Gas Pressure: Exploring the case for gas-fired power in South Africa

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31 March 2022

IISD
International Institute for Sustainable Development

This presentation is a summary of the report

Available at:

https://www.iisd.org/publications/report/south-africa-no-need-for-gas

Why are we looking at gas-fired power?

A. Gas-to-power as an anchor tenant for gas industry?

Without demand, it is difficult to develop supply and without supply it is difficult to develop demand.

“One way of breaking this impasse is to create significant “anchor” gas demand through the development of a gas-to-power programme.”

Source: South African Gas Master Plan Consultation Document

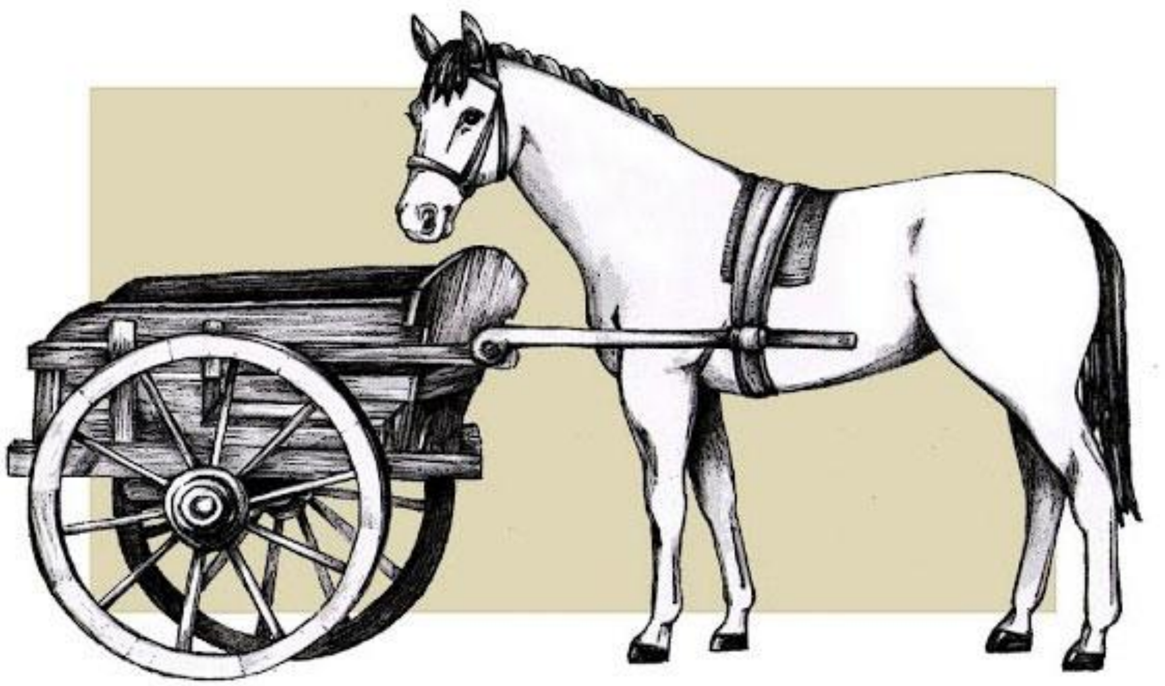


Image: https://dsm-llc.com/putting-the-cart-before-the-horse-small-business-edition/

South Africa should **first** objectively analyze the merits of gas-to-power versus alternatives that can fulfill the same function.

Gas-to-power should **not** be used to catalyze development in the broader gas industry, if it is not the best option for the power sector.

B. South Africa's ambition in terms of gas-to-power

- Integrated Resource Plan 2019: **3000 MW** gas or diesel by 2030
- Proposed new projects that have been granted an environmental authorization, or were still in process during 2021: >**14 000 MW***

* Including Richards Bay 6520 MW (Phinda, Eskom, Nseleni, RBG2P2), Coega Development Corporation 3000 MW, Saldahna 1500 MW (AMSA), Atlantis 1500 MW, Risk Mitigation Independent Power Producer Procurement Programme 1418 MW. List is not exhaustive

There appears to be appetite for a **large** investment in **new** gas-to-power, but is this the best decision for the country now?

Name

Event

Date

Outline

1. Introduction
2. Status quo of gas-to-power in South Africa
3. Risks of gas-to-power investment
4. Alternatives to gas-to-power are improving
5. SA power system can meet demand to ~2035 without gas supply
6. Focus on short-term priorities and knowledge gaps
7. Conclusions

1. Introduction

Gas turbine types

Open-cycle gas turbines (OCGTs): Simple combustion process - residual heat is lost, rapid response.

Combined-cycle gas turbines (CCGTs): More complex combustion process - residual heat is recovered, slower response.

