gravitricity

Versatile, fast response, long-life Energy Storage

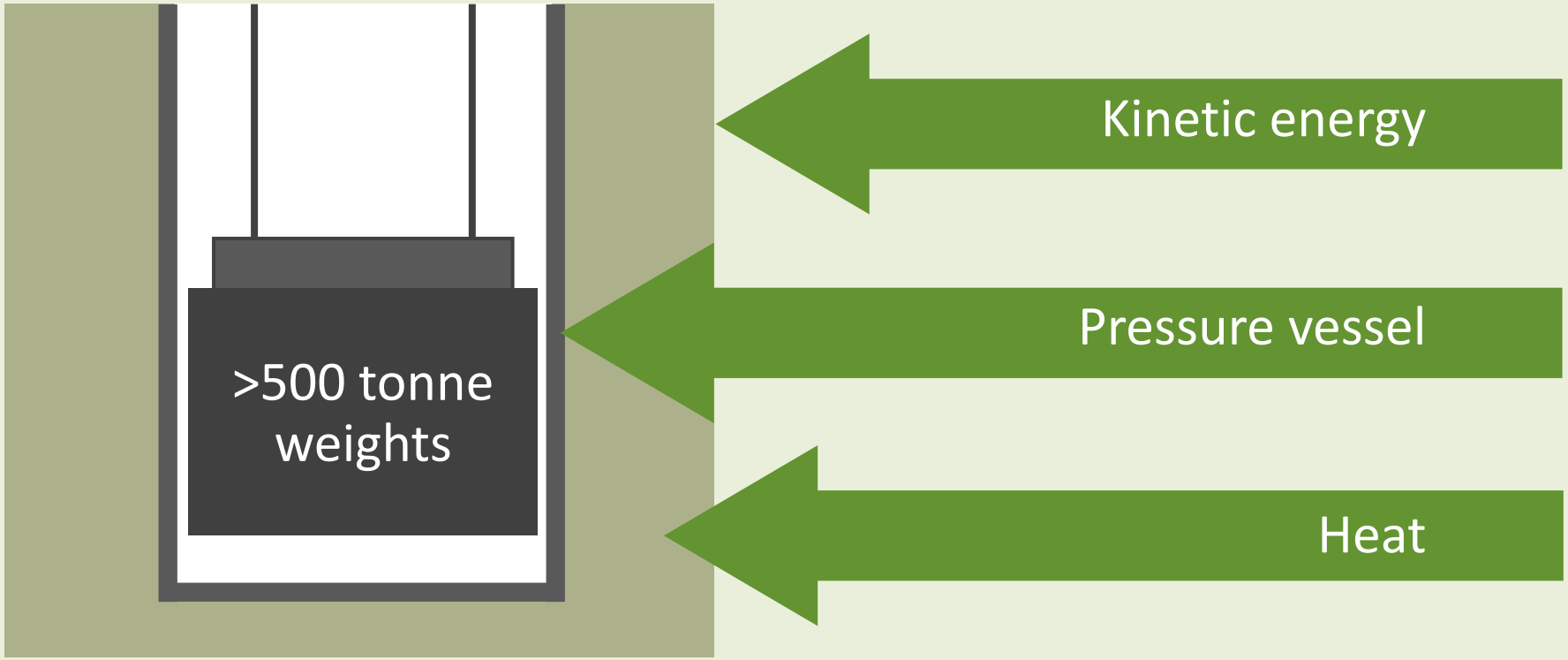
Robin Lane
Commercial Director

Get Enspired, November 2022

Underground spaces can be utilised to store energy in three ways

gravitricity

Multiple utilisation of underground shafts will provide long-life infrastructure assets capable of storing significant energy



