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Repurposing Fossil Fuel Assets for a Low-Carbon World

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Executive Summary

The energy transition is about more than the move to low-carbon fuels. It also suggests the movement of capital, as energy investments both foreshadow and follow global initiatives to reach net zero, the negating of all greenhouse gas emissions produced by burning fossil fuels and other human activity in order to limit global warming.

Both dynamics are well underway: The International Energy Agency reports that, based on current policies, renewables will contribute 80% of new power capacity by 2030, with solar photovoltaic technologies alone accounting for more than half, while investment in clean energy is up 40% since 2020. That's not to say fossil fuels are dying – oil, natural gas, coal, and their derivatives currently meet 80% of global energy demand, enabled by specialized infrastructure and other assets valued at $30 trillion. Even under the most ambitious net zero scenarios, there will continue to be some demand for fossil fuels, especially for natural gas, which is the cleanest burning fossil fuel.

Nevertheless, demand is clearly reaching a plateau and will eventually decline, risking the abandonment of trillions of dollars in assets – including pipelines, boilers, gas turbines, transmission infrastructure, and storage facilities – well before the end of their useful lifespans.

Ironically, perhaps, the energy transition offers a solution, as many fossil fuel assets can be repurposed for the low-carbon energy value chain. That offers a dual benefit, reducing the cost of the transition to low-carbon energy systems while providing new life for assets that would otherwise sit idle, incurring decommissioning costs before their time.

In addition to physical plants and other infrastructure, industry assets include its skilled workforce and the knowledge and data generated by that workforce. Those, too, are translatable to the clean energy economy. Existing subsurface data used in oil and gas drilling can be used to assess the prospects for new geothermal developments, for example. Skills used by reservoir engineers are useful for geothermal energy and carbon dioxide sequestration, and mechanical engineering will be a key skill necessary for modifying turbines, boilers, and other equipment in any conversion from coal or natural gas to hydrogen, biomass, or other renewable energy sources.

Repurposing isn't a new idea. More than 120 coal-fired power plants in the United States were converted to burn other types of fuel, primarily natural gas, between 2011 and 2019, driven by stricter emission standards and the era's low natural gas prices. And a handful of clean energy conversions already are underway, notably several in the United States to produce clean hydrogen and use it to supplant fossil fuels in power generation and other activities, along with European efforts to replace coal-fired power plants with those using renewable biomass.

But if we are to take advantage of existing fossil fuel infrastructure to speed the energy transition while reducing the cost, repurposing efforts must move forward at an unprecedented scale. Certain criteria will be key in evaluating which assets are good candidates for repurposing, including:

- How compatible existing equipment and technologies are with potential new low-carbon technologies.
- The condition, location, and size of existing assets.
- What access the existing asset has to infrastructure, including pipelines, power transmission, river or ocean ports, rail infrastructure, roads, and water supply.
- A track record of regulatory compliance and a history of low environmental impact at an existing asset can decrease potential liabilities inherited by new operators/ownership.
- Availability of workers with construction, operations, and maintenance skills appropriate or adaptable to the repurposed asset.

Large scale repurposing won't happen overnight, and it won't be easy. Obstacles range from lagging technology development – many of the technologies needed for repurposing are still in the early stages – to the lack of governmental financial incentives, accelerated permitting, and job training programs to help the workforce transition. Others include:

- Uncertainty over government policy and regulations. Certainty is critical for investors considering repurposing an asset that might have a 40 or 50-year lifespan.
- The lack of workable permitting processes for new types of investments, with the flexibility needed for new situations. "Grandfathering" existing permits, for example, would allow repurposing to proceed without bringing everything on the site up to current code.
- There are no widespread and systematic policies in place to support developing a market for low-carbon products. Consumer resistance to paying a premium for low-carbon energy products could add to the challenges.

