Future of LNG: Market, Geopolitical, and Innovation Trends to 2034

by

Andrew Pickford, Adjunct Research Fellow, Energy and Minerals Institute, University of Western Australia, +61 8 6488 4266, andrew.pickford@uwa.edu.au

and

Mark Stickells, Director, Energy and Minerals Institute, University of Western Australia, +61 8 6488 4266, mark.stickells@uwa.edu.au

Abstract

In 2034, the commercial LNG industry will celebrate its 75th anniversary. At this milestone there will be a very different industry when compared to 2015. Change, evolution, and disruption is a familiar phenomenon for those who have been part of LNG’s earlier growth phases. From the journey of the world’s first LNG tanker The Methane Pioneer in January 1959, to 237-million tonnes of LNG being transported in 2013, there has been considerable expansion over the past half century. In the future, it is probable (although by no means certain) that volumes of LNG will be greater still. However, forecasting LNG demand is a challenging undertaking. When creating models, economists rely on assumptions which can be based on linear forecasts. This approach has its limitations, especially as disruptive events can make this type of forecast redundant in a very short time. While a quantitative approach is required for data analysis, a better qualitative process is needed to determine parameters and boundary-setting inputs for models. To develop a more complete planning framework for the future, we utilise the original scenario tools developed by Herman Kahn and popularised through the work of Pierre Wack at Royal Dutch Shell. Utilising a more expansive concept of scenarios than currently practised, we construct a matrix that considers futures based on the impact of innovation, geopolitics, and market structure, three interdependent macro-trends. The results provide a basis to forecast the potential state of the LNG industry in 2034.

1. Introduction

While economics is often referred to as the “dismal science”, strategic analysis, or forecasting, is often thought of as a combination of the dark arts and guesswork. Neither is accurate; empirical evidence, grounded assumptions, and observations are features of both economic modelling and scenario planning. Nevertheless, concerns remain over the perception of the future and the robustness of underlying models. When considering the future of the LNG industry, it is important to contextualise the contemporary industry structure and its outlook:

Changing Perception of Gas: It began as a problematic waste by-product and has evolved into a transition fuel on the way to a lower carbon future in the current “dash for gas”. The shifting perception of gas has been driven and bound by technical innovation, geopolitics, and market structure. Long-term forecasting must take the changing role and perception of gas into account. Gas is a fossil fuel and the international role of fossil fuels is expected to radically evolve over the coming decades as low-carbon and renewable technologies compete at greater scale. While natural gas emits half as much CO2 as coal, it could quickly lose its favourable status as a perceived transition fuel if sentiment changes and newer technologies create more alternatives.

Forecasting Gas Trends in Practice: The difficulties of forecasting in the energy and gas sectors are illustrated by the failure of earlier reports to predict regional peaks and shifts in supply and demand. Examples such as the rapid expansion of shale gas, the unexpected evolution of regional demand patterns, and disasters such as Fukushima show that there will always be technical innovation, geopolitical, and market structure developments that surprise forecasters. Strategic analysts refer to “surprises” as disruptive trends, turning points, or “black swans”.
Long Time Frame of LNG Projects: From initial discovery in 1973 to an expected first shipment of gas in 2016, Chevron’s Gorgon Project, the largest single-resource development in Australia’s history, took over 40 years. While the Western Australian Government provided in-principle approval for the Gorgon Project’s onshore gas plant to be based at Barrow Island in 2003, technological, geopolitical, and market changes between 2003 and 2016 have delayed the project. The next generation of major gas projects, involving LNG transport, are likely to require large capital investments and face similar challenges. Even with accelerated development, the time from discovery to first production can only be compressed to a certain point. Floating LNG (FLNG) technologies may help to mitigate this challenge by enabling more rapid deployment and reducing reliance on land sites.

2. Natural Gas Demand Outlook

Forecasting natural gas supply and demand is challenging, but a review of the history of natural gas growth and expected expansion provides a useful background for scenario-based analysis.