Gas turbines, despite name, can run on liquid fuels

1. Introduction

Functional categories for utility scale facilities

Bulk supply

Significant or majority proportion of total electricity generation ->CCGTs

Peaking

Daily spikes of high electricity demand, short periods (minutes to hours) ->OCGTs

Balancing and backup

Respond to changes in supply or demand, longer periods than peaking (hours to days)

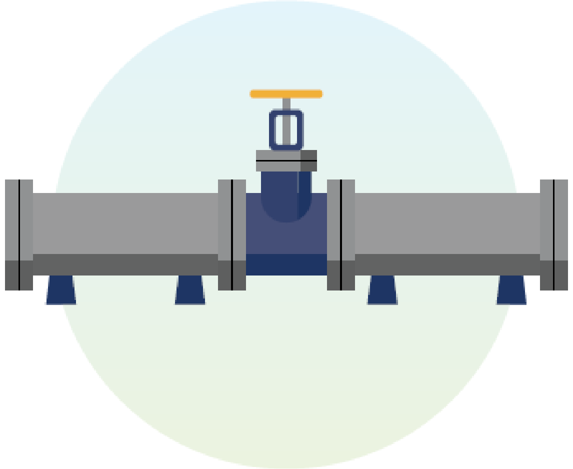
->OCGTs, CCGTs

2. Status quo of gas-to-power in South Africa

1

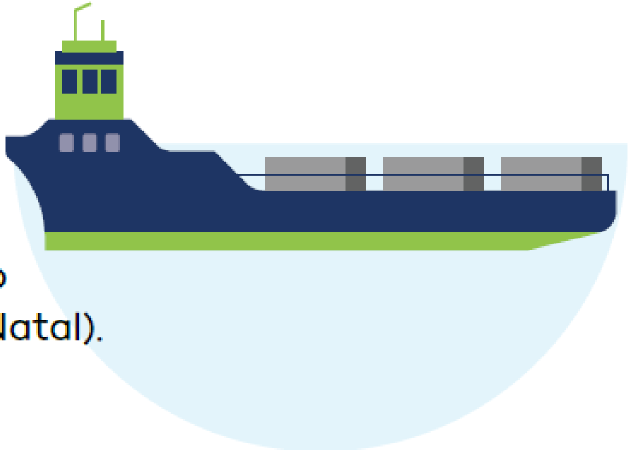
Gas is not yet used for utility-scale electricity production.

Gas use is almost entirely for industry, mainly the production of synthetic fuels.



2

Gas supply relies on overland piped imports from Mozambique, but future supply options (domestic offshore or land imported) remain on the drawing board.



3

There is no existing infrastructure for large-scale liquefied natural gas (LNG) importation via the sea.

Existing infrastructure for inland piped gas is limited to three provinces (Mpumalanga, Gauteng, and Kwazulu Natal).

4

Several important gas-related plans and policies are still under development, require updating, or have not been implemented.

Overall, the policy framework is incomplete and insufficient to guide sectoral development—there is no Integrated Energy Plan (IEP) and a Gas Master Plan (GMP) has still not been completed.

5

Gas is often promoted as a way to complement variable energy sources, but only a tiny fraction of the electricity supply currently comes from variable renewable energy (VRE).

Electricity supply is dominated by dispatchable technologies (coal, nuclear, and liquid fuels) at over 93%, while variable sources, mainly wind and solar, account for only about 5%

2. Status quo of gas-to-power in South Africa

- There is a push for a **high level of utilization**

  - Risk Mitigation Programe: Eskom would need to pay for a minimum of 50% of the net available capacity each year, for a 20 year period.

3. Risks of gas-to-power investment

1. **Gas-to-power value chain contributes significantly to climate change.**

- Methane, then main component of natural gas, has a global warming potential about *85 times* that of carbon dioxide over 20 years.

- Value chain analysis: **methane leaks must be added to the CO2 released from burning of gas**:
  - means that electricity produced from gas could have comparable or *worse* GHG emissions than that produced from coal when analyzed on a 20-year basis.

3. Risks of gas-to-power investment

2. Increasing international pressure to move away from gas due to climate impacts.

- Bans on exploration and extraction
- International Energy Agency: “no new investments in oil, gas and coal”
- Coalitions: e.g. Beyond Oil and Gas Alliance
- Multilateral agreements: e.g. Methane Pledge at COP 26