Key policy changes are needed to address those obstacles if repurposing initiatives are to proceed at a pace sufficient to both speed the clean energy transition and reduce its costs, while at the same time reducing financial losses and waste in the fossil fuel sector. Some form of carbon tax, placing a fee on carbon dioxide emissions, would encourage companies to find the most efficient ways to reduce emissions, shifting the focus to lowering emissions rather than choosing a "winning" technology.

Other recommended policy changes include:

- Permitting reform to streamline the permitting process, which plays a crucial role in regulating energy projects and ensuring environmental sustainability and transparency about other impacts. Many permitting processes involve different agencies, conflicting regulations, and indeterminate timelines. Proposals for streamlining include designating a lead agency and putting time limits on different permitting sets.
- Similarly, quickly establishing the new safety codes and standards that some repurposing projects will require – such as specifications for pipelines and storage facilities repurposed to carry hydrogen, ammonia, and carbon dioxide – will ease barriers and could reduce community resistance.
- Funding for research and development projects involving industry and academia can lower the financial barriers to exploring and implementing new technologies that could be used to repurpose existing assets.
- Governmental incentives, including but not limited to tax credits, can accelerate repurposing.
- Expanding the definition of "public use" in cases of eminent domain could encourage investment in projects including pipelines for hydrogen and carbon dioxide, as well as expansions of transmission capacity.

Background

Meeting current energy needs is heavily dependent on fossil fuels, with oil, natural gas, coal, and their derivatives supplying 80% of today's global energy demand[1]. Even as the use of renewable energy grows, particularly for power generation, complex upstream, midstream, and downstream oil and gas value chains deliver more than 60% of global energy supply, while coal and natural gas continue to play dominant roles in power generation[2].

The related fossil fuel infrastructure and other assets are estimated to be worth more than $30 trillion[3], a stark reminder of the complicated financial stakes as concerns about the warming climate spur the move to cleaner fuels.

The transition has already begun. Although demand for coal temporarily rose as natural gas prices surged after the Russian invasion of Ukraine in 2022, efforts to reduce climate-damaging emissions, coupled with the growth of clean-energy technologies, have led to predictions of a steady drop in demand for coal and other fossil fuels. The International Energy Agency predicts the share of coal, oil, and natural gas in the global energy supply will drop to 73% by 2030, spurred in part by the growth of solar photovoltaic technologies and a boom in electric vehicles.

This eventual plateauing and decline in demand for fossil fuels threatens to strand trillions of dollars in fossil fuel assets – including boilers, cooling systems, gas generators, and transmission infrastructure – before the end of their useful lives. The energy transition, as the world moves to a low-carbon energy system, both hastens the decline of these assets and offers a potential solution.

Investment in clean energy continues to surge, up 40% from 2020. Half of new U.S. car registrations in 2030 are projected to be for electric vehicles. Other parts of the world are seeing similar trends, from a renewed interest in nuclear energy in Korea and Japan to the growth of wind, solar, and electric vehicles in China.[4] While fossil fuels will remain a critical part of the global energy system for several decades, if not longer, the development of new clean energy value chains offers an opportunity to repurpose many of the fossil fuel assets at risk of otherwise falling into disuse.

Symposium Focus

The Gutierrez Energy Management Institute (GEMI) in the Bauer College of Business at the University of Houston held a symposium and workshop on the potential for significant repurposing of fossil fuel assets for a low-carbon economy in February 2024, seeking to deepen understanding of the drivers, opportunities, and challenges of repurposing those assets. The session included presentations summarizing recent graduate student research on the topic, followed by panel discussions and small group discussions of key questions.