The past few decades were marked by an increase in total primary energy supply and in the proportion of natural gas within this mix. The BP Energy Outlook forecasts primary energy demand to increase by 41 percent between 2012 and 2035. In this same period natural gas is expected to increase from around 22 percent to 24 percent of the world primary energy mix and to be increasingly used for transport. As a result, demand for natural gas is expected to rise by almost 50 percent by 2035.


As economic growth and energy demand recovered from the Great Recession in the early 2010s, forecasts on the future of natural gas were optimistic. In this time, new gas production came on-stream, nuclear power plants in Japan were restarted, Asian growth slowed, and the U.S. moved to export shale gas, changing the dynamics of the global gas market. With the U.S.-led shale gas revolution, new technologies, and a move away from coal, analysts predicted a fundamental change in the energy market. In a 2011 report of the same name, the International Energy Agency asked *Are We Entering a Golden Age of Gas?* while *The Economist* suggested “[t]his is indeed a golden age, then, but for gas consumers.” There has also been a convergence of regional gas prices with greater market liquidity and some analysts predict that gas prices will remain subdued to at least the early 2020s.

While there is a general consensus about the likely path for development of natural gas supply and demand through to the 2020s, traditional forecasting more than five years into the future tends to be imprecise. This is where a scenario-based approach may give useful insights.

3. Methods

The process of creating scenarios for strategic planning has its roots in work from the 1950s pioneered by Herman Kahn at the RAND Corporation for the U.S. Air Force on nuclear strategy. His method, termed “future-now” thinking, combined detailed analyses with imagination to create reports written as though by people in the future. In the late 1960s and early 1970s, Pierre Wack adopted Kahn’s “future now” work for scenarios in a corporate context. Royal Dutch Shell utilised this technique, which became known as scenario planning. By adopting these practices, Shell positioned itself well for a period of flux in global and energy markets, predicting the OPEC energy shocks of
1973 and 1979, the push of energy conservation (and corresponding reduction of demand for oil), and the evolution of the global environmental movement.

In spite of its successful use by Royal Dutch Shell, scenario planning in the oil and gas industry in 2015 is less prevalent and has shifted away from Herman Kahn’s original approach. This paper will revisit Kahn’s methods to achieve a more expansive understanding of the future. This includes:

- looking at a much longer term horizon (decades rather than a 3-5 year window); and
- imagining a realistic future which is not bound by contemporary, conventional thinking.

Drawing on this expanded framework, we consider markets, geopolitics, and innovation in 2034 based on the impact of a series of peaks in global population, oil demand, and carbon emissions occurring in 2050. Through analysis, discussions, and review of commentary we collated information on this future in a matrix. While this necessarily involves a limited and speculative set of data points, the insights and ideas are tested through informal and unstructured discussions with academic researchers, industry insiders, consultants, government officials, and security specialists in order to provide confidence in the observations. Finally, from our matrix, we consider four potential scenarios and their implications for the LNG industry.

Disruptive Trends and Turning Points

In creating scenarios, it is important to consider trends. A recent book by McKinsey Global Institute directors titled *No Ordinary Disruption: The Four Global Forces Breaking All the Trends* identifies four global trends:

- Shifting focus of economic activity and dynamism to emerging markets such as China and to cities within those markets.
- Acceleration in the scope, scale, and economic impact of technology.
- Demographic forces, especially aging.
- Global interconnection and movements in capital, people and information.

A particularly interesting possibility is the end of cheap capital. Following a 30-year period of declining interest rates and unconventional monetary policies, we could be heading towards a shift in the demand patterns for capital if it becomes more expensive. Towards mid-century, after possible global population peaks, property asset values are predicted to “reset” as the underlying demand shifts. The likely timing for a transition in capital pricing and availability is the 2020s.

*No Ordinary Disruption* considers energy in the chapter *Reversing the Cycle: Resource Opportunity*, where it describes the challenges presented by the high cost of bringing new supplies of certain commodities to market. Along with the industrialisation of countries in the Indo-Pacific region, these forces were seen to be creating a unique commodities “super-cycle”. Discussion of a super-cycle during 2015 largely disappeared as prices fell.

