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Untangling 'Stranded Assets' and 'Carbon Lock-In'

What are the risks associated with new gas-fired power in developing economies, and how can we mitigate them?

In the face of intensifying climate change impacts, we must shift decisively away from unabated fossil fuels. At the same time, many of the world's poorest countries (most of which emit very little), must end chronic energy poverty as quickly as possible in order to improve lives and employ their growing populations. This creates exciting opportunities to build out power systems in new, cleaner ways. But it also creates tension – as countries, investors, and development partners debate whether, how, and under what circumstances to support new gas-fired infrastructure as part of an energy transition.

First, why would a low-income country even consider gas-fired power?

The costs of wind and solar have fallen dramatically - and most projections agree that renewable energy will supply the bulk of future electricity in developing economies. That said, some energy-poor countries, facing rapidly growing demand and current market limitations, see strategic near-term development of gas-fired power as a way to:

- **Provide firm power to meet immediate needs and balance expanding fleets of variable wind and solar generation.** Ideally, variable renewable power can be balanced with firm low-carbon sources like geothermal, hydropower or nuclear – and/or with battery storage. But in many emerging and frontier markets, these sources are still limited: many lack geothermal and hydropower resources, nuclear is not currently viable, and storage solutions are not yet affordable at the scale required, or become cost-prohibitive at durations longer than a few hours. In this context, dispatchable gas-fired power can provide power now while enabling the expansion of wind and solar deployment.
- **Power industry.** Industrial and manufacturing processes use huge quantities of heat, representing about a quarter of total world energy use. Many developing economies seeking to grow these sectors use natural gas-fired combined heat and power (CHP) facilities to enable efficient co-production of both electricity and heat. Available alternatives to generate necessary heat inputs are either more carbon intensive (in the case of diesel and coal) or not yet commercially viable – particularly in emerging markets (in the case of green hydrogen). Biomass can have lower life cycle emissions, but comes with high air quality impacts and the potential for significant impacts on local ecosystems.
- **Meet other downstream uses.** Although this analysis focuses on gas for electricity production, many countries also consider downstream natural gas to be critical – at least for now – to petrochemical production, fertilizer, and cleaner cooking.

Three major risks

Skeptics of financing gas-to-power projects in emerging markets frequently cite two related (but distinct) concerns: 'stranded assets' and 'carbon lock-in'. What do these concepts actually mean, what danger do they pose, and to whom?

The Risk of Stranded Assets

An asset becomes stranded when it can no longer earn a return on investment, due either to economic factors (e.g. market dynamics make the asset too expensive to operate profitably) or regulatory factors (e.g. policy interventions limit demand or preemptively curtail the asset's use). For example, a gas-fired power plant might become 'stranded' if operating costs increase dramatically and the plant can no longer run profitably – or if the government decides it must shut-down the plant early in order to meet its climate objectives. A world with more stringent carbon policies will generally increase stranding risk.

The Risk of Carbon Lock-In

Carbon lock-in refers to the concern that investments in carbon-intensive infrastructure today will delay or foreclose a clean energy future by making it too difficult or too expensive to transition to alternative energies, thereby 'locking' a country into a fossil fuel-dependent development pathway.

The Risk of Both

In some ways, the risks of lock-in and stranding are mutually exclusive: generally, you would expect lock-in to occur only when the asset is economically viable, which implies it's *not* stranded. But in certain cases, an asset that is no longer economically competitive could be kept running (for example, for political reasons) – locking the system into both continued emissions and an economically inefficient generation source.

These risks are lower for downstream gas than for other types of gas infrastructure

The severity of these risks varies significantly, both by technology and by segment of the value chain. Downstream gas infrastructure (including gas-to-power) is significantly less impacted by both stranded asset and carbon lock-in risk than upstream or midstream infrastructure. Table 1 broadly assesses risk across the main types of natural gas infrastructure based on each asset's payback time (e.g. a project with a shorter payback period is generally less likely to be stranded) and each asset's ease of adaptation to a zero-carbon future (e.g. technology with options for fuel switching and/or carbon capture are less likely to become stranded or to lock-in long-term emissions).