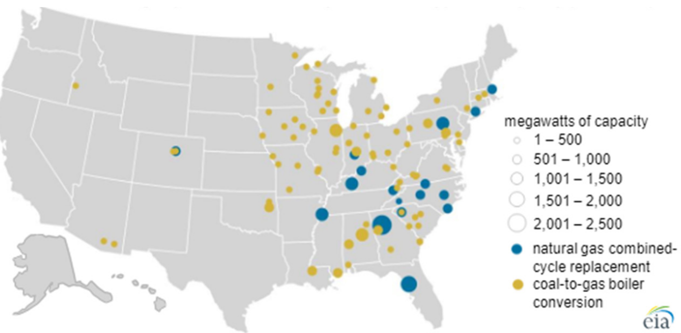
Participants included high-level energy executives, academics, and other energy thought leaders, with sessions conducted under the Chatham House Rule, used around the world to encourage inclusive and open dialogue in meetings. Its guiding spirit is to share the information you receive without revealing the identity of the source of the information or that of other participants.

This white paper is based on information from the symposium, along with additional research.

Asset Repurposing in the Past

The concept of repurposing energy assets isn't new. There is a substantial history in the United States of retrofitting coal-fired power plants to use natural gas as a fuel, driven by the implementation of the rules associated with the 1990 Clean Air Act Amendment, which focused on reducing sulfur and nitrogen oxides5. The expectation had been that coal-fired plants would install scrubbers and selective catalytic reduction equipment, but a significant number of the old coal plants converted to natural gas. Of the 121 U.S. coal-fired power plants repurposed to burn other types of fuels between 2011 and 2019, 103 were converted to or replaced by natural gas-fired plants, driven by the stricter emission standards, low natural gas prices, and more efficient new natural gas turbine technology.[6]

Figure 1: U.S. Coal-to-Natural Gas Plant Conversions by Type and Capacity (2011-2019)



Source: U.S. Energy Information Administration, Annual Electric Generator Report and Preliminary Monthly Electric Generator Inventory.

Rather than replacing the boilers, plants in some cases were able to install new burners or modify the existing equipment, preserving the generation capacity at a significant savings compared to building a new gas-fired plant. This shift from coal to natural gas is credited for most of the U.S. drop in carbon dioxide emissions from electricity generation[7], which dropped 32% between 2005 and 2019, with two-thirds of the decline attributed to the shift from coal-fired to natural gas-fired electricity generation, according to the Energy Information Administration.

This is an interesting example of how a new regulation drove repurposing in a very different direction than was expected.

Drivers of Repurposing

A primary incentive to repurpose an asset is to preserve the asset's economic value, allowing the asset owner to continue to reap the benefits of the equipment and related infrastructure. Finding a new use – converting from natural gas storage facilities to those that can store hydrogen, thermal energy, or compressed air energy, for example – allows the asset to continue to generate profits and preserve a company's position in a key energy product or geographic market. It also allows the company to defer decommissioning costs, a not insubstantial financial incentive.

The potential to reduce greenhouse gas emissions and preserve investors' financial stake in these assets aren't the only benefit to consider when deciding to undertake such a project. It can preserve jobs and tax revenues for local communities, as well as potentially benefiting energy security through boosting the supply of low-carbon energy.

Of critical importance to society at large, a broad repurposing of these otherwise potentially stranded assets offers a chance to reduce the overall cost of the transition to a low-carbon energy system. Exactly how much that transition will cost has been debated, but it's expected to require an investment of as much as $200 trillion between now and 2050 to reach net zero[8]. This investment will be required to create new value chains – production, transportation, storage, and use – for all facets of the transition, including low-carbon electricity; low-carbon hydrogen; carbon capture, use, and storage; low-carbon synthetic liquid fuels; and advanced biofuels.

Many fossil fuel assets can be reused in these new low carbon energy value chains. Coal-fired plants can be converted to biomass, wind, or solar generation, hydrogen, production or energy storage facilities. Pipelines originally designed to carry oil or natural gas might be retrofitted to carry hydrogen, which produces no carbon dioxide when it burns. These projects will require substantial investment but have the potential to save both time and money, costing less than building new, starting with land acquisition, and accelerating the scale-up of these new value chains.

Repurposing the assets will create employment opportunities in construction, engineering, and related industries as the asset is adapted for new use. Once completed, it may require additional staffing, although employment levels will vary depending on the type and scale of the project.

