

Gas  
Transmission

# Enabling net zero

Gas Future Operability Planning

November 2020

nationalgrid



# Introduction

Our previous **Gas Future Operability Planning (GFOP)** document on [Stakeholder Feedback](#) provided a summary of your feedback from the past 18 months.

We asked you to prioritise your feedback into topics of exploration for 2020 GFOP documents. You told us you wanted to see insight pieces on increasing low carbon gases in the gas networks.

We already know from your feedback that you think decarbonisation efforts will impact the long-term predictability of future gas supply patterns. You also told us that we should consider the potential for increasing low carbon gases such as hydrogen and biomethane in our network planning.

**Your feedback is important to us. This document will explore how increasing low carbon gases in the gas networks could enable net zero carbon emissions. For the purpose of this document, we will focus on two potential roles the National Transmission System could play in a net zero future.**



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## Executive summary

**The United Kingdom has a target to achieve net zero carbon emissions by 2050. As National Grid Gas Transmission, the owner and operator of the gas National Transmission System, we are committed to playing our part to achieve this target.**

**The Gas National Transmission System will have a critical role in enabling the United Kingdom to achieve net zero by 2050.**

**Throughout this document we ask for your thoughts to help shape solution options in the journey to a net zero future.**

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# Achieving net zero by 2050

The United Kingdom (UK) became the first major economy to commit to achieving net zero carbon emissions by 2050. Setting these legally binding targets will lead to unprecedented changes across the UK's energy landscape.



Crucial to achieving net zero is reducing emissions from the end-use of unabated natural gas to zero. Today, natural gas plays a key role in meeting the UK's heating, power generation and industrial demand.

The gas National Transmission System (NTS) is well proven in its safe, reliable and affordable provision of energy. This document explores how the NTS could enable the UK to achieve net zero at least cost and disruption to consumers by making the most of this existing national asset.

## 2018/ 2019 gas year:

 **881TWh** Gas delivered over three times more energy than electricity in the UK

 **23.2m** gas customers  **85%** of households connected to gas networks

 **40%** of power needs supplied by gas  **38%** of industrial demand met by gas



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# Low carbon gases to replace the end-use of unabated natural gas

There are a variety of options to replace the end-use of unabated natural gas. Although there are non-gas options, in this document we focus on alternative gas options (Figure 1). It is important to note the below list of alternative gases and technologies is not exhaustive, and that low carbon gases could also play a key role in replacing other unabated fossil fuel end-uses, such as replacing petrol or diesel for transport.

Figure 1: Alternative gas options to replace the end-use of unabated natural gas

Alternative gas	Key resource	Production technology	Carbon
<b>Blue hydrogen</b>	Natural gas	<ul style="list-style-type: none"> <li>Reformation: Natural gas (<math>\text{CH}_4</math>) is split into its components of Carbon and Hydrogen.</li> <li>An additional process of carbon capture usage and storage (CCUS) is necessary to limit and permanently store the carbon produced through the reformation process.</li> </ul>	Low carbon <sup>1</sup>
<b>Green hydrogen</b>	Renewable electricity	<ul style="list-style-type: none"> <li>Electrolysis: Water (<math>\text{H}_2\text{O}</math>) is split into its components of Hydrogen and Oxygen using electricity.</li> </ul>	Zero carbon <sup>2</sup>
<b>Biomethane</b>	Biomass, animal or food feedstock	<ul style="list-style-type: none"> <li>Anaerobic digestion: Biomass, animal or food waste is broken down to produce biogas. Biogas is further processed into biomethane for transportation in gas networks.</li> </ul>	Carbon neutral <sup>3</sup>
<b>BHCCS (Biomass-derived Hydrogen with Carbon Capture and Storage)</b>	Biomass	<ul style="list-style-type: none"> <li>Gasification: Biomass is combusted and the generated gas further processed to produce Hydrogen.</li> <li>Adding carbon capture usage and storage (CCUS) to permanently store carbon produced through the gasification process delivers negative carbon emissions.</li> </ul>	Negative carbon <sup>4</sup>

1. Low carbon: Low carbon technologies produce low amounts of carbon emissions. For example, reformation technology can capture up to 97% of carbon emissions. Remaining emissions from low carbon technologies can be offset by the use of negative emission technology or carbon credits to achieve overall carbon neutrality.

