could be more interesting for the Japanese to have an LNG hub in Shanghai. In our opinion, Singapore will become first (within 10 years) a virtual hub for LNG spot trade and latter Shanghai will become a physical hub (within 20 years).

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