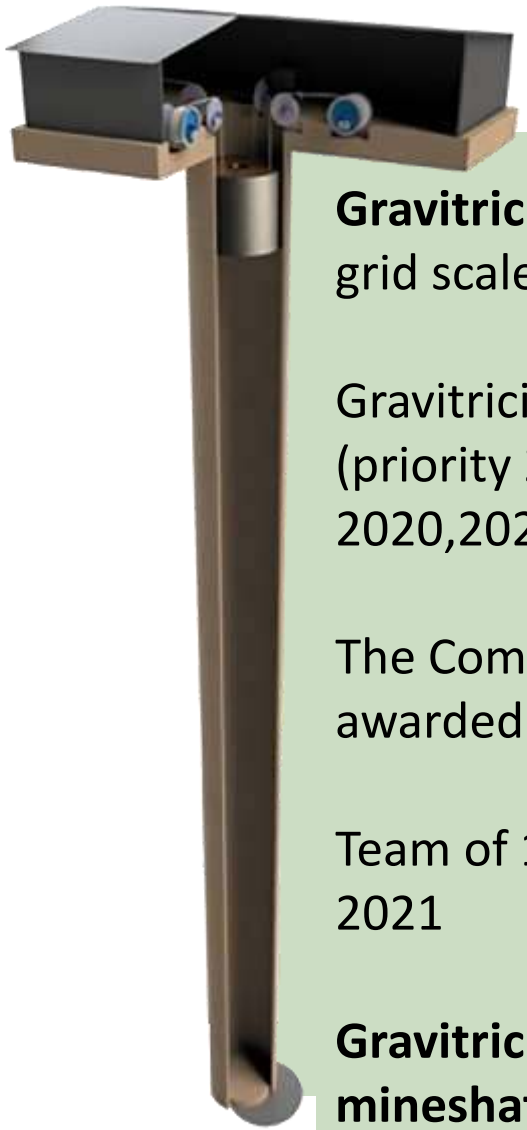
# gravitricity

Introduction Slides – March 2021

# About us



**Gravitricity Ltd** was founded in 2011. Gravitricity develops novel grid scale electricity storage technology.

Gravitricity has 7 patents submitted; four granted or approved (priority 2011, 2012, 2017, 2019) and two pending (priority 2019, 2020,2021)

The Company has raised £1.7m from private investors and been awarded ~£1.1m in innovation grants.

Team of 11 full-time staff. Will be hiring mining engineers later in 2021

**Gravitricity Ltd is currently developing projects in existing mineshafts around the world, and is expanding its Industrial Consortium alongside winch partner Huisman.**

# Summary

**Types of Energy Storage System**

| Electrochemical | Mechanical | Electrical | Thermal |
|---|---|---|---|
| -Battery<br>-Flow Batteries<br>-Hydrogen | -Flywheels<br>-Compressed air<br>-pumped hydro | -Capacitor<br>-Super Capacitor<br>-Superconductive magnetic | -Hot water storage<br>-Thermal fluid storage<br>-Ceramic thermal stor |

