

# Development and Scale Up of Fe-V RFB for Applications in MENA

أرامكو السعودية  
saudi aramco  
research & innovation



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where energy is opportunity™

# Green Initiative for carbon neutral planet

- KSA aims to transform its top oil economy into “a global leader in greener world.” – Saudi Green Initiative.
- Target 50% renewable generation by 2030; Deploy over 20GW solar by 2023; Carbon neutral by 2050.
- Demanding 100' GWh ESS that can stably operate in hot environment (up to 60°C).



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ  
الْحَمْدُ لِلَّهِ الَّذِي  
أَنْزَلَ هَذِهِ السُّورَةَ  
وَهُوَ أَعْلَمُ بِمَا  
يُخْفِي



# Promoting Green, Sustainability at Aramco



Increasing investments in Green energy;



Seeking sustainable power solutions to hundreds of off-grid and grid-connected power systems, e.g., cathodic protection, oil well, gas well, water injection, ....



Demanding multi-GW long duration ESS to replace Pb-acid, Ni-Cd, diesel, etc.



ESS required of long cycle life and stable operation in an environment with ambient temperatures up to 60°C

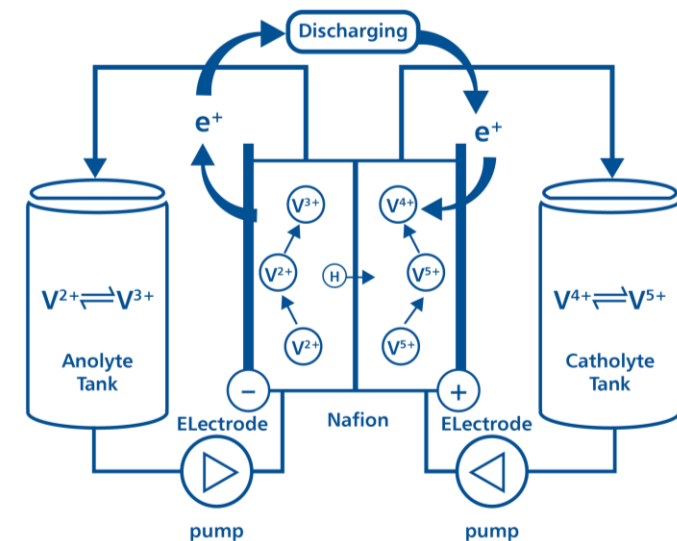


# V base RFB offers a good fit for applications at Aramco and MEA

- Excellent reversibility – over 20,000 charge/discharge cycle life – allowing multiple-cycles a day
- 0~100% SOC - 100% access to rated capacity over life
- No degradation over 25 years
- Demonstrated at scales up to 100MW by RKP and others
- Inherent safe and capable of long durations
- Field-tested @ 55° Celsius ambient temperature

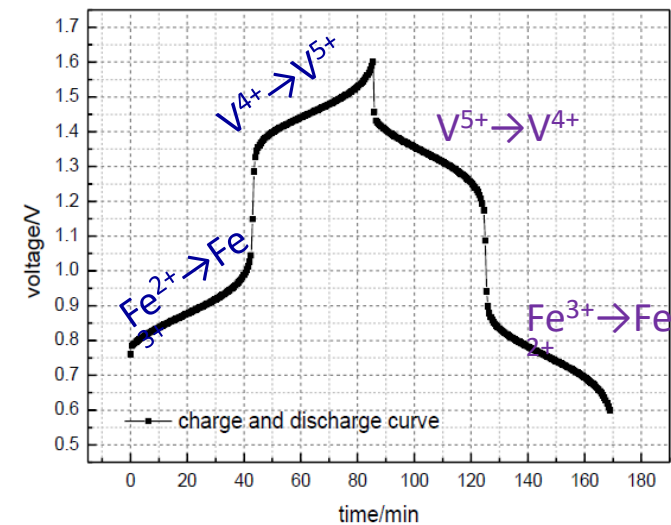
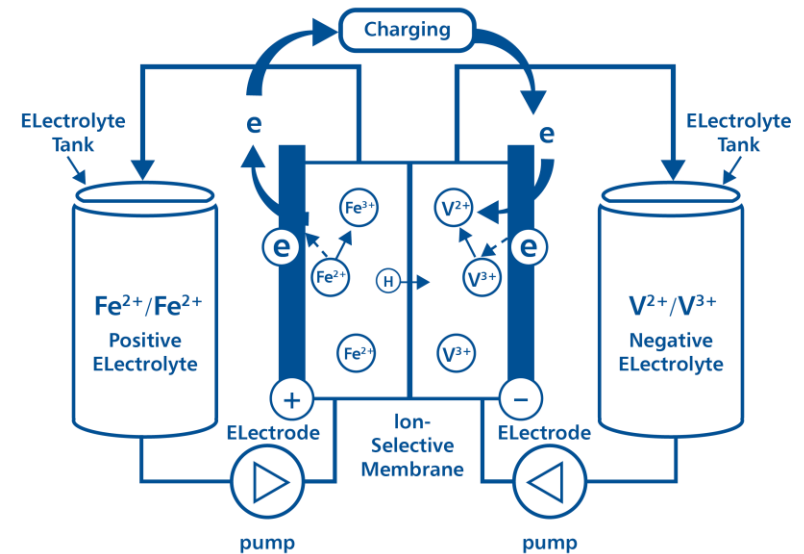


200MW/800MWh



# Fe-V RFB - Further improving temperature capability, reducing cost, ...

- $V^{4+}/5+$  and  $Fe^{2+}/3+$  on cathode-side, only  $V^{2+}/3+$  on anode-side
- Excellent reversibility – unlimited cycle life, as V-V RFB
- Limited  $V^{4+}/5+$ , allowing up boundary operation temperatures to 55°C or higher
- 100% V utilization, reducing cost
- Potential use of less-expansive membranes or separators



# Development of D-Power products



Present varied products developed and under development, and highlight features.