Good Candidates for Asset Repurposing

Not every generating plant, drilling rig, or pipeline will be a candidate for a role in the low-carbon future. A number of factors will determine whether it is financially feasible to transition assets from fossil fuels to a low-carbon or net zero use, including:

Asset Condition and Size:
Sites with equipment in good condition can reduce the cost and uncertainty of repurposing. Site size is important, as well, in determining the ability to build a repurposed asset at critical scale.

Strategic Location and Access to Infrastructure:
Direct access to various forms of infrastructure can significantly

reduce repurposing costs. This includes access to feedstocks and product markets via pipelines, power transmission, major river or ocean ports, and rail infrastructure. Adequate road access and water supply is also important.

Technological Adaptability and Versatility:
Compatibility of existing equipment and technologies with potential new low-carbon technologies makes a site more attractive for a variety of repurposing options.

History of Environmental and Regulatory Compliance:
A track record of regulatory compliance and a history of low environmental impact will decrease the potential liabilities inherited by new operators/ownership.

Critical Skills Availability:
An available workforce with construction, operations, and maintenance skills appropriate or adaptable to the repurposed asset will make a project more feasible.

Government Policy Support:
Specific government support in terms of financial incentives, accelerated/flexible permitting, and job training will increase the attractiveness of a site.

Community Engagement and Stakeholder Collaboration:
Positive historical community relationships, along with support for the repurposing initiative, is critical.

Likelihood of Necessary Investment in the New Value Chain:
Many assets will be dependent on investments upstream or downstream of the asset to be successfully repurposed. For example, repurposing a gas-fired power plant to hydrogen or hydrogen blends depends on sufficient production of low-carbon hydrogen which will be available to the site.

Plants located along the Mississippi River illustrate some of the opportunities for low-carbon energy production, ranging from power generation using biomass or waste, delivered from across the Midwest via barge or rail, to wind or solar electricity generation. Existing process equipment could potentially be leveraged for low-carbon energy production, including hydrogen, biogas, synthesis gas, or liquid biofuels. That also holds true of outbound transportation logistics, including pipelines and river barges. The large number of processing plants currently operating along the Mississippi suggests a skilled labor force is available.

Repurposing Options for Different Fossil Fuel Assets

There are likely to be good repurposing opportunities across the fossil fuel value chains (Figures 2 and 3). Some of these repurposing projects would require major investment, but others would be relatively inexpensive, involving minor equipment replacement or adjustment.

Figure 2: Options in the Oil and Gas Value Chains

Asset Type	**Repurpose**
Offshore Production Facilities	Solar generation, wind generation, wave/tidal generation, CO^2 sequestration
Onshore Production Facilities	Geothermal generation, CO^2 sequestration, thermal energy storage, compressed air energy storage, direct lithium extraction
Drilling and Completion Equipment	Geothermal generation, CO^2 sequestration, direct lithium extraction
Pipelines	Liquids - biofuels, synthetic hydrocarbons Gas - hydrogen, hydrogen blends, biogas, syngas, CO^2
Processing Plants	Refineries - crude to chemicals, biofuels, synthetic liquid hydrocarbons, biogas, syngas, olefins (FCC), aromatics (reforming)
Storage Facilities	Liquids - biofuels, synthetic hydrocarbons Gas (salt domes) - seasonal hydrogen storage, CO^2 sequestration, compressed air energy storage/generation LPG - ammonia
Terminal Facilities	Refined products - biofuels, synthetic hydrocarbons LPG - ammonia LNG - hydrogen, ammonia, bio-methane, synthetic methane
Shipping	Refined products - biofuels, synthetic hydrocarbons LPG - ammonia

Source: UH Bauer Energy Research

Figure 3: Options in Power Generation and Mining Value Chains

Asset Type	Repurpose
Coal and Gas Power Plants	Generation - Solar, wind, biomass, waste, small modular nuclear, hydrogen/ammonia co-firing, coal to abated gas firing Hydrogen production Energy storage - battery storage, thermal storage
Coal Mines	Generation - solar generation, wind generation Energy storage - pumped hydro storage

Source: UH Bauer Energy Research

For example, there are a number of promising opportunities in both onshore and offshore upstream and midstream.