2. Zero carbon: No carbon emissions are emitted from the use of these technologies.

3. Carbon neutral: These technologies balance emitted carbon with an equal amount of carbon storage.

4. Negative: These technologies remove and store more carbon than the carbon emitted into the atmosphere, achieving negative carbon emissions.

# Resources in the UK to support low carbon gas production

The UK is fortunate to possess abundant natural resources that create potential for increasing low carbon gases. Below we have explored several of these natural resources with examples of how they could support low carbon gas production.

**Natural gas supply**




Natural gas is supplied to the UK at eight coastal terminals. Natural gas supplies could be reformed into blue hydrogen, with carbon capture usage and storage.

**Offshore depleted oil and gas fields**



The UK has depleted offshore oil and gas fields that could permanently store carbon to facilitate blue hydrogen production or BHCCS.

**Offshore renewables**



The UK could generate green hydrogen through electrolysis powered by current and future offshore renewable wind power.

**Biomass, animal and food waste**



The UK currently uses biomass, animal and food waste to produce biomethane for transportation in gas networks, with opportunity to generate more.

**Onshore geological storage**



The UK has eight onshore gas storage facilities, with opportunity to develop more to support low carbon gas production.

**Onshore renewables**



The UK could generate green hydrogen through electrolysis powered by onshore renewables, such as solar and wind power.

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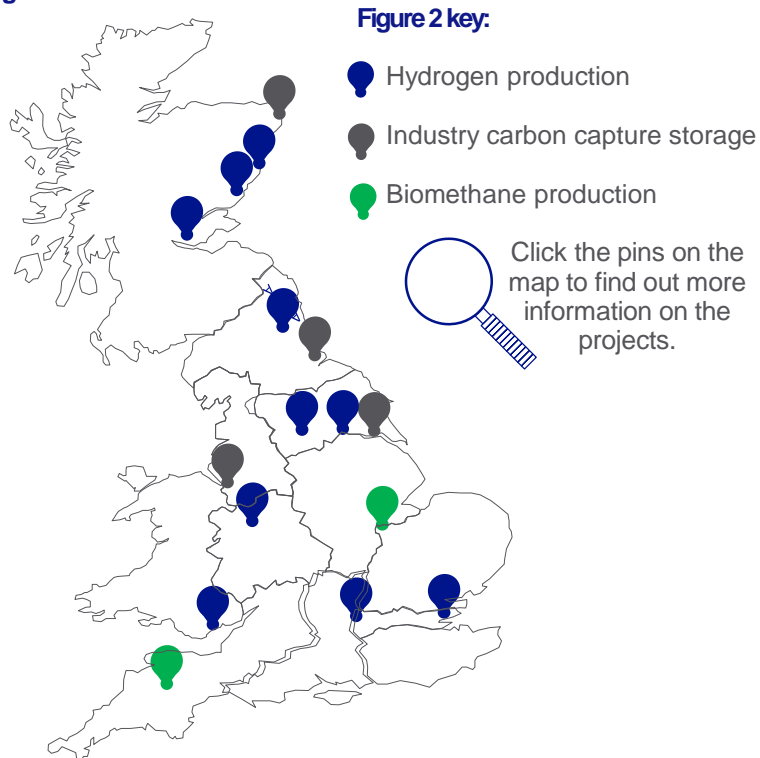
# Current UK projects focused on increasing low carbon gases

Recently, the UK has seen a huge development in gas projects aiming to increase low carbon gas production and reduce carbon emissions.

Figure 2 indicates the locations of some examples of ongoing projects aiming to increase low carbon gas production. Please note, this map is only indicative and not exhaustive.

The locations of many of these projects could provide important insight to where low carbon gases could (and currently are, in the case of biomethane) enter the transmission and distribution networks, in the short to medium term. In the future, it is likely other low carbon gas projects will emerge in new locations.