# Technology Roadmap



Deployment at gas well site



# Official Announcement



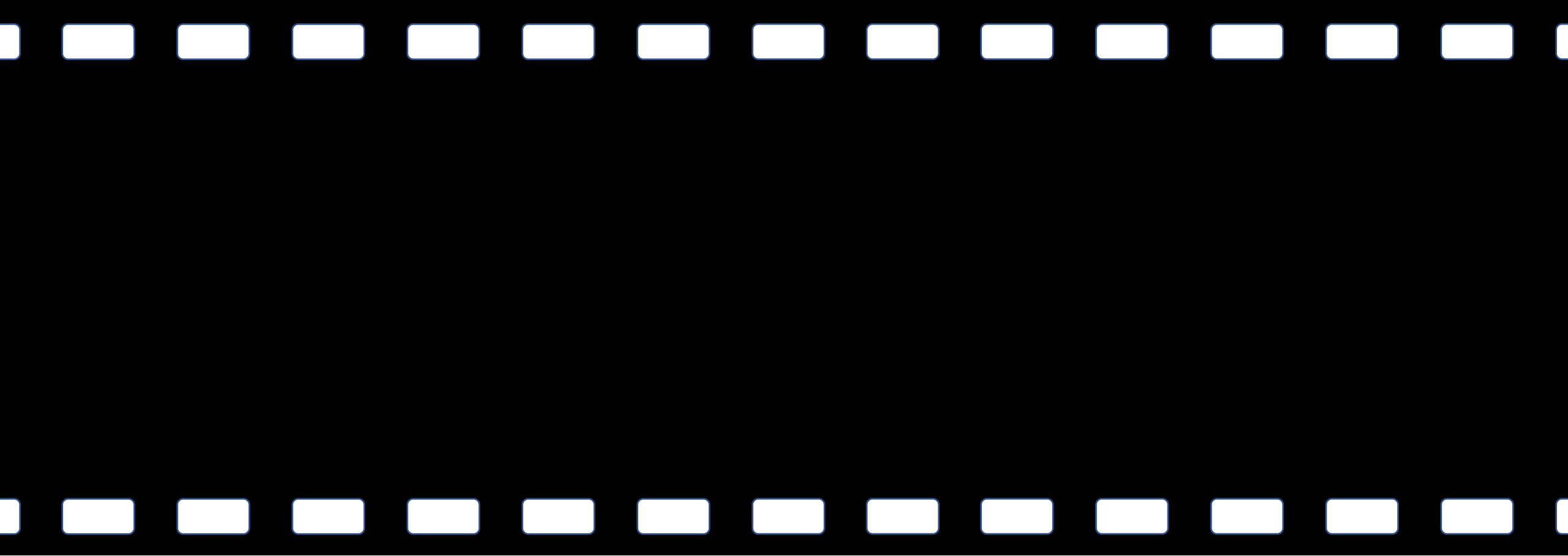
Our patented Iron-Vanadium flow battery, developed with Rongke Power, supports gas operations by improving solar reliability in remote areas and enabling more ... more

Aramco achieves world-first with commissioning of megawatt-scale flow battery to store renewable energy for gas operations

- Delivers the first-ever 1-megawatt-hour Iron-Vanadium (Fe/V) flow battery system for gas production
- Operates in temperatures from -8°C to 60°C without additional thermal management systems
- Uses liquid electrolytes with minimal fire risk compared to other battery systems, and has lower capacity loss after repeated cycles
- Supports up to five wells over its projected 25-year lifespan with a modular design suited for isolated sites

- Technology is potentially a flexible and cost-effective energy solution for a variety of industrial applications
- The new (Fe/V) flow battery commissioned by Aramco aligns with the company's focus on renewables investment and energy efficiency, as part of its ambition to achieve net-zero Scope 1 and Scope 2 greenhouse gas emissions across its wholly-owned operated assets by 2050
- Deployment paves way for further integration of renewable power to support emissions-reduction ambition

# THE NOVELTY'S BEEN WIDELY APPRAISED



# Commercializing via Global Partnership



Research &  
Development



Customized Design,  
Optimization,  
Demonstration



Manufacturing, with  
local resources In  
KSA

# From Lab to Load – RKP’s role in delivery

## »»» 1. Custom Engineering

- Lab research of Fe-V electrolyte developed with ion balancing design
- RKP proven platform architecture ensures system reliability
- IP65-rated enclosure and optimized thermal management

## »»» 2. QA/QC in Delivery and Integration

- Full routine testing and Factory Acceptance Testing (FAT) accordingly to RKP standards & procedures
- High-temperature environmental testing in lab and verification at customer site
- Design validated by RKP internal engineering team — aligned with project targets by customer

## »»» 3. Execution & Delivery



- Designed, tested and grid-ready in 9 months — from chemistry to containerized integration
- Delivered as fully integrated containerized system
- No staging required—single-phase deployment



## RKP – Collaboration with Aramco on VFB

### »»» 4. RKP as a Trusted Partner

- Delivered to Saudi Aramco's performance expectations for harsh environments
- Ongoing on-site service and spare part support

### »»» 5. Customer Value Delivered

- ✓ On-time engineering and deliver through RKP professional expertise
- ✓ Safe engineered product design based on proven RKP expertise
- ✓ Cost-effective and future proof design to allow scalable installations, etc,
- ✓ Performance and reliability proven by field installation and testing



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**RKP**

**Thank you.**