Figure 4: Examples of Potential Repurposing of Existing Assets

Onshore O&G production sites repurposed for geothermal energy production.

Offshore O&G production platforms repurposed for wind and solar power generation

Gas pipeline networks repurposed for hydrogen or CO_2 transport

Drilling support vessels repurposed for offshore aquaculture support

Source: Akinola Idowu, UH Bauer Energy Research

The reuse of equipment will vary considerably in different repurposing cases. For example, much of the equipment in coal and gas power plants is likely to be reusable as shown in Figure 5.

Figure 5: Potential Reuse Strategies for Coal & Gas Power Plants

Coal-Fired Power Plants	Natural Gas-Fired Power Plants
• Boilers • Cooling Systems • Transmission Infrastructure • Waste Management • Labor and Workforce • Regulatory Compliance and Permits	• Gas Turbines • Generators • Heat Recovery Steam Generators (HRSGs) • Cooling Systems • Transmission Infrastructure • Gas Storage Facilities (for peaking plants)

Source: Manish Khera, UH Bauer Energy Research

Timing of Repurposing

Assets can be repurposed at different life stages:

End of Life:
At some point, resource depletion assets such as upstream oil and gas production facilities reach the end of their economic life. In many cases, these assets are shut down and face decommissioning and remediation. Repurposing can preserve some economic value and delay retirement costs.

Life Extensions:
About 36% of global power is still generated by coal-fired power plants[9]. Many of those, particularly in developed countries, will be shut down within the next 15 to 20 years, either due to aging equipment or to comply with emission regulations. For example, half of all U.S. coal plants are expected to close by 2026, just 15 years after the peak in 2011[10]. Many of those plants are mid- size power plants, generating between 300 MW and 500 MW. There are several repurposing options that can extend asset life while significantly reducing emissions.

Other types of assets including refineries, pipelines, and storage and terminal facilities, even if they don't face shutdown because of aging equipment condition or limits on emissions, face lower utilization and declining value due to the plateauing and eventual decline in fossil fuel demand. Repurposing these assets can extend their lives and preserve economic value.

Expanding Use:
While most opportunities involve an end of life or life extension repurposing, there are also opportunities to add low-carbon energy production to existing fossil energy production. For example, wind or solar generation could be added to an existing offshore platform or onshore field while it is still producing oil and gas. Wind or solar could be added to an existing gas-fired power plant to provide both baseload and intermittent power supply.

U.S. Energy Secretary Jennifer Granholm used her speech at CERAWeek 2024 in part to call on the oil and gas industry to take the lead in growing geothermal energy, noting that geothermal uses "all the skills and infrastructure of traditional oil and gas drilling."[11] A small number of companies have begun drilling wells, using both conventional drilling techniques and hydraulic fracturing, to produce geothermal energy.

There are many promising repurposing projects already underway, especially in the coal and gas power sectors, as shown in Figure 6.

Figure 6: Repurposing Projects Underway

Coal/Natural Gas to Renewable Energy (Solar & Wind)
- Moss Landing Power Plant, California, USA: Gas to Electricity Storage
- Huntly Power Station, New Zealand: Gas to Solar & storage (4 MW)
- Former Fossil Fuel Sites in Germany: Coal to Solar (25 MW)
- Redcar and Cleveland, United Kingdom: Coal to Wood pallets
- Repurposing Coal Mines in Australia: Coal to Wind farms

Coal to Biomass or Waste-to-Energy
- Ruien Power Plant, Belgium: Coal to Biomass
- Langerlo Power Plant, Belgium: Coal to Wood pallets
- Ironbridge Power Station, United Kingdom: Coal to Biomass
- Ferrybridge Power Station, United Kingdom: Coal to Waste wood
- Fortum Power Plant, Finland: Coal to SRF (Solid Recovered Fuel)