Figure 2: Examples of UK projects focused on increasing low carbon gases



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# Potential roles of the NTS in a net zero future

The Committee on Climate Change has affirmed the UK's gas networks will have an important role to play in a net zero 2050. This document focuses on the role the NTS could play in a net zero future.

Options could include blending different types of low carbon gases into the NTS, reinforcing the NTS to facilitate new connections from low carbon gases such as biomethane, and repurposing the NTS to transport zero carbon gases such as green hydrogen.

**For the purpose of this document, we will explore two potential roles the NTS could play to enable a net zero 2050:**

- 1. Natural gas NTS that enables a net zero 2050**
- 2. Hydrogen NTS that enables a net zero 2050.**

It is important to note the potential roles of the NTS explored within this document represent potential extremes of what may occur in the future. Enabling net zero will involve a mosaic of solutions, and to achieve net zero by 2050 other outcomes and potential roles for the NTS could occur.

At National Grid Gas Transmission we are exploring a range of innovative technologies to drive net zero for the UK.

For example, we are exploring [gas separation technology](#) (the ability to separate different types of gases, such as hydrogen and natural gas) to make sure we can continue to deliver the gas quality our customers need.



Please view our gas [innovation webpage](#) to learn more about our innovation projects shaping the future of gas in the UK.

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# The NTS in a net zero future

Although good progress is being made, there is a lot of work to do over the next 30 years to enable net zero for the UK. This document aims to:

- Illuminate two potential roles for the NTS in facilitating a net zero future;
- Articulate the activities that National Grid Gas Transmission and other gas industry participants could deliver to enable each role to become reality.

## Current role of [National Grid Gas Transmission](#):

We are the System Operator and Transmission Owner of the gas NTS. We deliver gas from supply entry points to demand exit points safely, efficiently and reliably.

As System Operator, we manage the day-to-day operation of the network. This includes balancing supply and demand, maintaining system pressures and ensuring gas quality standards are met. We are also responsible for identifying the long-term needs of the network.

As Transmission Owner, we make sure all NTS assets are safe and fit for purpose. We also develop and implement effective maintenance plans and asset replacement schedules.



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## Role 1: Natural gas NTS in a net zero 2050

**The NTS could enable net zero by 2050 through continuing to deliver natural gas and biomethane to consumers.**

The NTS could continue to transport natural gas from supply sources to areas of gas demand. The NTS could also transport increasing volumes of biomethane from new connections.

In this role, the gas supply the NTS transported could facilitate the production of blue hydrogen or bio-mass derived hydrogen. The produced hydrogen could meet demand from hydrogen converted consumers such as distribution networks, industrial clusters, power generation sites and refuelling stations.

The NTS could also potentially transport captured carbon to permanent carbon storage facilities.

This potential future role for the NTS was selected for exploration as a credible option to enable a net zero future.

For example, in the 2020 [Future Energy Scenarios](#), hydrogen was required for all UK net zero scenarios. In addition, the Energy Networks Association report [Pathways to Net Zero](#) found that a future UK energy pathway that includes decarbonised gases alongside electrification could save UK consumers £13bn per year, as opposed to a fully electrified pathway.

Taken together, these reports demonstrate the need to further explore how to unlock the potential of increasing low carbon gases in the UK's gas networks, where this document focuses on the NTS.



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# Natural gas NTS in a net zero 2050

The following pages explore a role for the NTS that involves transporting natural gas and biomethane in a net zero future.

This NTS role is based on our interpretation of the System Transformation scenario from the 2020 Future Energy Scenarios (FES). This scenario includes a high proportion of hydrogen which is mainly produced through natural gas reformation plus CCUS. Some negative emissions are achieved through hydrogen production from biomass-derived hydrogen production plus CCUS.

As illustrated, this scenario could lead to dramatic change in gas demand on the NTS. For example:

- In 2018/19, gas demand on the NTS was spread across the network at multiple exit points (Figure 3).
- By 2050, we could see gas demand on the NTS concentrated at larger in size and fewer in number exit points, where natural gas and/or biomethane could be utilized to produce hydrogen (Figure 4).

The following pages explore how operational tools, asset investment and commercial rules could be developed to support this potential future NTS role (Figure 4).