A Longer Perspective

*No Ordinary Disruption* captures the impact of trends over the coming decade and into the 2020s, which forms a useful starting point for our analysis. However, following the methods of Herman Kahn, we are considering a much longer time horizon (at times looking out to 2175). Rather than describe current trends, we will use the year 2100 as our starting point, since it is the goal year set by G-7 leaders to phase out fossil fuels.

For some economists, 2100 may seem a more appropriate realm for science fiction than forecasting. However, those working in grand strategy must consider such time spans in their analysis. By 2100, the world will be a very different place. The following are reference points we have used for scenarios:
Through internal disintegration or a slow decline, Europe will no longer be pivotal to global affairs, and will perhaps be on the periphery of international decisions. China and India will not necessarily be the leading economies. National borders, and even the concept of nations, may prove to be a particular feature of the 20th Century and slowly fade away.

In addition to the changes brought about by competing societies, we predict that global peak-oil demand, peak-emissions, and peak-population will have occurred and be a matter for historians by 2100. These three turning points are interlinked. Some analysts expect global population levels to start declining in 2050, and this will affect overall energy consumption. It should be noted, though, that peak-oil demand is not be the same as peak-energy consumption. If non-carbon-emitting energy sources rise in importance, peak-energy consumption need not be determined by peak-oil consumption and may not occur this century.

Carbon emissions remain the focus of the current nexus between development, consumption, and ecology. Prior to the December 2015 United Nations Climate Change Conference meeting in Paris, it is unclear if emissions will be reduced via a political decision, by technological developments, or a shift in the demand for fossil fuels. A political consensus may accelerate the passing of peak carbon emissions, but if not, a later crisis may force a more radical and rapid process of decarbonisation. Oil demand, linked to carbon policy, development, and population levels, could begin to plateau in developed nations within a couple of decades. With the use of battery and renewable technologies, by the 2030s the picture of oil demand growth (or decline) will be clear.

Most current commentary on the link between development, consumption, and ecology is focused on the December 2015 UN meeting. The agreement (or lack thereof) will have an immediate impact on the fossil fuel industry (including natural gas), but broader forces are at play. With a longer term perspective, the timing of peak carbon emissions is only the first of many transition points for humanity. The extensive literature on “peak oil” may be viewed as tangential to the transition away from oil altogether. While earlier energy shifts, from wood to coal to oil, may be useful reference points, this transition (or set of transitions) could look much different, but like current commentary, most conceptions of energy futures tend to be dominated by a focus on oil. There is very limited analysis into alternative futures and strategies, such as the impact of a radical reduction in the cost of intercontinental electricity transmission, which could change the economic feasibility of higher adoption and penetration rates for renewables. In the same way that many forecasters focus on oil at their peril, advocates of a utopian, oil-free future can fall into the trap of using only contemporary thinking about non-carbon fuel sources, and as a result focus only on known technologies like wind and solar power.

Looking Backward from 2100
This paper’s time frame for analysis of the future of the LNG industry is from 2015-2034. The year 2100 is well out of this range. However, if we predict that global population, oil demand, and carbon emissions will all peak in the 21st century, the key question is: when? If peak global population occurs in 2050 as opposed to 2040, this will affect energy patterns. As we approach peak carbon emissions, will natural gas be a transition fuel or will it be skipped over completely? Could there be a temporary divergence between developed and developing nations on carbon emissions and energy utilisation which results in a carbon emission scenario with more than one peak?

To assist (and simplify) analysis, we assume that peak-global population, -oil demand, and -carbon emissions all occur in 2050. By 2034, the end of the time frame we consider, the timing of peak population, emissions and oil-demand will be clearer and increases in all three will have had an impact. In considering the effects on LNG of these factors, we analyse the impact of three main drivers:

- **Markets**: the demand for natural gas
- **Geopolitics**: actions by state and non-state actors which influence the movement, production, and demand for natural gas
- **Innovation**: new tools and processes that improve productivity and the efficiency of LNG across the value chain
4. Results