Transformation of Coal/Natural Gas to Energy Storage Facilities
- Moss Landing Power Plant, California, USA: Lithium-Ion Battery storage (400 MW) – World's largest energy storage facility
- Huntstown Energy Storage Facility, Ireland: Peat-fired to Storage

Transformation of Coal/Natural Gas for Hydrogen Production
- Gasunie Hydrogen Services, Netherlands: Gas to Hydrogen storage
- Lausward Power Plant, Germany: CHP and Hydrogen production
- Lingen Hydrogen Plant, Germany: Gas to Green hydrogen facility

Source: Manish Khera, UH Bauer Energy Research

Several promising examples of clean energy conversions in the

United States have focused on transforming natural gas power plants into hubs for green hydrogen – hydrogen made by splitting water into oxygen and hydrogen using renewable energy. Several power plants in the United Kingdom have converted from coal to biomass.

At the Intermountain Power Plant in central Utah, work is underway on a project that, when complete, would replace an aging coal-fired power plant with one using a blend of hydrogen and natural gas. The hydrogen would be produced using solar and wind power when demand for electricity is low, storing it as hydrogen gas in giant caverns created from a geological salt formation. Commissioning is expected in 2025; ultimately the project is expected to run on 100% hydrogen.[12]

Across the Atlantic, in the United Kingdom, four of six boilers at the Drax Power Station in North Yorkshire have been converted from coal to biomass, using compressed wood pellets, a move the company says has reduced its carbon emissions by 80%; the plant now produces 11% of the UK's renewable power. The remaining two coal units ceased production in 2021[13].

Repurposing Beyond Physical Assets

Successful repurposing requires more than just finding a new use for physical infrastructure. It should take advantage of not only the "hard" physical investment but also companies' "soft" investments. That includes:

Repurposing Fossil Workforce Skills:
When companies invest in a new asset or new region, they invest in more than the physical plant. They invest in training workers, and, especially in remote places, in other infrastructure including roads, ports and living facilities. They build relationships with communities and with all levels of government, in the process gaining knowledge that is valuable in maximizing the value of the asset. Repurposing can leverage these non-plant assets. Repurposing a pipeline, for example, would require many of the same skills but could require workers to learn new safety procedures and new design codes. Importantly, retraining workers with the skills needed for the clean energy transition maintains the employment base and the associated economic impact on the local community, which is a key part of a just transition.

Repurposing Fossil Fuel Goods and Services Technology:
Many repurposing proposals will provide the opportunity for using existing fossil fuel equipment or services. For example, advanced geothermal or enhanced geothermal technologies are emerging that use existing shale technologies, including horizontal drilling and hydraulic fracturing[14]. These oil and gas services can be deployed along with the new geothermal technology to produce geothermal energy in locations around the world, not just where there are super-hot resources close to the surface, as is required for conventional geothermal. Similarly, producers of gas turbines can redesign some products to fire hydrogen or hydrogen blends[15].

Repurposing Rights of Way:
The fossil fuel industry, especially the oil and gas midstream industry, own significant rights of way, which can potentially be repurposed for new uses[16], provided the right of way agreements are amenable or can be renegotiated.

Repurposing Data and Knowledge:
The fossil fuel industry has significant sources of data and knowledge, which will potentially be valuable in repurposed assets. Existing subsurface data can be used to assess the prospects for new geothermal developments or depleted reservoir sequestration in previously mapped areas. Knowledge in many engineering areas is transferrable, i.e., reservoir engineering (for geothermal, carbon dioxide (CO_2) sequestration, thermal storage); chemical engineering (for hydrogen and ammonia and biofuels production, pipeline flows) and mechanical engineering (combustion modifications for turbines and boilers, materials for hydrogen service).