Figure 3: 2018/19 aggregated natural gas demand on the NTS

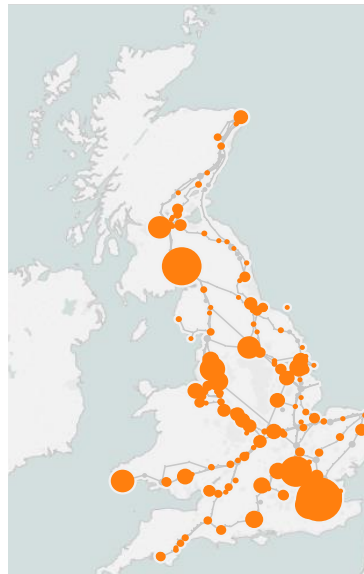


Figure 3 key:

● NTS natural gas demand (data from the 2018/19 Gas Ten Year Statement)

Figure 4: 2050 aggregated natural gas/biomethane NTS



Figure 4 key:

● NTS natural gas/biomethane demand in the FES System Transformation scenario

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# Natural gas NTS in a net zero 2050

Operational tools for a natural gas role for the NTS could enable net zero.

Currently, National Grid Gas Transmission undertakes network analysis to evaluate how changing gas supply and demand patterns could impact the operability of the NTS.

We also analyse the capability of the NTS to address drivers of change, which include immediate and long term customer needs, asset management requirements, legislative change and decarbonisation targets.

Our network analysis has enabled the operation of the NTS to evolve over time to manage changing gas flow patterns.

To facilitate the connection of blue or bio-mass derived hydrogen production sites across the NTS in a net zero future, operational tools could be developed including:

- **Adapting compressor strategies to move gas from supply entry points to new demand exit points.**
- **Planning network operations to meet pressure requirements at new demand exit points.**



## What are your thoughts?

- How many blue or biomass-derived hydrogen production sites could there be connected to the NTS by 2050?
- Who will operate hydrogen production sites connected to the NTS?

# Natural gas NTS in a net zero 2050

## Investment in assets could enable net zero.

Critical to National Grid Gas Transmission's role is making sure NTS assets are safe and fit for purpose for operation. In addition, our network analysis enables us to develop asset solution options that deliver gas where it is needed safely and efficiently in an ever changing gas energy landscape.

To facilitate the connection of blue or bio-mass derived hydrogen production sites on the NTS, a range of asset investment solution options could be deployed including:

- **Reinforcing the NTS**

This option may be required for large quantities of gas to be delivered to new demand exit points on the NTS.

- **Building and/or modifying compressors**

This option may be required if the current NTS compressors are not adequately sized or located to move gas from supply entry points to new demand exit points.

- **Repurposing NTS pipelines to transport carbon to permanent offshore storage.**

Extensive network evaluation would be required to ensure this did not impact continued security of natural gas or biomethane supply on the NTS.



### What are your thoughts?

- What asset solution options could you need from a natural gas/biomethane NTS in a net zero 2050?

# Natural gas NTS in a net zero 2050

## Commercial rules could enable net zero.

In our role as NTS System Operator, National Grid Gas Transmission plays a vital role in enabling a competitive gas market regime for the UK. For example, we share gas demand forecasting information with the market to help industry participants balance their supply and demand positions.

To facilitate the connection of blue or bio-mass derived hydrogen production sites on the NTS, the market regime must continue to benefit industry and consumers, involving:

- **An open and transparent entry and exit capacity framework for the NTS.**
- **Residual balancing service for gas (natural gas and biomethane) on the NTS.**
- **Monitor and maintain Gas Safety (Management) Regulation standards on the NTS.**

### What are your thoughts?

- Should new capacity products be developed to incentivise the injection of low carbon gases such as biomethane into the NTS?



Given the level of uncertainty in the transition to net zero, an industry-based process is needed to proactively and strategically consider how market frameworks may need to change to facilitate low carbon gases.

To achieve this, National Grid Gas Transmission in collaboration with industry and policy-makers have launched the [Gas Markets Plan](#) (GMaP). The GMaP brings together stakeholders to prepare for future gas market frameworks. Our current focus areas for exploring potential market change include Hydrogen, Gas Quality and Balancing.