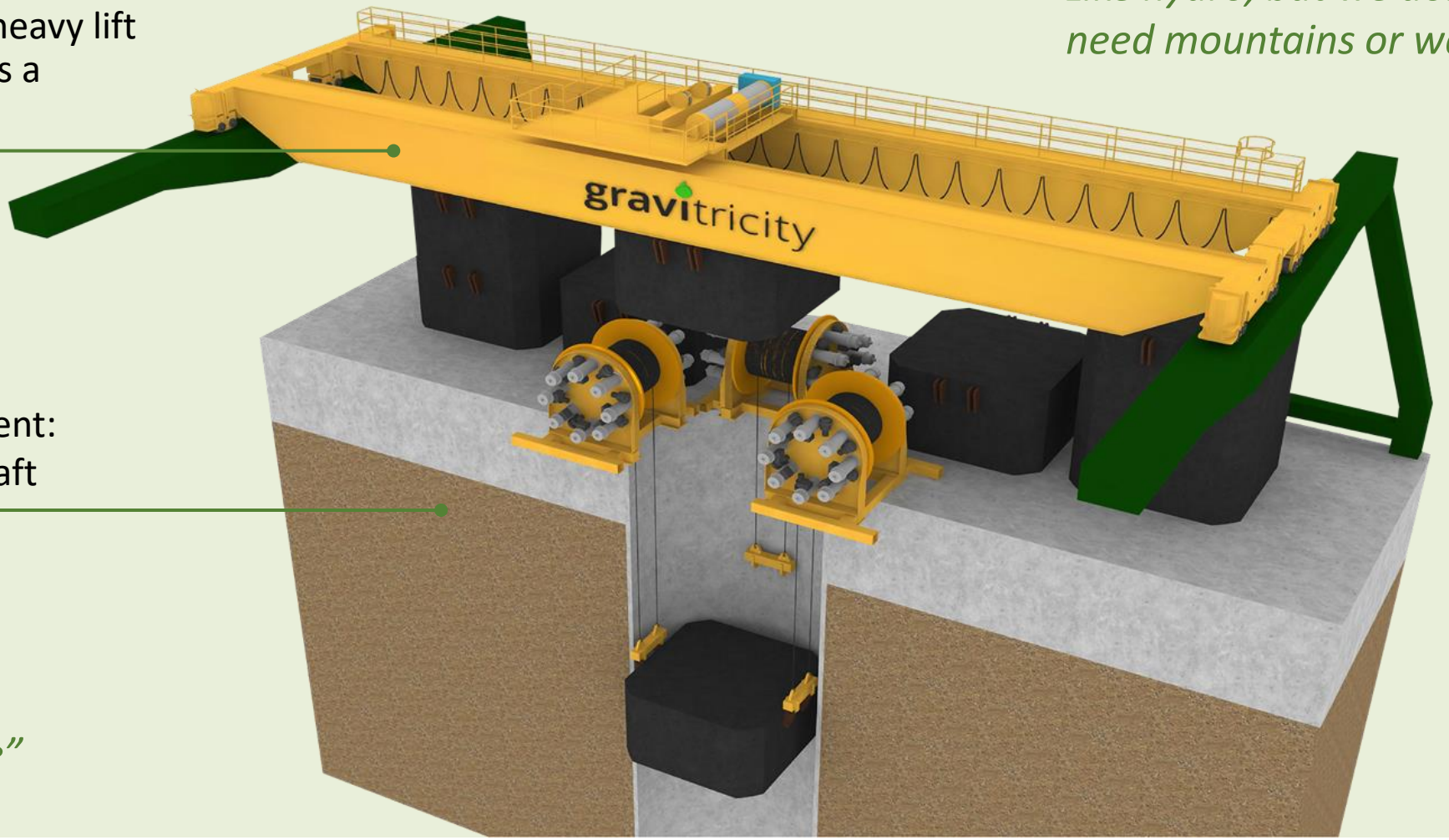
Gravitricity technology will be deployed in existing mines and purpose built shafts

Technology overview

gravitricity

Surface equipment – heavy lift equipment, working as a generator in reverse

"Like hydro, but we don't need mountains or water"



Underground equipment: Cables, weight and shaft

"New engineering, new integration, but not new science"

Design of technology underpinned by scientific principle

gravitricity

E=MGH… Energy = mass x gravity x height

2 design principles

Heavy weights

Tonnes?