Challenges and Barriers

Despite the many potential advantages to be found in repurposing conventional fossil fuel infrastructure and other assets for the energy transition, there are substantial challenges ahead. These range from the regulatory, adhering to environmental regulations and permits, to community concerns and the difficulty of navigating changing global market trends.

For example, power plant conversions will require changes to grid connections and other technological adaptations. Projects may raise questions about zoning and other land use regulations, along with strategies for ensuring worker retraining and minimizing job losses.

Key factors to consider in repurposing fossil fuel assets for a low-carbon energy system include:

Pace and Funding of New Technology Development:
Many technologies that potentially will be used in repurposing are not yet ready for deployment. While the U.S. government and those of other nations currently fund some technology development and have supported some initial investments needed for the transition, government funding by itself is unlikely to be sufficient to prepare the technology for broad deployment. Energy companies will have to make significant investments to bring these technologies to commercial viability.

Uncertainty over Government Policy and Regulations:
Repurposing an asset that might have a 40 or 50-year lifespan makes assumptions around the evolution of government policy and regulations that will determine whether the economics of investing in repurposing make sense. Existing incentives, mandates, and regulations could change significantly, affecting the ultimate return on the repurposing investment.

Workable Regulations:
Getting appropriate regulations in place will be challenging. Ideally there would be political agreement on a goal (i.e., reducing emissions to certain levels), with industry, academia, and communities freed to develop and implement the best solutions.

Effective Permitting Processes:
Implementing workable permitting processes will be a challenge, as well. Regulators will have a learning curve on regulating new technologies, such as the subsurface regulation of geothermal energy. In addition, most regulatory processes lack the built-in flexibility or ability to address new situations. For example, many regulations don't address the potential benefits of repurposing vs. required decommissioning of an offshore platform. There are likely to be disputes over the validity of existing permits covering repurposing. If permits cannot be "grandfathered" for repurposing, everything on the site could be required to meet current code. Repurposing could also run afoul of zoning and land use restrictions.

Addressing Existing Asset Liabilities:
Addressing the existing liabilities of a planned repurposing site will be a major challenge. There may be uncertainty about what level, if any, of remediation is required prior to repurposing. This introduces significant uncertainty in the overall cost of the project, making it difficult for companies to have confidence in the likely return on investment.

One solution might be a government program to cap liability for assets being repurposed. This might be done in conjunction with government funding support for brownfield redevelopments, which has been available to varying extents over the last 30 years.

Low-Carbon Product Market Development:
Eliminating any requirement for direct linkage of a low-carbon fuel from its consumption could significantly accelerate market development. In several of the early low-carbon product markets, the ability to separate production and consumption has been important for the development of the market. An example is the Texas retail electricity market. When you buy low-carbon electricity, low-carbon electrons are not necessary supplied to you[17]. You might receive electricity from coal or gas power plants, but your electricity provider is required to purchase renewable energy credits, at least theoretically supporting the green energy market. Another example is the renewable natural gas (RNG) market in California. Currently, the Low Carbon Fuels Standards (LCFS) regulations allow for RNG to generate LCFS credits for production outside California if (1) the RNG is injected into the common carrier natural gas pipeline system that reaches the state and (2) a corresponding volume of fuel is matched to compressed natural gas (CNG) or liquefied natural gas (LNG) dispensed in California for transportation use[18]. That is not the case with liquid biofuels like biodiesel or ethanol, where a producer must physically deliver the biofuels to California. Hydrogen would be likely treated similarly to biofuels.

Public Support:
Lack of consumer willingness to pay a premium for low-carbon energy products or accept a carbon tax could add to repurposing challenges. The public in Europe has been more accepting of in terms of a carbon tax and the new carbon border adjustment mechanism.

Stakeholder Concerns:
Community groups, local governments, and employees may have significant concerns about the impact of repurposing a specific asset, concerning jobs, tax revenues, safety, or emissions. An initial challenge will be to manage concerns around the ancillary impacts of repurposing assets. These projects bring increases in traffic, noise, dust, and road safety challenges due to heavy truck traffic during the construction phase.