3. Risks of gas-to-power investment

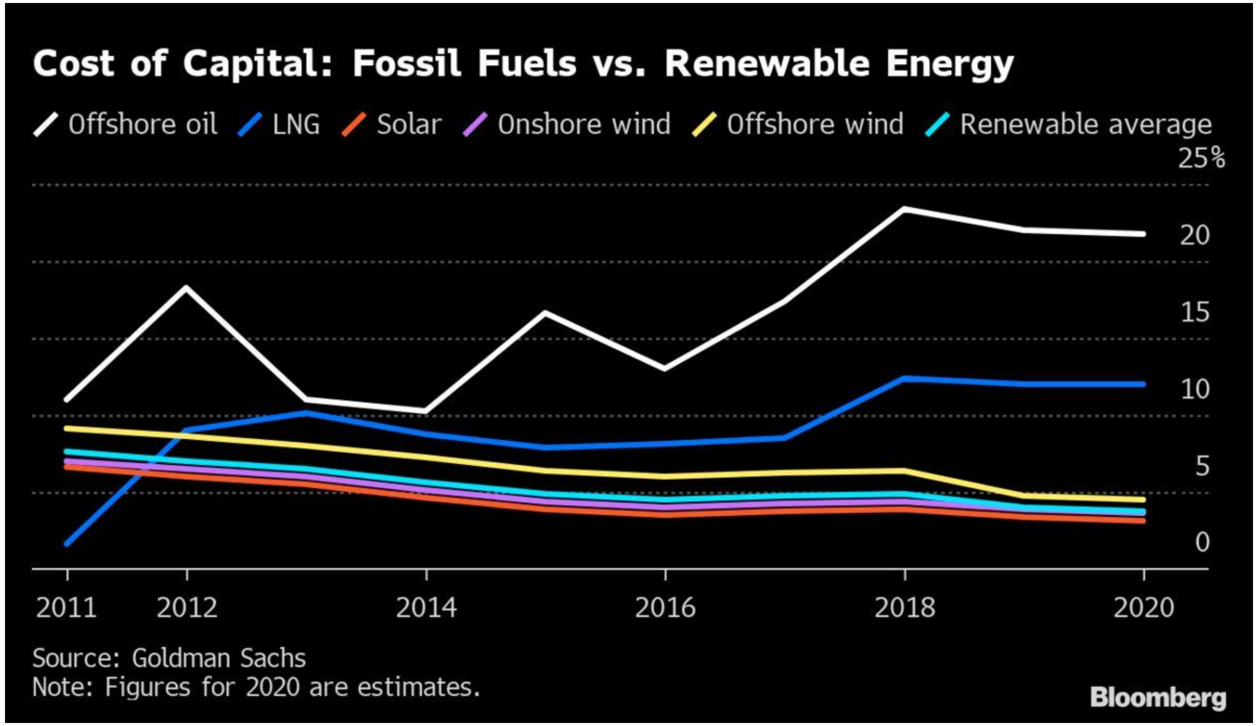
These climate related risks translate to financial risks

3. Risks of gas-to-power investment

3. Failing economics linked with gas-to-power.

- Countries ending public finance
- Banks pulling out gas project financing (e.g. Nedbank)
- Cost of capital increasing
- Carbon Tax
- Divestment
- Carbon Border Adjustment Mechanism

3. Risks of gas-to-power investment



https://www.bloombergquint.com/business/cost-of-capital-widens-for-fossil-fuel-producers-green-insight

3. Risks of gas-to-power investment

4. Reduced security of affordable gas supply.

- Domestic supply of gas for electricity generation is uncertain in SA
- Long-term reliable options for importing piped gas are also not guaranteed.
- LNG imports comes with price volatility risk

3. Risks of gas-to-power investment

5. Stranded gas assets.

- Asset that has suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities.

  > investors or governments will be unable to recover their investments

- Example, India:
  - 60% (or 14.3 GW) of gas capacity was declared stranded in 2015.
  - In 2019, the State Bank of India indicated that they would need to write these investments off.
  - Nine gas plants (5.7 GW) were stranded within 5 years of being commissioned.

Gas is the new coal with risk of $100bn in stranded assets

19TH APRIL 2021

BY: BLOOMBERG

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Natural gas is falling out of favor with emissions-wary investors and utilities at a quicker pace than coal did, catching some power generators unaware and potentially leaving them stuck with billions of dollars of assets they can't sell.

https://www.engineeringnews.co.za/article/gas-is-the-new-coal-with-risk-of-100bn-in-stranded-assets-2021-04-19

Who would bear the costs associated with stranded gas assets in South Africa?