LNG Industry in 2034

We compiled a matrix to examine the interaction between specific turning points (the assumed peak-global population, oil demand, and carbon emissions by 2050) and the drivers for LNG (markets, geopolitics, and innovation). Some of the identified scenarios are contradictory, but this is inevitable when trying to map out different futures. Economists may worry that this unnecessarily creates additional variables, rather than trying to narrow down the complexity. However, strategists, who favour considering complexities in their predictions over simplification for the sake of their models, view this as a necessary step to paint possible pictures of the future before proposing scenario.
<table>
<thead>
<tr>
<th>LNG</th>
<th>Markets</th>
<th>Geopolitics</th>
<th>Innovation</th>
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<tbody>
<tr>
<td>Global Population</td>
<td>• An increasing global population will result in increased demand for LNG. The main driver will be the extent to which LNG demand centres extend beyond traditional North East Asian markets.</td>
<td>• Population movements and increasing security concerns in parts of Eurasia make conventional gas pipelines less attractive compared to LNG.</td>
<td>• Citizens of increasingly affluent mega-cities will start to demand cleaner air.</td>
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<td>• As South East Asia, India and the Middle East transform, they require much larger supplies of energy, including imported gas, to meet demand.</td>
<td>• The ascent of gas and lower oil prices weaken OPEC and member nations. Fast growing populations in Middle East and North Africa force countries to diversify their economies to compensate for uncertain oil revenue.</td>
<td>• Urbanisation will require new options for transportation.</td>
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<td>• The development of economical compressed natural gas and LNG vehicles results in a transition of cars or at least heavy trucks shift to gas-power.</td>
<td>• Failing nations such as Somalia (perhaps Pakistan and parts of Melanesia) spread piracy, resulting in increased insurance premiums for LNG carriers and demand for naval escorts, increasing the LNG unit price.</td>
<td>• Uber and digital technologies in transport will shift focus from owning a car to leasing transport vehicles to move freight and people. The global car fleet peaks and then declines.</td>
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<td>• Lower gas and energy prices spur growth in coal power in developing nations as developed countries transition away from coal, shifting the location of coal consumption rather than reducing it in the energy mix.</td>
<td>• A rising Iran starts to reshape the Middle-East. The Persian Gulf becomes a magnet for larger immigrant populations and Arab-Persian competition results in Wahhabi extremists blocking a critical choke point for exporting gas, bringing Qatar’s industry to a halt.</td>
<td>• Moving electricity becomes more of a focus and more investment takes place in power systems and transmission capabilities.</td>
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<td>Oil Demand</td>
<td>• Oil demand growth for developed nations declines before it does in developing nations.</td>
<td>• Declining oil demand and growth of gas demand make gas-producing fields more strategically important.</td>
<td>• Floating, modular, and automated LNG structures and receiving points become more common.</td>
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<td>• Shale oil and advanced technology slow price inflation through the 2010s and early 2020s.</td>
<td>• Security policies change to consider both oil and gas producing zones.</td>
<td>• Innovations in extracting shale oil continues to change pricing patterns of oil across the commodity cycle.</td>
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<td>• Major new oil fields in Iran and frontier regions result in lower oil prices, delaying the shift away from oil.</td>
<td>• The entry of Iran into oil markets and a less confrontational Russia puts downward pressure on oil prices.</td>
<td>• The global shale revolution fails to materialize as shale extraction remains isolated in the U.S.</td>
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<td>• Because the oil price has limited influence over transportation innovation and breakthroughs, as new technologies come to market, a shift to lower-carbon energy consumption occurs regardless of the oil price.</td>
<td>• To counter declining oil demand, terrorist proxies undertake a concerted effort to destroy gas infrastructure and assets, including a “spectacular” attack on an LNG tanker, forcing a review of security and a pause on new investments.</td>
<td>• Earlier renewable subsidies start to provide commercial alternatives to traditional oil use.</td>
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<td>• An accident involving an LNG tanker in a major harbour creates a set of cascading explosions. A moratorium is placed on new LNG facilities and the industry defers all major projects for a decade.</td>
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<td>• Reduced fuel subsidies in developing countries stimulate innovation and development of non-traditional energy sources.</td>
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<tr>
<td>Carbon Emissions</td>
<td>• A temporary coal renaissance defers peak carbon emissions, but forces increased emphasis on carbon-capture and storage efforts.</td>
<td>• A weak agreement in Paris moves countries toward less carbon intensive economies, further breaking the link between fossil fuel consumption and economic growth.</td>
<td>• Thorium and mini uranium reactors and hybrid renewable applications radically change the nature of the grid and humanity’s carbon footprint. These innovations spur a mass introduction of electric vehicles. Diesel and petrol remain important but shift to niche uses in remote, isolated areas for several decades.</td>
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<td>• As LNG becomes a more fungible commodity where spot sales and flexible long-term contracts are more common, a deeper market emerges.</td>
<td>• Gas' tenure as a transition fuel is short lived, and so gas demand slows after a temporary increase as renewables are prioritised.</td>
<td>• Following a spill in Paris, green tariffs and protectionism mark a sharp retreat from global trade as countries turn inward. Large projects are eschewed for local options.</td>
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<td>• Following the U.S. experience with shale gas, which reduced reliance on coal, nations encourage natural gas to meet their targets. This spurs new technologies, extraction options, and encourages growth of the LNG industry.</td>
<td>• Development of cost competitive carbon capture and storage makes coal a longer term energy source for developed nations. As a result, coal demand temporarily declines (or potentially crashes) and then recovers.</td>
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<td>• Technological developments allow for low-carbon emission use of fossil fuels, causing recovery of oil, coal, and gas demand following breakthroughs in emissions and capture.</td>
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<td>• A weak agreement in Paris moves countries toward less carbon intensive economies, further breaking the link between fossil fuel consumption and economic growth.</td>
<td>• Non-energy uses for gas and other fossil fuels (such as fertilizer) create lasting demand, even as products are phased out as energy sources.</td>
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**Scenarios**