Sharing Information and Data:
There are likely to be significant benefits from access to available data or to facilitate exchanges of data and knowledge expected as part of repurposing, which will expand the collective knowledge of industry and stakeholders. This is particularly important regarding the environmental and safety aspects of new technologies and repurposing approaches. Take a "smart pig" used in the pipeline industry. These devices collect information on conditions inside a pipeline. They are very "smart" – that is, the sensors and other technologies they employ allow them to gather sophisticated information – but they can only identify what they've seen before. They have no ability to identify a condition if they've not seen it before. That makes it critical that information gleaned from operating the smart pig through countless pipeline inspections is gathered in an accessible database, allowing users to learn from a wider range of experiences.

Preserving Necessary Fossil Fuel Infrastructure:
Natural gas is the cleanest fossil fuel in use today. Even under the most aggressive de-carbonization scenarios, there will still be demand for natural gas in 2050[19]. Repurposing natural gas pipelines to CO_2 or hydrogen is an option for an individual asset, but repurposing too many of the pipelines could leave us short of the natural gas infrastructure we still will need.

Recommendations to Accelerate Repurposing

Smart policies can accelerate the move toward repurposing fossil fuel assets, speeding the transition to low-carbon energy while cutting the cost of the energy transition. As an example, Energy Secretary Jennifer Granholm has announced that federal oil and gas leases that are converted to geothermal leases won't have to go undergo permitting review.

Other policies needed to boost the repurposing movement include:

Carbon Taxes:
Carbon taxes involve placing a fee on CO_2 emissions. These encourage companies to find the most efficient ways to reduce emissions without choosing a “winning” technology. They also ensure that customers incorporate the cost of carbon emissions into purchase decisions.

Permitting Reform:
Permitting plays a crucial role in regulating energy projects and ensuring environmental sustainability and transparency about other impacts of a repurposing investment. Many permitting processes involve different agencies, conflicting regulations, and indeterminate timelines. Proposals for streamlining include designation of a lead agency and putting time limits on different permitting sets. Streamlining the permitting process can significantly reduce the time involved in repurposing projects.

Research and Development Grants:
In addition to conducting research in government labs, providing research funding to universities and companies can lower the financial barriers to exploring and implementing new technologies for repurposing existing assets.

Government Incentives:
Governments can make different types of incentives available to accelerate repurposing. At the federal level, the U.S. government has relied mainly on tax credits to support investments in facilities using new low-carbon technologies[21]. Specific additional incentives on brownfield investments would accelerate repurposing.

Accelerated Establishment of Codes and Standards:
Several repurposing options will require new safety codes and standards. These could include specifications for pipelines and storage facilities for hydrogen, ammonia, and CO_2. Accelerating new standards could reduce community resistance to these repurposing options

Expanded Eminent Domain:
Expanding the definition of “public use” could accelerate investment in hydrogen and CO_2 pipelines and power transmission capacity.

Conclusion

The eventual plateauing and decline in demand for fossil fuels as the world moves to a low-carbon energy system threatens to strand trillions of dollars of fossil fuel assets before the end of their useful lives. Fortunately, the development of new clean energy value chains offers the potential to repurpose many of these assets. This repurposing could reduce the cost and time required for the energy transition. It could also maintain the value of fossil fuel assets for owners.

Finally, countries and communities can use repurposing to maintain jobs, tax revenues, and energy security while reducing emissions and other environmental impacts of energy facilities.

NOTES

[1] IEA World Energy Outlook 2022

[2] IEA World Energy Outlook 2022

[3] Decline and Fall- The size and vulnerability of the fossil fuel system, Carbon Tracker, June 2020

[4] IEA World Energy Outlook 2023

[5] 1990 Clean Air Act Amendment Summary, U.S. Environmental Protection Agency website

[6] U.S. Energy Information Administration, Today in Energy, August 5, 2020

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