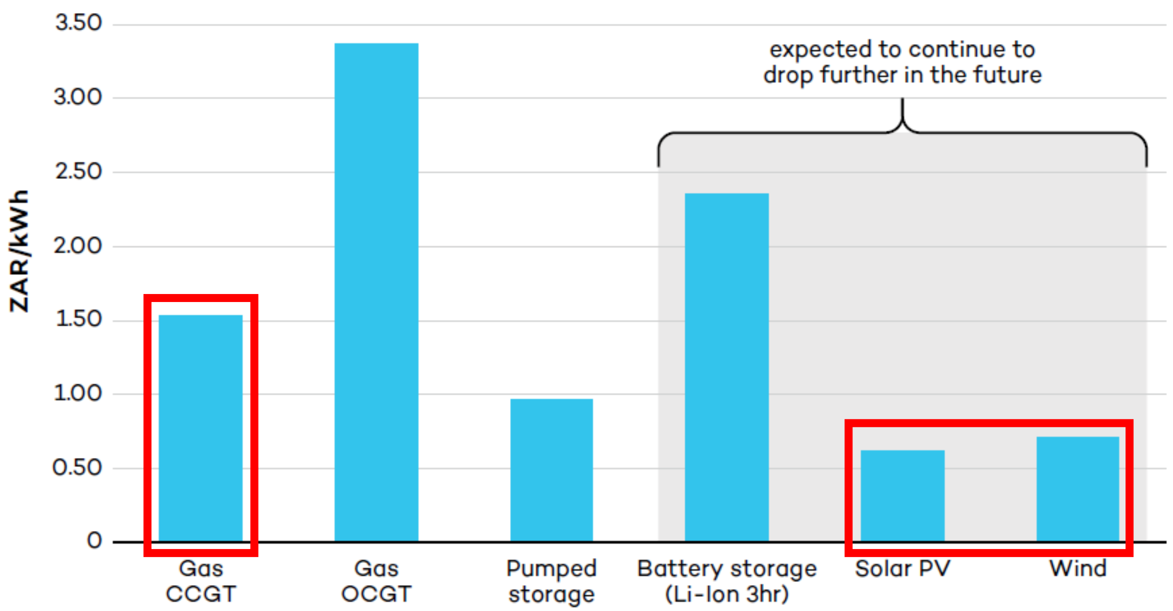
3. Risks of gas-to-power investment

6. Additional just transition burden.

- Gas-to-power would be a short-lived industry
  - Cause the next generation of gas workers and communities to face a repeat of the transition hardships faced by the coal sector now.

4. Alternatives to gas-to-power are improving

Figure 2. LCOE estimates for South Africa 2020



Source: Roff et al., 2020; Wright & Calitz, 2020. The gas price assumption in 2019 was ZAR 147 (USD 10.17) per GJ, so at higher gas prices the LCOE for gas turbines will increase.

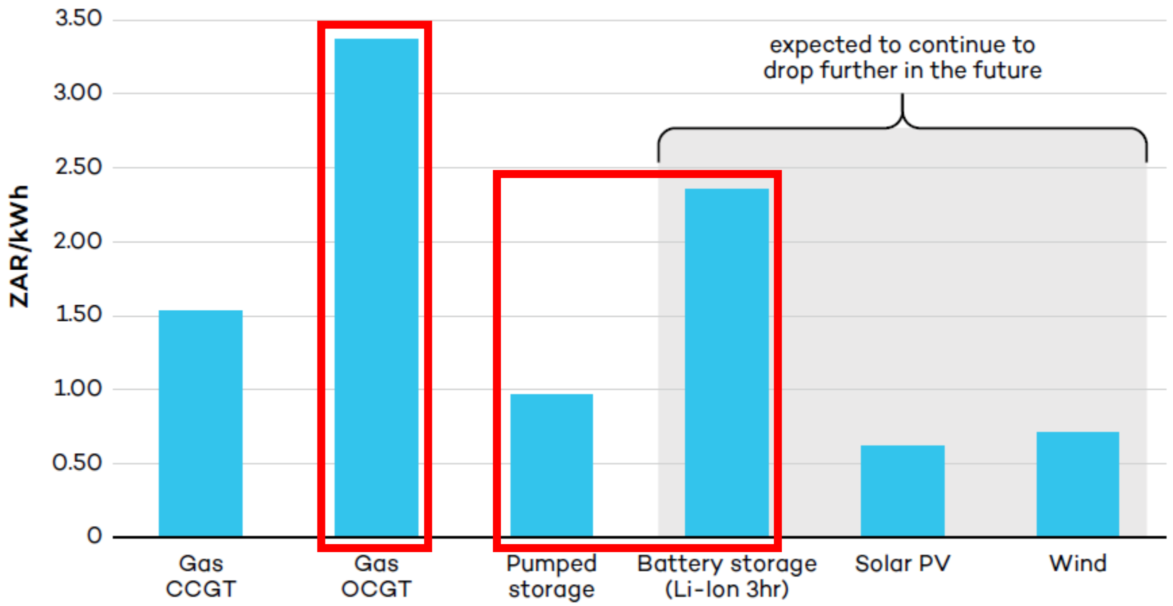
Bulk Supply:

Renewables can provide cheaper electricity than gas

LCOE : levelized cost of energy

4. Alternatives to gas-to-power are improving

Figure 2. LCOE estimates for South Africa 2020



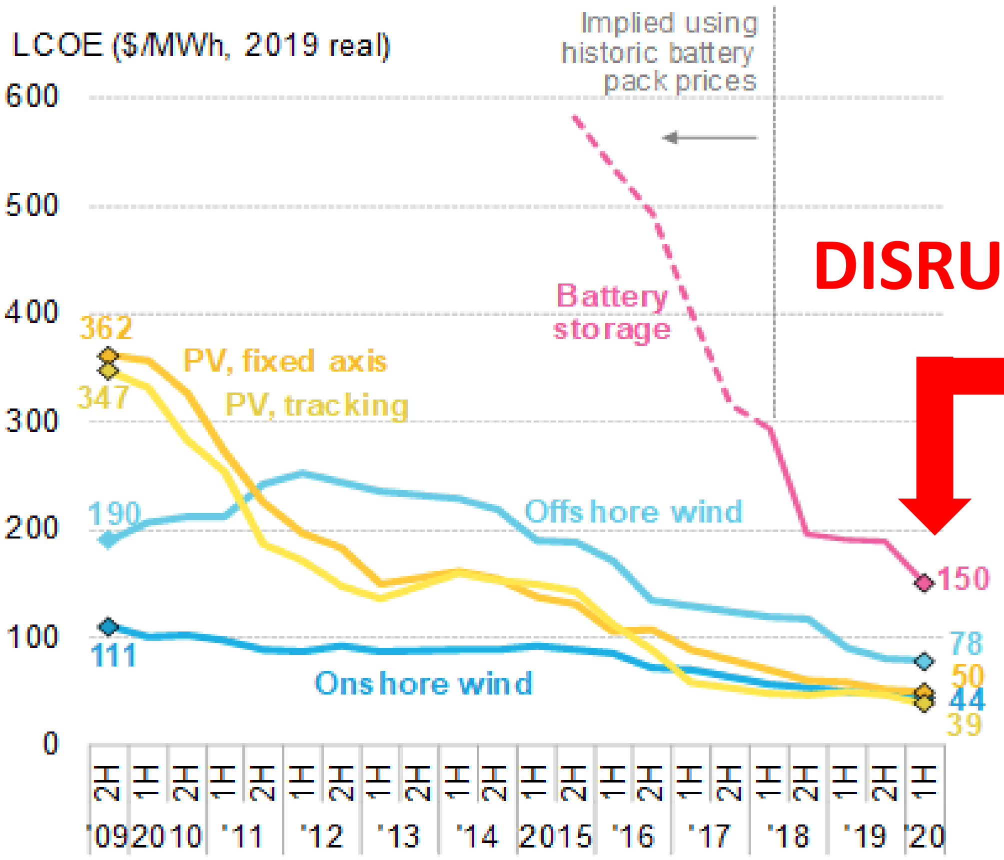
Source: Roff et al., 2020; Wright & Calitz, 2020. The gas price assumption in 2019 was ZAR 147 (USD 10.17) per GJ, so at higher gas prices the LCOE for gas turbines will increase.

Peaking:

Energy storage prices have already dropped sufficiently to replace gas

LCOE : levelized cost of energy

More on peaking:



https://about.bnef.com/blog/scale-up-of-solar-and-wind-puts-existing-coal-gas-at-risk/

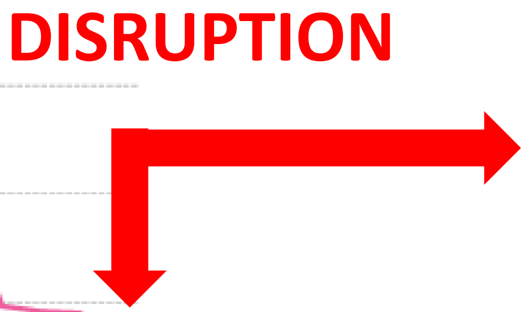
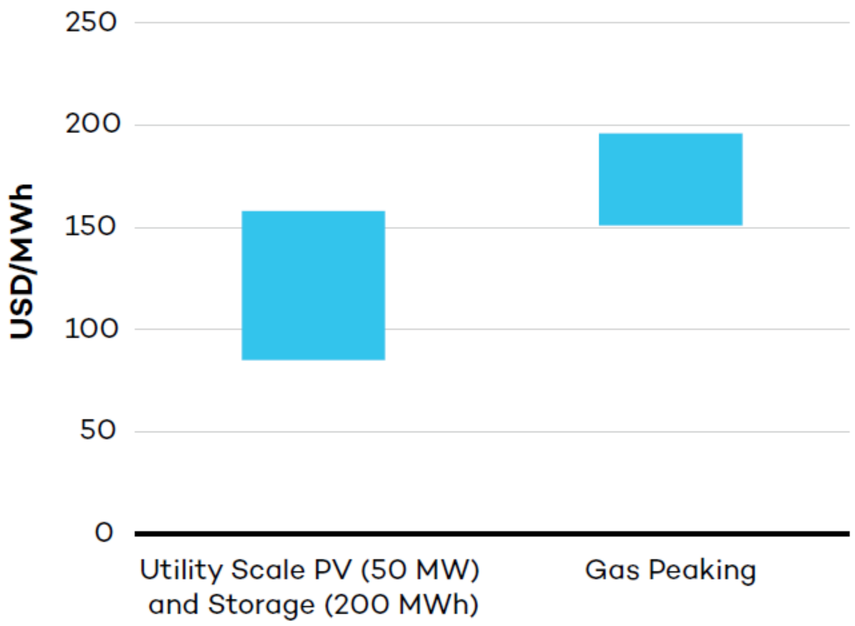


Figure 3. International, unsubsidized LCOE ranges for utility-scale PV plus storage systems vs. gas peakers



Source: Lazard 2021a, 2021b. In the graph, "Utility-Scale PV and Storage" refers to an energy storage system designed to be paired with large solar PV facilities to better align timing of PV generation with system demand, reduce solar curtailment, and provide grid support.