## Role 2: Hydrogen NTS in a net zero 2050

**The NTS could enable a net zero 2050 by transporting hydrogen to customers.**

Existing NTS pipelines could be repurposed to transport hydrogen. This could include blue, green or biomass-derived hydrogen, and could also include imported hydrogen supplies. Any NTS pipes repurposed to hydrogen would only be selected after considerable network evaluation.

In this role, the NTS could transport hydrogen to meet demand from hydrogen converted customers such as distribution networks, industrial clusters, power generation sites and transport refuelling stations.

The NTS could also potentially play a role in transporting captured carbon to carbon storage facilities.

This potential future role was selected for the NTS as a credible option to enable a net zero future.

The 2020 [Future Energy Scenarios](#) state hydrogen must be deployed for net zero and assume hydrogen could be transported in either the UK's distribution or transmission networks. In addition, analysis from the ENA 2020 report on [Hydrogen Cost to Customer](#) indicates that developing a UK hydrogen supply chain could provide wide ranging economic benefits including job creation.

Taken together, these reports demonstrate the need to explore how to further unlock the potential of increasing low carbon gases in the UK's gas networks.



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# Hydrogen NTS in a net zero 2050

The following pages explore a role for the NTS that involves transporting hydrogen in a net zero future. For the purpose of this document, we will focus on an example of a section of the NTS that could be repurposed to transport hydrogen.

This example is based on [Project Cavendish](#), a feasibility study led by National Grid Gas Transmission in partnership with distribution networks SGN and Cadent. This project explored the potential to generate hydrogen on the Isle of Grain in Kent. The hydrogen would be used to replace the end-use of unabated natural gas for power generation, industry, domestic heat and transport to decarbonise London and the South East of England.

In the Project Cavendish roadmap, two sections of NTS pipeline located on the Isle of Grain could be repurposed to transport hydrogen (Figure 5).

The following pages explore how operational tools, assets investment and commercial rules could be developed for this potential NTS role in a decarbonised future.

Figure 5: Hydrogen NTS on the Isle of Grain

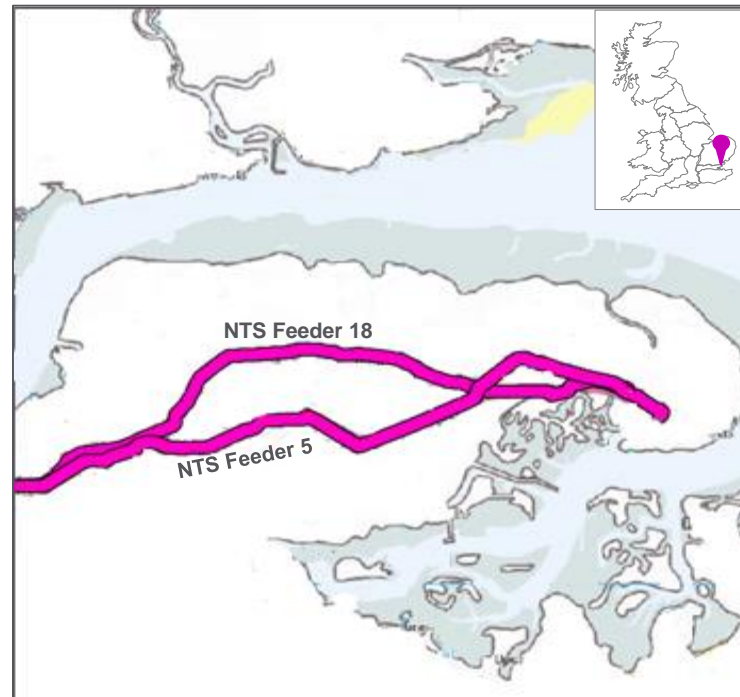


Figure 5 key:

— National Transmission System repurposed to hydrogen (illustrative)

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# Hydrogen NTS in a net zero 2050

Operational tools need to be developed to enable net zero through a hydrogen NTS.

Significant operational changes and new tools could be required to operate a hydrogen NTS.