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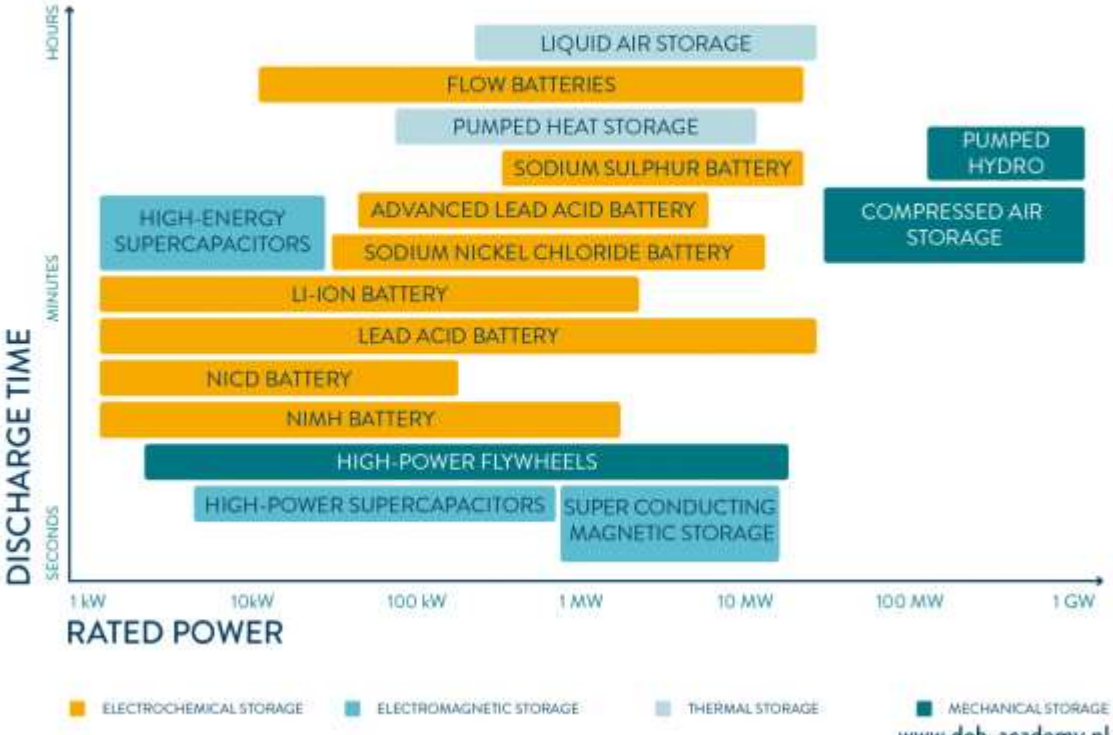
## ENERGY STORAGE



# Mission

**Gravitricity exists to enable the transition to zero-carbon energy**

**Renewables**

**Nuclear**


**Electrification**

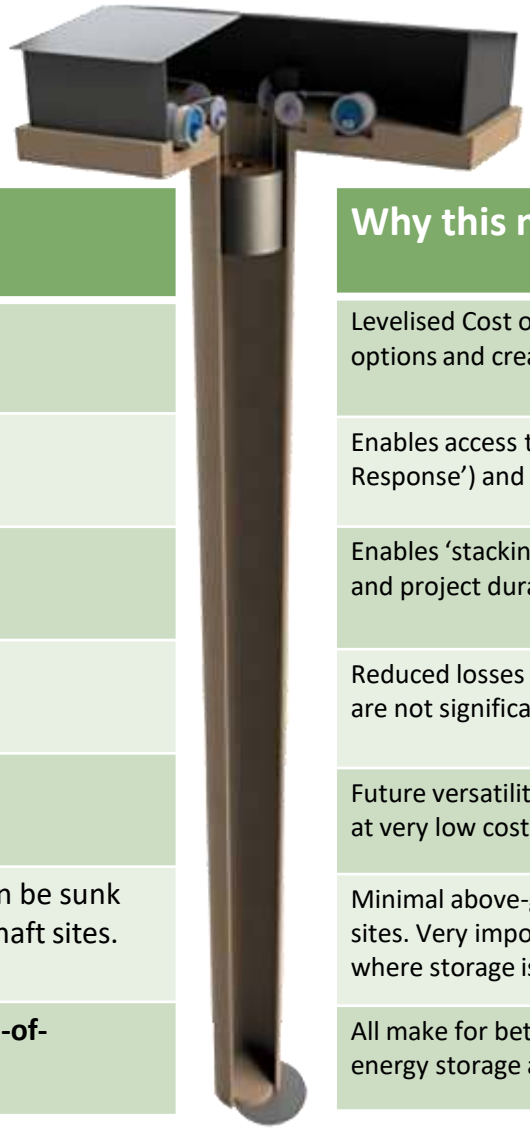
**Full Energy system transition**

**Massively increasing flexibility required, including grid-scale storage**

Gravitricity's long-life, mechanical energy storage technology:

1. Provides balancing for wind and solar generation
2. Strengthens grids' capacity to cope with increasing renewables, electric vehicles and heat pumps
3. Enables on-site integration of wind, solar and other renewable options
4. Allows islanded and off-grid systems to operate independently without fossil fuel backup