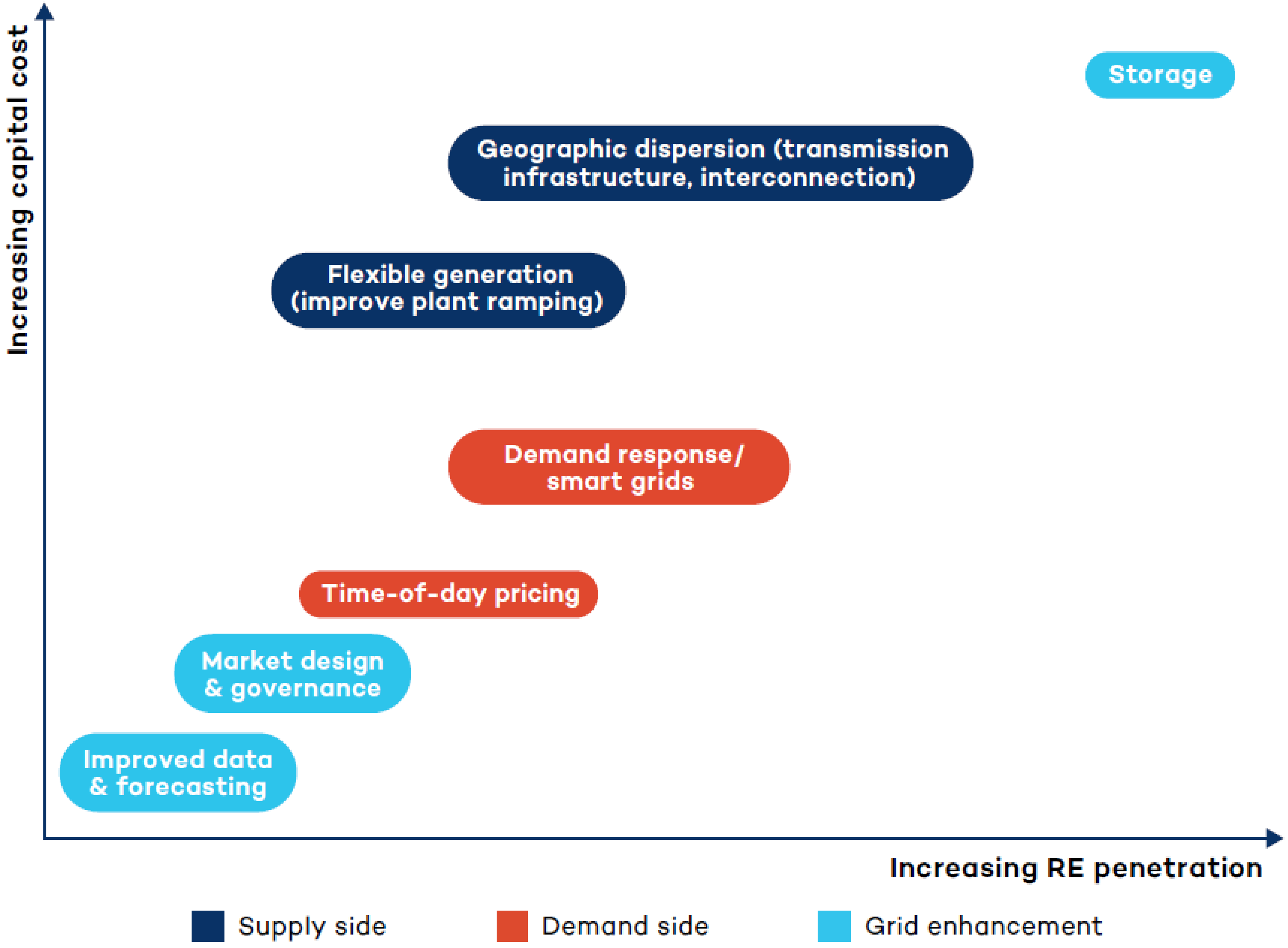
4. Alternatives to gas-to-power are improving

Balancing and Backup:

Alternatives to gas are improving and decreasing in price

1: grid integration of renewables

Figure 4. Measures to integrate renewables into the grid

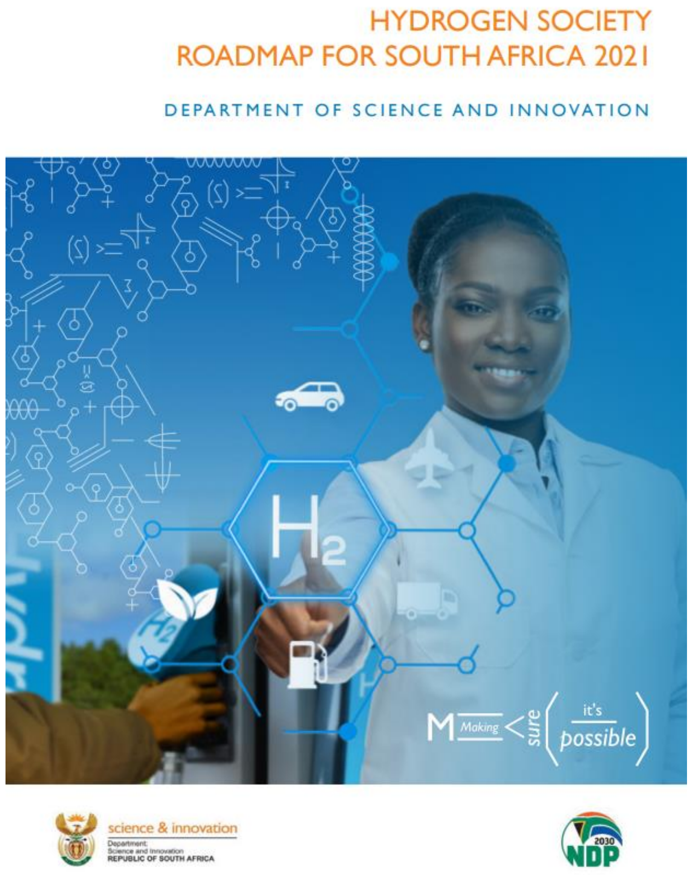


Source: Adapted from Muttitt et al., 2021.

4. Alternatives to gas-to-power are improving

2: direct replacement for gas: green fuels

Green hydrogen is the term used for the hydrogen produced from the electrolysis of water into oxygen and hydrogen using renewable (green) electricity.



"Revise the IRP to include hydrogen gas for generation" between 2025–2030.

Green hydrogen as a fuel is not yet cost competitive, but it is improving

Direct replacement for natural gas

Gas turbines in the US are being prepped for a hydrogen-fuelled future

By Modern Power Systems 06 Jan 2021

FEATURES & ANALYSIS | POWER | FOSSIL FUEL / COAL AND GAS

Projects being undertaken by GE and Mitsubishi Power are paving the way for natural-gas powered plants to convert to running on emerging hydrogen fuels

https://www.nsenergybusiness.com/features/gas-turbines-hydrogen-us/

If existing gas turbines are already being converted to run of hydrogen, does it make sense for South Africa to build new natural gas turbines if there is potential to leapfrog when this function is required?

5. Power system can meet demand to 2035 without gas supply

Wind and Solar PV Resource Aggregation Study for South Africa

Final report

By optimally distributing renewables across the entire country, **a 20%–30% share** of renewables can still provide a reasonably smooth output without significant short-term fluctuations

i.e minimal balancing needs in short term

5. Power system can meet demand to 2035 without gas supply

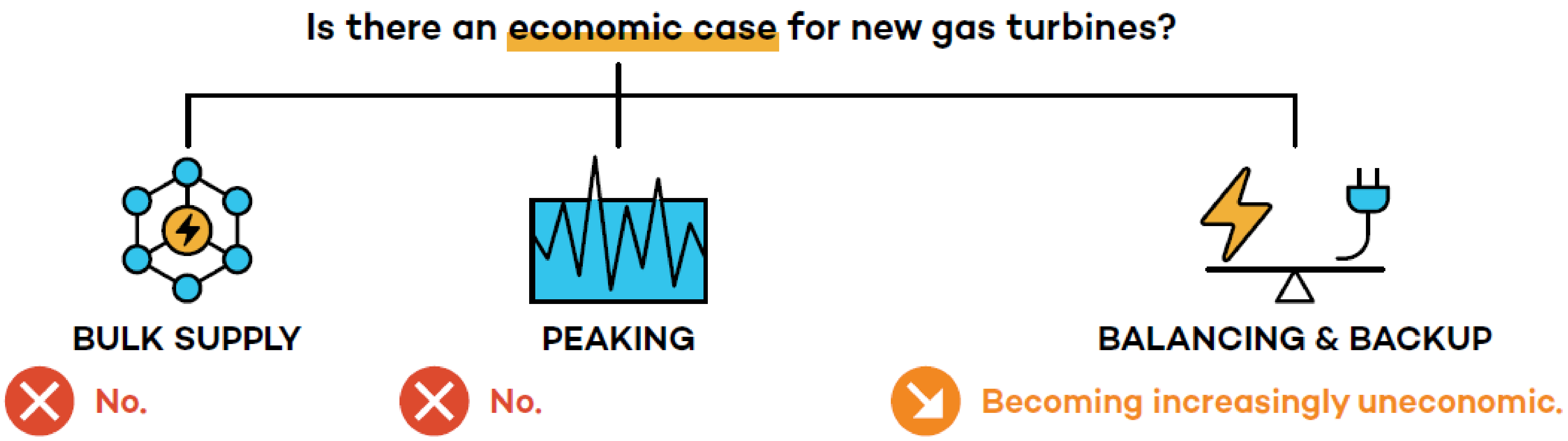
Existing and new OCGTs, run within the historical OCGT liquid fuel use range, can provide all peaking and balancing requirements, in all realistic mitigation scenarios, for the next 15 years

In an optimised system, these OCGTs provide **reserve capacity**, but are used very infrequently, so fuel use is low.