Tens of tonnes?

Need weights in **hundreds of tonnes** to generate interesting amount of electricity

Big drops

Cranes?

Buildings?

Going underground allows us to use the **geology of the earth** to hold up the weight

Timeline of achievements and next steps…

gravitricity

2018-2021

>£3.5m — Total R&D funding

> £4m — Raised in equity funding

8 — Patents filed (5 granted, 3 pending)

2 — Independent studies by Imperial College London verifying levellised cost of storage over 25yrs below Li-ion, CAES, Flow batteries

1 — Grid connected, 250kW **Concept Demonstrator** validates technology capabilities (<s response, multi weight system)

2022-2024

1
Sub scale system –
1MW / 80kWh – short duration

2
4MW / 1MWh, single-weight system designed to optimise revenues from balancing services

3
Hydrogen storage deployment

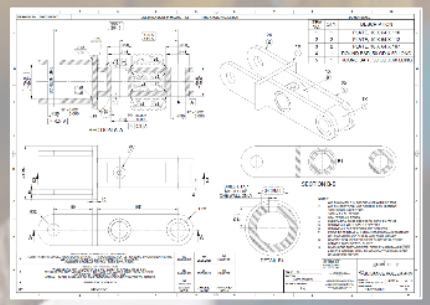
4
Fundraising!

250kW Scale Demonstrator – ‘Project Alpha’

gravitricity

Technical specifications	
Rated Power (import or export)	250kW
Weights	Two x 25t (50t total)
Weight composition	Magnadense with steel basket
Winches	2 x 125kW
Speed of response	<1 second

- Rapid Response
- High Efficiency
- Long Duration
- Grid Compliance
- Voltage Support