TABLE 1: Illustrative risk assessment of various types of gas investment

	INFRASTRUCTURE	INITIAL INVESTMENT	PAYBACK TIME	EASE OF ADAPTATION TO A ZERO-CARBON FUTURE	MEANS OF ADAPTATION TO A ZERO-CARBON FUTURE
Upstream	Gas field	High	Long	Low	CCS
Midstream	Import terminal (fixed)	High	Long	Low	CCS
	Import terminal (FSRU)	Medium	Medium	Medium	CCS / relocation
	Processing plant	High	Long	Low	CCS
	Storage facility	High	Long	Low	CCS
	Trunk pipelines	High	Long	Medium	CCS / H2 blending
Downstream	Gas distribution lines	Medium	Medium	Medium	CCS / H2 blending
	Power plant (Combined Cycle Gas Turbine)	Medium	Medium	Low	Design for dual fueling
	Power plant (Open Cycle Gas Turbine)	Low	Short	Medium	Design for dual fueling
	Power plant (flexible fuel generator)*	Low	Short	High	Change fuel
	Petrochemical plant	High	Medium	Low	CCS
	Factories using gas for process heat	Medium	Short	Medium	CCS / Change fuel

* For example: https://www.mainspringenergy.com/technology/.

Options to mitigate the risks for gas-to-power investment

The right policy interventions depend on which risk needs to be addressed and who needs to be protected. Let's explore three scenarios:

	WHAT WOULD HAVE TO HAVE HAPPENED	POLICY IMPLICATIONS
Scenario 1: Stranded Asset – Gas-to-power plant becomes stranded	Market forces change (e.g. gas prices rise, electricity prices drop), or the government takes action to close the plant early – meaning the plant can no longer operate profitably.	**Policy Priority:** Protecting investors **Policy Options:** 1. Develop the asset with an early transition in mind 2. Use DFI guarantees and/or insurance products to protect the private sector
Scenario 2: Carbon Lock-In – Gas-to-power investment locks the country into a high-carbon future	Market forces remain largely the same, and gas-to-power remains price competitive, allowing the plant to operate profitably over the duration of its planned economic life.	**Policy Priority:** Facilitating transition away from unabated gas-to-power **Policy Options:** 1. Make parallel investments in infrastructure that enables timely transition to a high-RE system (e.g. T&D, storage) at the end of the plant's economic life 2. Transition the asset early (e.g. to hydrogen) 3. Add carbon capture
Scenario 3: Both – Gas-to-power plant can't operate economically – but still locks the country into a high-carbon future	This is the worst of both worlds. Economic and/or regulatory forces mean the plant can't operate profitably. But the government feels trapped (either because it needs the electricity and can't quickly replace it, or by political forces) and decides to prop up the plant with subsidies. The country ends up saddled with an emissions-intensive plant that drains public resources.	**Policy Priority:** Avoiding economic harm to the country and facilitating a transition away from unabated gas-to-power **Policy Options:** 1. Use public and/or philanthropic money to buy-out gas-fired assets and shut them down early 2. Adequately support transition planning to alleviate political pressures

Key Takeaways for Policymakers

Ultimately, while the risks associated with 'stranded assets' and 'carbon lock-in' are very different, the strategies to mitigate them are very similar.

- **Distinguish the risks for upstream versus downstream.** The question of whether, how, and under what conditions to support new gas exploration and extraction should be distinct in policy discussions from those related to new gas-fired power plants. This is especially true in emerging and frontier economies where the need for electricity is both urgent and severe, gas extraction has mostly been for international export, and available alternative clean firm power sources are limited.
- **Start with the specific role gas-to-power is intended to serve:** This will largely determine the most appropriate generation technology, and therefore the specific financial and sectoral risks faced. Open-cycle gas turbines have low capital costs and can therefore break even on a relatively short time horizon, reducing investment risk. And, in a high-renewables system they can provide critical reliability services by running only when there isn't sufficient renewable power available, which actually supports a renewable energy build-out in the medium-term. While open-cycle gas turbines are technically less efficient than combined cycle, their low-fixed cost character could make them *more* compatible in a clean energy transition.
- **Build out the energy system in anticipation of a high renewables future:** Natural gas plants can help meet immediate electricity needs, but investment in the hard and soft infrastructure to ultimately enable a zero carbon power system must also happen *now*. Depending on the country, this might mean developing significantly more T&D, building out ancillary services for renewable energy management, or investing early in hydrogen-based downstream uses.
- **Enact specific policy and regulatory measures to ensure that any gas plants built today are integrated in a longer-term plan for decarbonization**. Whenever possible, limit the duration of a plant's life by prioritizing technologies that can be paid back more quickly, or can be converted to use zero-carbon synthetic fuels or hydrogen.

Conclusion: Many countries aim to utilize gas in their transition to a low carbon energy system, yet fears of stranded assets or carbon lock-in are often cited as a rationale for ending public investment in fossil fuels. Disentangling the value chain and the precise risk takers can help to guide policy that maximally supports both objectives.