The matrix, paired with further analysis, makes it possible to consider four different futures, or scenarios. Each scenario has particular implications for the LNG industry.

**Rise of the Machines**

Despite billions in subsidies for the development of renewable energy sources, the main driver of energy transition is technology, specifically the convergence of existing technologies for traditional renewables, transport options, big data and analytics, cloud computing, and radical shifts in long-distance electricity transmission capacity. By 2030, the unexpected direction of the evolution of the energy mix and demand make the need for an international consensus for carbon emissions with enforcement mechanisms less pressing. Per capita energy usage will increase, but global population is expected to peak in 2038 and renewable and low-carbon fuel sources will progressively reduce coal and oil use. This scenario is not without challenges as all societies will undergo major internal upheavals as automation and robotics displace the traditional labour force. Living standards around the world continue to converge, creating unrest within the traditionally most developed nations who have lost their perceived advantage compared to countries they've historically considered “developing nations”.

- **LNG Scenario**: In this future, LNG is used for both transport and electricity options as demand grows. LNG plants, FLNG, and shipping are nearly completely automated. Long-distance electricity transmission accelerates the shift away from coal and oil, which means that gas lives up to its reputation as a transition fuel. However, while gas demand remains strong for the 2030s and 2040s, the accumulated innovations mean that the transition to a decarbonised economy will occur well before 2100, and gas demand is expected to reach its peak by the 2060s.

**Deindustrialisation and Global Disorder**

After the Paris climate talks, there are diverging responses to reducing carbon emissions. Positions vary markedly as creeping protectionism is introduced, initially as green tariffs but then with blunter instruments. Declining economic growth and government policies in developed nations accelerate deindustrialisation and the shift away from coal. Countries turn inwards, likely using their natural gas domestically rather than exporting it. Developing nations take a different path, using various energy combinations. These nations initially avoid constraints on carbon emissions, but then pursue a belated shift to cleaner forms of fuel. As part of the more unstable global environment, terrorist proxies successfully destroy an LNG carrier and offshore platform. A number of countries with LNG terminals close to city centres halt the trade and LNG demand plummets for two to three years before assets are moved, hardened, and the community begins to accept the resumption of LNG imports.