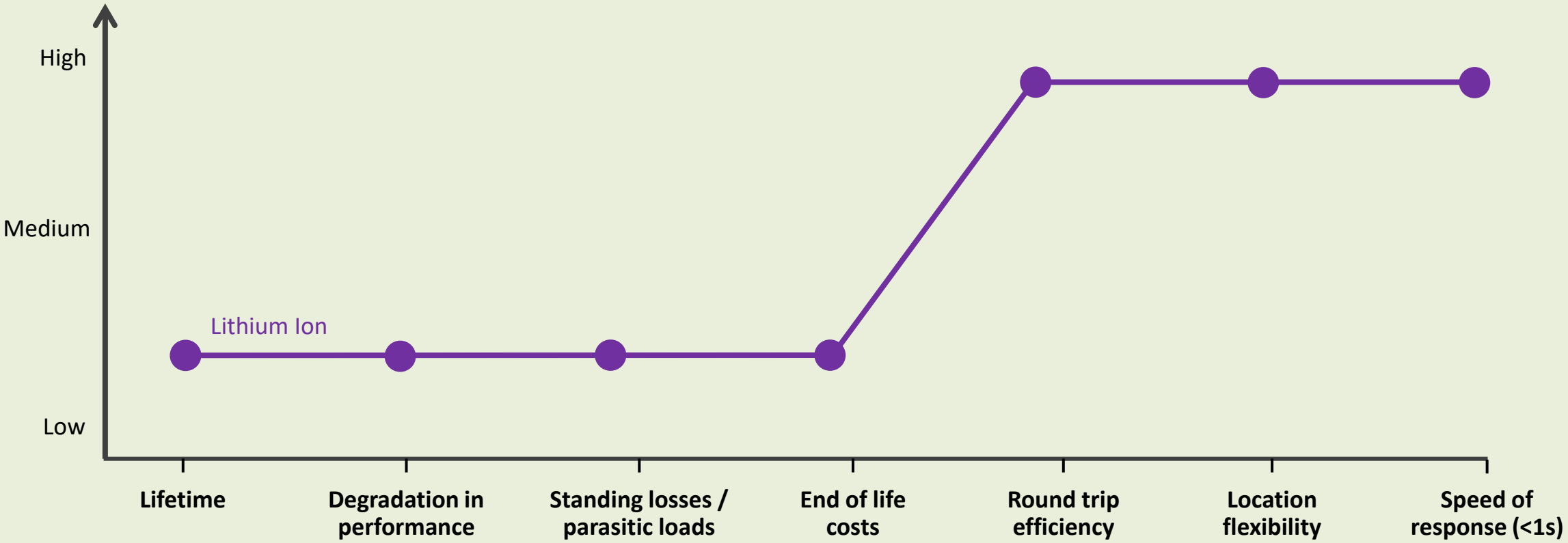


industrial systems and control

Huisman

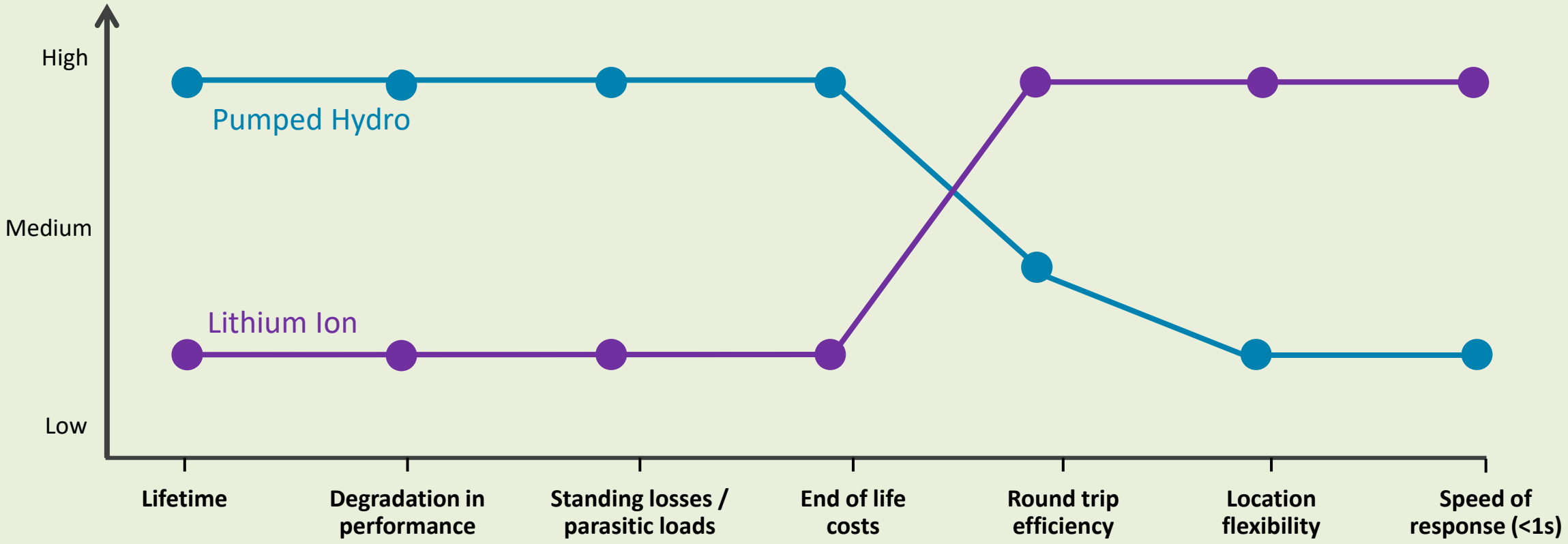
UKRI Innovate UK

Gravitricity vs. alternative ES technologies

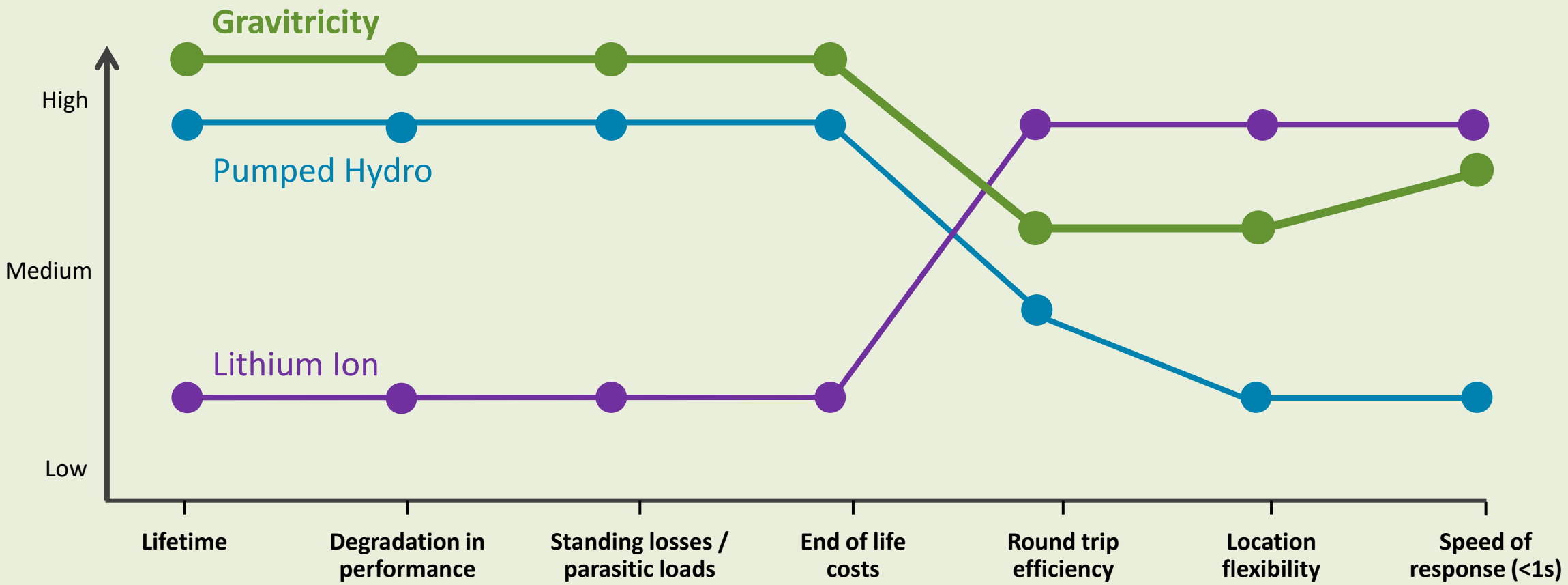


Gravitricity vs. alternative ES technologies

gravitricity



Gravitricity vs. alternative ES technologies

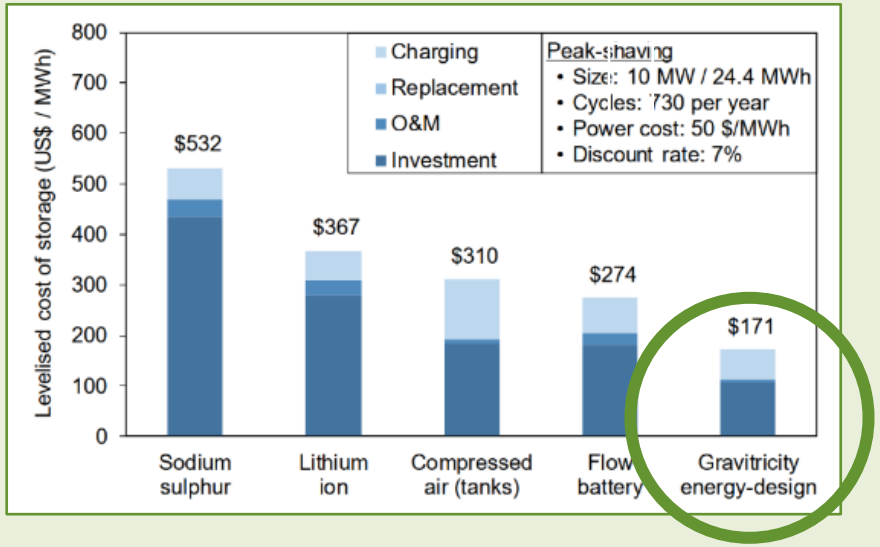


Competitors (2) – Gravitricity gravity energy storage

gravitricity

Feature set which equates to highly compelling commercial proposition

Category	Feature / benefit	
Economics	• High efficiency (up to 80% round trip) **with no cyclical degradation** • Long life (>25 years) • No standing losses or parasitic loads	✓
Performance	• Rapid response (<1s) for lucrative fast-response markets • Versatile energy / power ratio (15 mins – 8 hrs) • No depth of discharge limits • High power output without degradation	✓
Implementation	• Low embedded carbon footprint (no ore mining) • No explosive chemistry • Small physical footprint	✓