As part of our Hydrogen in the NTS (HyNTS) programme, National Grid Gas Transmission completed a study with the Health and Safety Executive to examine the [Feasibility of transporting Hydrogen within the NTS](#). The results of this study concluded it is technically feasible from a materials perspective to transport hydrogen within the NTS.

To facilitate the operation of a hydrogen NTS, further research is required. This research must evaluate what operational changes should be implemented to continue to deliver a safe, secure and efficient service for consumers.

## What are your thoughts?

- What gas quality forecasts or information would you need if a potential transition to a hydrogen NTS involves hydrogen blending?



At National Grid Gas Transmission, we are currently exploring potential future operational requirements of a hydrogen NTS.

Please be sure to view our upcoming 2020 [Gas Ten Year Statement](#) (GTYS) for further details on our plans to prepare for net zero. The GTYS will also include an update on our Hydrogen in the NTS programme of work, seeking to explore the opportunities and address the challenges of transporting hydrogen in the NTS.

# Hydrogen NTS in a net zero 2050

Investment in assets would be required to enable net zero through a hydrogen NTS.

Focusing on the Project Cavendish example, to facilitate the transportation of hydrogen through the NTS a range of asset investment solution options could be deployed including:

- **Repurposing NTS pipelines**

Repurposing existing infrastructure could be a least disruptive and least cost solution for end consumers.

- **Reinforcing NTS pipelines**

This option may be required to ensure continued natural gas and/or biomethane security of supply.

## What are your thoughts?

- What role could hydrogen imports play in the future of the UK's hydrogen supply?



In our 2020 [RIIO-2 business proposal](#) National Grid Gas Transmission included a potential new build hydrogen transmission pipeline as an Uncertainty Mechanism for Project Cavendish.

We included this potential new build hydrogen pipeline as it could allow specific customers in the South East to convert to hydrogen, while still ensuring continued natural gas security of supply to other customers connected to the NTS.

# Hydrogen NTS in a net zero 2050

New commercial rules would need to be developed to enable net zero through a hydrogen NTS.

To facilitate the transportation of hydrogen through the NTS, a new market regime would need to be established to benefit industry and consumers, potentially including:

- **An open and transparent entry and exit hydrogen capacity framework for the NTS.**
- **Residual balancing service on the hydrogen NTS.**
- **Monitoring and maintaining Gas Safety (Management) Regulation standards on the hydrogen NTS.**

National Grid Gas Transmission in collaboration with industry and decision makers are collaborating on the [Hydrogen Gas Markets Plan](#). This project is considering market regime change activities required to integrate hydrogen into the UK's energy mix with minimum impact to gas market participants. Please contact us via our [website](#) if you would like more information or to get involved.

## What are your thoughts?

- What could a hydrogen network contractual framework look like?



In the journey to net zero, how energy used by society is going to change. These changes will drive transformations in how all forms of gases are produced, transported and consumed. In a potential future NTS role of hydrogen transporter, there may be new commercial rules the NTS should facilitate.

To collaborate with National Grid Gas Transmission, industry and decision makers on shaping market solutions for the UK's gas market in a net zero future, please see our [Gas Markets Plan](#) programme of work.

# We want to collaborate with you

We want to work with you to shape solutions that enable a net zero future for the UK.

We want to explore the questions we have identified in this document and further discuss with you how operational tools, asset investment and commercial rules could enable net zero by 2050. We are also keen to understand any potential barriers that you see in the development of potential NTS roles in a net zero 2050.

**Please contact the GFOP team [here](#) to tell us your thoughts on operational tools and asset solutions for the NTS that could enable net zero.**

- Your feedback will help guide our focus for upcoming [Gas Future Operability Planning](#) documents in our continuous improvement program.

**Please contact the Gas Markets Plan team [here](#) to tell us your thoughts on commercial solutions for the NTS that could enable net zero.**

- Your feedback will support the development of the [Gas Market Plan](#). Please provide your feedback by mid December 2020 for your feedback to be included in upcoming Gas Markets Plan project development.



**Your feedback will help to maximise the value the NTS can deliver now and in a net zero future. We look forward to hearing from you.**

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