- **LNG Scenario**: In this future LNG demand is volatile but will decline, even though overall gas use may continue to rise. The response to terrorist attacks will disrupt the LNG market. Under more protectionist arrangements, domestic gas policies force a redirection of gas output to domestic uses, even when this is not economically efficient.

**Decline and then resurgence**

There is no clear direction or pathway for the economy, and this results in an unstable global power structure. Global growth is patchy, there is significant volatility in commodity and financial markets, and developed nations that have failed to adjust to a more dynamic environment stagnate. This varied picture of growth does not preclude technological breakthroughs, but they occur less frequently and are difficult to deploy. The traditional competition between states continues. Some countries prosper in this new environment and by 2034 the world is quite different, but has not experienced a major conflict. Global-level environmental agreements have given way to more regional and local agreements and arrangements. As a result of the turbulence, some existing infrastructure is abandoned for cheaper, cleaner, and more efficient options. This speeds the shift away from coal, although oil demand grows for longer than expected. The adaption to climate change and energy use patterns occurs at the regional and local levels at different degrees and rates.

- **LNG Scenario**: After a protracted slump and temporary decline of LNG demand, which is most pronounced in 2028, LNG demand rebounds. In this scenario the LNG industry becomes increasingly dominated by government-related entities.
Small is Beautiful

The concept of economies of scale is turned on its head as nanotechnologies, 3D printing and miniaturisation revolutionise a number of industries, including natural gas and LNG. With new tools available and barriers to diffusion lifted, a widespread period of economic growth means that population peaks much earlier than expected (as widespread wealth encourages smaller families). Nations devolve political power to smaller units and demand growth for oil and coal slows with expected declines in demand by the 2040s. With innovation occurring at a faster rate, these smaller political units align their economies to their local environment and specialities. Many new products and energy-related tools begin to appear. The diffusion of new technology occurs between similar groups via electronic communication across continents, so adoption does not follow typical geographical movements. Declining energy costs break the link between higher demands for energy (improving lifestyles) and a degraded environment.

- **LNG Scenario:** As with other technologies, LNG offerings are miniaturised and created in modular format to be used in a wider range of applications. In this context, LNG becomes a key transition fuel for a longer period as oil and coal are progressively phased out. Natural gas demand for energy applications eventually declines, but its use in other industries means that it still has a key role in the economy.

Analysis

The results from our scenario process show that the LNG industry may be radically different by 2034. This could result in a much higher level of demand if LNG is used as a transition fuel for an extended period, or, if carbon emissions are predicted to peak in 2050, there may be a substantial ramp up in coal power generation in a temporary renaissance that would defer the uptake of gas. If the geopolitical scenario results in regional disruptions to markets, this could slow the growth of oil demand and gas could become a preferred fuel, able to command a strategic premium that stimulates investment.

Urbanisation in developing countries may force a fast switch from coal to gas in the next two decades, as was historically the case in some parts of Europe and North America in response to higher levels of particulate emissions and other pollutants and their impact on life expectancy in cities and standards of living generally. Furthermore, in mega-cities comprising tens of millions, there may be demand for different types of mini-LNG applications which encourage innovation, servicing not just traditional LNG importers but a wider number of Indo-Pacific countries that can unlock stranded or currently uneconomic resources.

Each country will have a different response to these changes. While Australia may become the leading LNG exporter during the 2020s, by 2034 it may lose this prize if the next wave of investment occurs in different jurisdictions.

5. Conclusions

Eisenhower famously said that “plans are useless, but planning is indispensable.” Although Eisenhower was referring to battle preparations, we contend that revisiting scenario methods that were once used with great success by the oil and gas industry will prove to be a useful planning tool. Through a robust use of scenarios, applying a longer time perspective, and considering an optimistic (but realistic) future, we conclude that analysts can gain new insights into the direction of the LNG industry. Like any consideration of future events, this process is imprecise. A more structured approach to establishing scenarios and predicting macro-trends will assist in highlighting future pathways for the industry. One shortcoming is that this approach relies on a qualitative analysis which is more an art than science. However, a planning process that includes a robust interaction with economists, industry specialists, and technologists can provide a window into future possibilities that enriches the work of both strategic analysts and economists.
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