Ref: Report *Levelised Cost of Storage for energy-designed Gravitricity storage systems,* O Schmidt, **Imperial College. July 2019.**

LCOS = (Capex (initial) + Capex (replacement) + O&M + Charging cost) / units generated; n.b. no end of life costs are included

Long-life, reliable, energy storage for critical national grid infrastructure

Primary target markets: four distinct use cases

Balancing Services

Energy Access & Mini Grids

Solar co-location

Industrial decarbonisation

Demand drivers

Routes to market

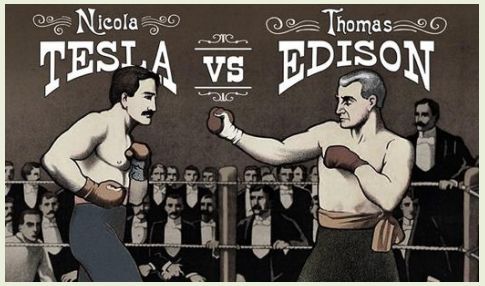
Technical requirements

Is Energy Storage a format war?

gravitricity

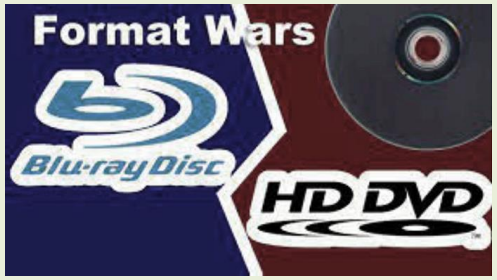
Format wars – one problem, two solutions

1890s



1980s

1990s



Is Energy Storage a format war?

1. At Gravitricity, we don't think so!
2. Identifying characteristic of energy storage is the variance in requirements:
   - **Duration**
   - **Energy & Power**
   - **Location**
   - **Conditions**
   - **High / low cycling**
   - **Importance of efficiency**
   - **Durability and longevity**
   - **Capex vs opex… and more**

Different requirements = different technology solutions

Key trends in large-scale Energy Storage

gravitricity

Key trends in global large scale energy storage market

Asset lifetime

- Growing vision of storage as an infrastructure asset, with associated requirements for asset lifetime
- Short term opportunism vs. long term strategic

Cycling frequency

- Storage increasingly used to balance fast changing, localised variations in supply & demand
- Fast changing = need high cycling

Storage duration

- Increased renewable penetration will drive need for longer duration energy storage – average duration of 1.8 hours in 2013 has already grown to 3.3 hours
- Ancillary services…
  daily peak shaving…
  solar & storage for 24/7 power

Value and opportunity will attach increasingly to flexibility services and technology solutions which can meet these evolving market needs

Robin Lane
Commercial Director
Robin.lane@gravitricity.com