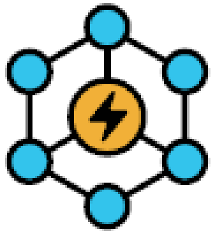
Could avoid lock-in to another fossil fuel in power sector

Turbines vs gas supply

See report for details

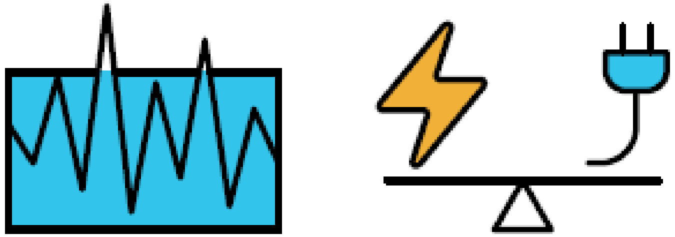


Is there a technical need for new gas turbines?



BULK SUPPLY

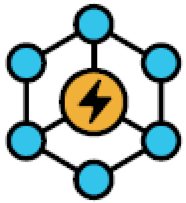
No.



PEAKING/BALANCING & BACKUP

Increasingly outcompeted by alternatives.

Is there a technical need for building new gas supply infrastructure? ← e.g., LNG terminals and pipelines



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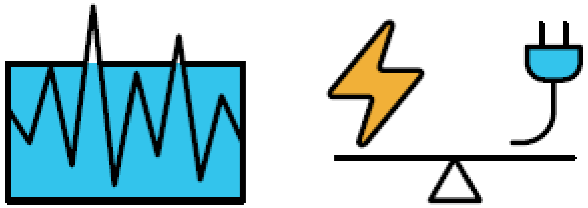

PEAKING/BALANCING & BACKUP

Not prior to 2035, if ever.

6. Focus on short-term priorities and knowledge gaps

Plans to 2050

We don’t need to solve the details of the 2050 problem now

(including “last mile decarbonization”)

6. Focus on short-term priorities and knowledge gaps

Debate: some plans do build more gas turbines to 2050, others do not.

a) Where new OCGTs are still included in optimized, realistic models up to 2050 it is only required to provide backup for long lull periods in renewables beyond the storage and recharging capabilities in those models.

But, these **long lull periods happen very rarely** so total fuel use is very low.

b) Where no gas is built, it is only renewables and storage.

The overbuild of renewables capacity will provide surplus electricity, or “**superpower**”, at near-zero-marginal-cost.

6. Focus on short-term priorities and knowledge gaps

Plans to 2030

Take the low-risk option

Focus on implementing what has evidence-based consensus on and that which is most future proof

Actively address knowledge gaps

Technology disruption (particularly storage) has been so fast that modelling outputs from 2019/2020 are already outdated

Figure 7. A low-risk approach to address power shortages and the rush for gas

Short-term priorities

Significantly increase rate of renewable capacity additions.

Implement:

1. Renewables grid integration techniques
2. Transmission network upgrades

Increase rate of storage capacity additions.

Develop bettering understanding of:

1. Role and timeframes for green hydrogen in power sector.
2. Potential for overbuild of renewables and storage to generate “superpower”

Gas recommendations

Do not use power sector as an anchor tenant for gas demand now.

A decision on whether any gas supply infrastructure is required for the power sector post-2035 can be made in ~2030 based on available technologies and costs.

Pause plans for the development of new gas turbines.

Fully investigate the short-term need for new OCGTs (or conversions to gas) given the significant recent changes in storage and renewables integration.

CCGTs run at high-capacity factor are not rational.

7. Conclusions

1. Potential negative outcomes of gas-to-power investment

Gas-to-power lock-in:

- GHG emissions reduce carbon budget in energy sector
- Future government subsidies or bailouts to keep uncompetitive sector going
- Delays or crowds-out uptake of superior alternatives even though they cost less and better for climate, environment and society

Divergence from optimal emissions and least cost pathway:

- Higher than necessary prices for electricity consumers, especially if gas used at high capacity factor

Gas-to-power sector faces a repeat of just transition challenges currently experienced by coal sector

Severity is correlated to the extent of investment.

7. Conclusions

2. Implementation: focus on priorities to address constrained power system (i.e loadshedding)

Significant increase in:

- renewables capacity
- energy efficiency
- grid integration methods
- storage capacity

7. Conclusions

3. Planning:

- Collaborative, transparent update of Integrated Resource Plan.
- Develop a method to factor in risks.
- Also need Integrated Energy Plan.

7. Conclusions

4. Pause development of gas-to-power

- Revisit need for gas supply in power sector in ~2030
- A large fleet of CCGTs at is not required
- Fully investigate short term need for new OCGTs with updated data

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