# Technical Characteristics



| Technical Characteristics (USPs) | Why this matters |
|---|---|
| **Low levelised (lifetime) cost** of storage. | Levelised Cost of Storage (LCOS) is the key metric for comparing storage options and creating project Return on Investment (ROI). |
| **Rapid response**: Full rated power <1s | Enables access to highest value revenue streams (i.e. 'Enhanced Frequency Response') and rapid-reaction backup power |
| **Long cycle life with no loss of performance.** (75,000+ cycles) | Enables 'stacking' of multiple revenue streams (multiple cycles per day) and project duration of 25+ years, like other energy assets. |
| **High efficiency:** 80-90%. As good or better than all alternatives | Reduced losses enables revenue generation even when differentials are not significant. Waste heat easily managed. |
| **Versatile Power/Energy ratio**: 15 min to 4 hour output. | Future versatility is essential. Increased Power can be added to system at very low cost. Modular energy increases can be added at later dates. |
| **Small footprint**: <30mx30m for 8MW facility. Can be sunk below ground. No locational constraint at new-shaft sites. | Minimal above-ground disruption. Less important at existing mineshaft sites. Very important at new-shaft sites, which can be deployed exactly where storage is required, including urban sites. |
| **No parasitic loads, no standing losses, no depth-of-discharge limits**. No explosive chemistry risk. | All make for better long-term commercial project ROIs than chemical energy storage alternatives. |

# R&D Plan

Gravitricity is currently building a 250kW Concept Demonstrator in Edinburgh. The winches for the Demo are being fabricated in Europe by partner Huisman, with the rest of the system being fabricated in the UK.

This will be followed by deployment of a **full-scale prototype system** in an existing disused mineshaft in 2021-23.

Gravitricity's project development tea are working on commercial project sites in **existing mineshafts**, which will be built from 2023. From 2025 projects will also be deployed in specially constructed **new shafts**.

**250kW Concept Demonstrator Model**
**Currently being manufactured**

**2020 - 21**

**Concept Demonstrator 250kW**
- Validation of dynamic simulations
- Proof of commercial characteristics

**2021-23**

**Full scale prototype 4-8MW**
- Full system integration (multiple modules)
- Proof of commercial operation via an aggregator

**2023 -**

**Mineshaft Projects**
- Turnkey equipment sales/leasing
- Licensing

**New Shaft Projects**
- R&D from 2020
- Projects from 2025

# Concept Demonstrator

**250kW** Concept Demonstrator winches from partner Huisman, fabricated in Czechia; **15m tower** and other steel components (including **2x 25tonne weight** baskets) in Scotland.

Onsite Assembly in Leith, Edinburgh, December 2020 and Jan 2021. Testing Feb-Apr 2021.

**Top frame, winch container and lower sheave blocks at demonstrator site 14th December**

**Second weight basket being unloaded at site followed by plinth/tower interface 16th December**

## What is it achieving?

- Demonstrates that this first-of-a-kind system complies with grid requirements of tightly regulated electrical sector and can delivery valuable ancillary services.
- Validate simulations for response times, system operational dynamics and round trip efficiency;
- Demonstration and optimisation of innovative control system to enhance system output
- Confirm capacity of the Gravitricity team to deliver a complex engineering project

# Growth Plan – repurposing expertise

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## Later Market (2025-): New Shafts

Global

Shaft sinking technology will allow Gravitricity installations to be deployed exactly where the grid needs them – reinforcing existing grids, and allowing new grids to be built for average flows rather than peaks.

Energy storage as permanent grid infrastructure – both behind and in front of the meter.

**New shafts** will be built with existing shaft sinking technology – Pictured is Herrenknecht Vertical Shaft Sinking Machine (www.herrenknecht.com).

2023 -

**Mineshaft Projects**
- Turnkey equipment sales/leasing
- Licensing

**New Shaft Projects**
- R&D from 2020
- Projects from 2025

# Interest

**Concept Demonstrator** contract signed and fabrication underway from January 2020. Grid connection approved, temporary planning application submitted, site lease in place.

**Intellectual Property**. Gravitricity now holds 4 granted patents with two others submitted and under examination. The priority date on the earliest patent is 2011. The most recent patents refer to our multi-weight system. There is additional IP and knowhow in the control system, dynamic simulation and electro-mechanical integration among other aspects. Gravitricity Trademark was awarded in 2018

**£1,650,000 raised** from private investors in 2019-20, and **~£1,050,000 in grant from the UK Government.** (Roughly 3/4 drawn down to date. Recent award of £209,000 Energy Catalyst grant specifically to develop market in South Africa.)

Close working relationship and NDAs/MOUs in place with multiple strategic partner companies, ranging from **winch manufacturer Huisman** to EPC Contractors and mining houses, as well as customers including global utilities.


Join us in developing fast,
long-life energy storage

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